

# 2012 Montana State University Research Plan of Work

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## I. Plan Overview

### 1. Brief Summary about Plan Of Work

**Situation:** Montana is a rural state with 93 million acres and a population of 975,000. The state has over 29,000 farms and ranches representing over 66% of its land. Montana ranks 2<sup>nd</sup> in the U.S. in acres devoted to agricultural enterprises with annual crop and livestock cash receipts of over \$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 barley and flaxseed. Montana ranks 3<sup>rd</sup> among states exporting wheat and wheat products. Montana's production of lentils in 2010 was up 130% from 2009 with planted acreage reaching 260,000 acres. Wheat and barley represented about 44% of the 2009 total agricultural receipts. Flax acreage in 2010 increased by 37% and production increased by nearly 60% over 2009. Camelina (*Camelina sativa*) production in Montana increased 35% in 2010 to 255,000 bushels. New contracts with biodiesel producers in 2010 encouraged growers to consider camelina as a viable alternative to other dryland crops. The value of Montana's agricultural exports during fiscal year 2009 totaled \$1 billion, a decrease of \$329 million versus 2008. The state's livestock industry represents over \$1.5 billion in cash receipts annually and is one of the largest industries in the state. Montana ranks 11<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 89% of the livestock receipts for the state and 49% of the total agricultural receipts in 2009.

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, and other industries in Montana by the latter half of the 21<sup>st</sup> century. U.S. programs that address carbon sequestration and reduction of greenhouse gasses are important projects for MSU researchers.

Dedication of the new 40,000 square foot Animal Bioscience Building occurred in fall of 2010 representing several years of construction and extensive fundraising. The complex represents the most important project to affect and benefit Montana's livestock industry in decades and provides advanced research laboratories, support rooms, and classrooms. The new facilities give students access to the latest in research, teaching, and outreach in animal and range sciences. Private funds accounted for over 50% of the financing followed by support from the State of Montana, exemplifying stakeholder support for our research and teaching programs.

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 the Montana Agricultural Experiment Station (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. Native American students enrolled in the College of Agriculture (COA) comprise about 7% of an increasing

number of Native American students earning degrees at MSU.

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 of the results of MSU's research and outreach activities will increase in importance and impact. The COA has made a major effort in 2010 to increase the availability of reports and research documents on our web site.

**Priorities:** As a result of stakeholder input meetings, focus groups, and 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 effective livestock disease control methods
- 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 developing improved management practices in crop production, IPM, livestock production, natural resources, nutrition and health, food safety, global food security, and range 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, Center for Invasive Plant Management Board, Center for Invasive Plant Management Science Advisory Council, Central Agricultural Research Center Advisory Committee, Assistant Dean's Student Advisory Council, Eastern Agricultural Research Center Advisory Committee (MonDak Region), Equine Advisory Committee, Foundation Seed Advisory Committee, MAES State Advisory Council, 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, Northwestern 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, grants, USDA, USEPA, and USFS.

**Outcomes and Impacts:**

Enhance Economically Viable and Sustainable Agricultural Systems

- Address childhood obesity by enhancing the nutrient content of small grains and developing value-added crops
- Contribute to commodity and product marketing and economic development
- Create comprehensive programs that address challenges 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 IPM and other sustainable practices
- Improve the fundamental understanding of plant and animal biology
- Improve value-added crops for sustainable energy production

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 information delivery systems
- Improve recruitment and retention of students

Each of the seven agricultural research centers holds annual field days in cooperation with USDA-ARS and allied communities 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**

**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, especially 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. Research models and projects are being developed to evaluate several scenarios to ensure that crop and livestock producers and land managers have timely and accurate information. Developing crop cultivars that are more resistant to drought conditions will be required in areas of limited water resources.

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

**Research Activities:** 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 the adaptation of flora growing and microbial species in or near the hot springs in YNP. Understanding the mechanisms of growth of organisms and 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. By understanding the relationships among agriculture-biofuel production, carbon sequestration, and natural resource conservation, as well as traditional commodity production, Montana agricultural producers can react effectively and sustainably to the demands of climate change. 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.

An MSU project is developing data to produce scientific publications and information for the general public that will improve the ability of public decision-makers to formulate policies regarding climate change and greenhouse gas mitigation. Additional projects are investigating the potential for soil carbon sequestration in rangelands and crops. MSU will offer two non-credit courses in 2011 that address current events and global issues in climate change.

## **Program #2** **Food Safety - 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 interactions with wildlife) has led to advances in genetics, improved performance, and increased reproduction success. 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.

**Priorities:** Disease management and research programs that increase the quality of meat, milk, and fiber products continue to be high research priorities. Animal losses due to environmental stresses, disease, and death create the need for an improved understanding of the factors affecting Montana livestock. MSU studies help ensure that Montana producers raise safe beef while improving the quality of the beef that is raised. Research and educational programs will continue to address the animal health, biosecurity, and production efficiencies concerns expressed by producers and consumers. Extension and research efforts have resulted in outreach programs that include beef quality education, feeder calf health certification, and information return and management from the packing plant.

**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: Northern Agricultural Research Center Advisory Committee, 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 benefit all Montana livestock producers. The Immunology and Infectious Disease unit at MSU is the only research entity in Montana focused on animal health, particularly the study of infectious

diseases of cattle. Viral pneumonias cause substantial morbidity and mortality in the cattle industry creating a need to develop effective vaccines for these diseases. 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.

Infectious diseases caused by coccidian parasites, such as *Eimeria* spp., 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. Rotavirus is the most important viral agent of neonatal diarrhea and generally affects calves less than six weeks of age. We are investigating new vaccines that have potential to develop into effective controls of these agents. Mastitis remains one of the most serious diseases of the dairy industry costing the U.S. dairy industry billions of dollars per year. Current therapeutics often fail to completely eliminate the infection and available vaccines have low efficacy. MSU researchers are developing a better understanding of mammary defense mechanisms to establish effective therapies. 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 and to improve our understanding of how the agents are transmitted within the host. Brucellosis (*Brucella abortus*) remains a threat to the health and well-being of livestock in Montana, Idaho, and Wyoming. Cohabitation of infected wildlife (especially elk) with cattle has compromised Montana's brucellosis-free status. Controversies surrounding the migration of bison and the potential contact with cattle have created a need for a brucellosis vaccine for bison. Studies have produced new subunit and live vaccines that are 75% effectively in bison and about 70% protective in domestic cattle. MSU researchers are working to develop a better vaccine, but their efforts are complicated by the fact that *Brucella abortus*, the bacteria that causes brucellosis, is closely watched and controlled by the federal government for fear that it could be used in a biological attack. That makes testing vaccines difficult, since researchers cannot run tests on large animals or on a large scale.

Beef cattle owned by the MAES will be used to develop new reproductive, genetic, and nutrient management strategies for rangeland-based animal agriculture. 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 disease resistance and increased production. The sustainable beef supply (SBS) program was established to return additional revenue and provide current information to cattle producers while meeting consumer needs in Montana and the nation. The SBS uses its resources to undertake research and educational issues that are of immediate concern to Montana beef producers (biosecurity, beef quality assurance, animal verification, feed efficiency). With the SBS program in place, Montana producers can more easily adapt to the global marketplace.

Projects between the Montana Wool Growers Association and MSU are dedicated to developing and implementing non-traditional strategies that increase the competitiveness of Montana's lamb and wool in the world market. Neonatal lamb mortality is a major source of lost income to the U.S. sheep industry. Our research has focused on nutritional strategies during late gestation that may impact fetal survival and immune functions. Approximately 80% of the US wool clip is exported. A particularly attractive area for fine wool producers in the U.S., such as the specialty wool undershirt market, requires sorting fleece lines finer than 18.5 microns to take advantage of price premiums. Research is being conducted to determine the practicality of using the OFDA2000 measuring system to rapidly determine the size of fibers and to sort out those individual sheep who produce more of the finer fibers.

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. Traceability of livestock through the production chain can add substantially to the cost of production. Methods are being developed that facilitate traceability of livestock at minimal additional expense to the producer while enhancing the benefits associated with participation in animal identification programs. Tracking will provide both source and process verification for easy trace-back in case there is a disease outbreak. A major effort is being directed to find alternative solutions to reducing the cost of animal identification technology. 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.

Educational programs on beef quality assurance (BQA) practices, voluntary beef cattle marketing options, and ranch management issues are offered throughout the state via meetings and interactive technologies. Programs that focus on management, nutrition, and health maintenance have been developed that provide cow-calf producers in Montana the tools to produce safe beef and improve the quality of that beef.

### **Program # 3** **Food Safety - 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.

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 policies. 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:** 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. Our long-term strategies are designed to ensure that Montana agricultural products are more desirable in U.S. and world markets. 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 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, the Montana Wheat and

Barley Committee, the Organic Certification Association of Montana, and state agricultural advisory committees. The increasing use of computer modeling and surveys also add to data being collected. The Montana Wheat and Barley Committee provide 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 check-off 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. 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 grasses, 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 (*Camelina sativa*) have been developed, and new uses for camelina oil and meal are being evaluated. As camelina acreage grows, the need for new varieties becomes apparent in order to meet the need for renewable and clean sources of industrial lubricants. Over 150 available accessions of camelina have been screened for fatty acid profile, total oil content, and total glucosinolate content. Oilseed crops continue to represent important new sources of income for farmers and provide opportunities for increasing crop diversity. The development of value-added high oleic and high linoleic safflower varieties is a current project that will increase crop sustainability and provide new products to commercial producers of edible oil, cosmetics, biofuel, birdseed, supplemental fat for livestock rations, and other end-use U.S. and foreign markets. Research information on water utilization and management in the Northern Rockies is very limited. We are currently evaluating riparian protection as one of our primary tools to protect and promote water quality in pristine, agricultural, and impacted watersheds. 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. 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. Two major initiatives address the needs of Montana livestock producers: targeted grazing (TG) and sustainable beef supply (SBS). The primary objective of TG is to develop and implement non-traditional strategies that will increase the competitiveness of Montana lamb and wool in world markets. 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. Ranching enterprises are 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.

#### **Program # 4 Global Food Security and Hunger - Integrated Pest Management (IPM)**

**Situation:** Weeds, diseases, and insects continually challenge Montana producers who are often already producing crops under less than ideal conditions. 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 to promote sustainable practices utilizing biological controls. Difficult-to-control pests require producers and researchers to evaluate new 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 are priorities 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 state funding, 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, Sustainable Agriculture Research and Education (SARE) 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 on-going interaction with chemical and biological pest control product manufacturers, state and federal agencies, and researchers in other states.

**Research Activities:** Currently, large areas of the West, including Montana, are infested with invasive Dalmatian toadflax. Targeted sheep grazing is an economical and ecologically sustainable tool available to manage lands with large infestations of invasive plants. One of our goals is to reduce pesticide use in grain farming operations, especially reduced tillage operations, while maintaining or improving grain production profitability. Sheep grazing protocols and projects have been developed involving 1,000 private landowners, county weed supervisors, and public agencies.

Biological controls, including *Muscodora albus* and other agents, are being evaluated in soilborne, foliar, and viral disease IPM programs for potatoes and sugarbeets. Incorporating biopesticides into insect management strategies helps to conserve natural enemies and pollinators.

The wheat stem sawfly (*Cephus cinctus*) is one of the most important insect pests of agronomic crops in Montana and cannot be effectively managed using conventional tools or agricultural practices. Current management is based primarily on the adoption of solid-stem cultivars that offer partial resistance. Research activities include investigating the sawfly's chemical ecology, and evaluating host plant resistance, pathogens, and cropping strategies.

Lepidopterous insects represent one of the largest insect pest groups of food and fiber crops worldwide. Sex pheromones have been identified from hundreds of moth species and are used in IPM programs as lures to monitor and trap pest species and to disrupt mating. One research study will identify and characterize the odorant receptor proteins from male moth antenna that detect the female produced sex pheromone.

Research is directed at obtaining a better understanding of the diversity, distribution, and activities of pollinators (including alfalfa leafcutter bees) in natural and agricultural ecosystems. The goal of this project



is gain a better understanding of the value of pollinator and predatory insects in agricultural and natural ecosystems, the effect of land management practices on these insects, and the basic biology of certain understudied groups. Screening of honeybee samples has led to a greater understanding of the pathogens infecting honeybees in the region and nationally.

Preserving the quality of grain during storage includes the management and control of insect pests. A multistate partnership focuses on insecticidal and non-insecticidal approaches 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. We are working to develop more environmentally friendly and lower cost mosquito management systems that include the use of ultra-low-volume (ULV) applications.

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 pests of small grains, including weeds. The multi-entry key has been linked to fact sheets containing information on the biology and ecology of agricultural weeds and invasive species improving the management and delivery of IPM programs across the region. Management of weeds in rangeland include research in several management areas, including prevention, chemical, mechanical, and biological control, prescribed burning, and revegetation.

Natural enemy efficacy studies against invasive weeds will determine the ecological and physiological basis for insect-host interactions. Identification and testing of various arthropods continues for the biological control of hoary cress, field bindweed, rush skeletonweed, houndstongue, Russian knapweed, tansy ragwort, and invasive hawkweeds. A better understanding of biological controls and their implementation will be achieved by monitoring the impacts associated with these biological control agents. MSU's Seed Laboratory provides testing services for State and Federal agencies, private seed companies, farmers, and ranchers to provide information on seed quality. The service provided by the Laboratory helps maintain high quality in the seed industry throughout the Rocky Mountain region and the Great Plains.

#### **Program # 5 Global Food Security and Hunger - 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 to 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. Additional work in the development of alternative crops continues to produce new market opportunities. Initiatives will provide new insights into food safety and risk assessment.

**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, improving wheat resistance to sawfly, and enhancing 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. 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 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.

The development of new, highly nutritious crop cultivars with characteristics that improve health and well-being are priorities at 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:** 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 grants and proposals are received from the Montana Wheat and Barley Committee. We apply for PVP Title V status on all released wheat and barley cultivars, which in turn increases revenues for research. 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:** 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. Developing hard red spring wheat cultivars with excellent qualities will 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.

MSU COA researchers cooperate with entrepreneurs in the state to develop value-added wheat products for use in Montana and exported flours, pasta, baked goods, and organic products. 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. Research projects address the effects that modifying the starch biosynthetic pathway have 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. barley cultivars with improved feed quality provide regional grain producers a marketing opportunity directed to beef producers.

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 with applications in drug delivery and in Magnetic Resonance Imaging (MRI). These discoveries significantly contribute to our long-term goal of producing new therapeutic treatments using plant virus nanoparticles with direct benefits for human and plant health.

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.

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. 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 with companies that have expertise in incubating new and existing products and businesses.

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 trans fats, and over 80% oleic acid. Nutrasaff, a high linoleic safflower (80%) with high seed oil content (46-48%), high meal protein (37-39%), and reduced meal fiber (25-26%) 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.

## **Program # 6**

### **Sustainable Energy**

**Situation:** The development of bio-based alternative 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, long-term opportunities continue to be promising. 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 (camelina, safflower, canola, and soybeans) 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 stakeholder meetings are 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 and reduce our reliance on non-renewable energy sources. The primary objective of our research is to develop value-added, agriculturally-based end-use products 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) establishing biobased product and food science education and research; and (4) conducting outreach activities related to biobased products and food science for producers and agribusiness.

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. 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, such as barley straw. 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. We are continuing to evaluate barley straw as a feed stock in ethanol production. Barley straw contains a large quantity of fructan (polymers of fructose). It is our hope that this process will permit on-farm straw-to-ethanol production for regional barley growers.

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

| Year | Extension |      | Research |      |
|------|-----------|------|----------|------|
|      | 1862      | 1890 | 1862     | 1890 |
| 2012 | 0.0       | 0.0  | 339.1    | 0.0  |
| 2013 | 0.0       | 0.0  | 339.1    | 0.0  |
| 2014 | 0.0       | 0.0  | 339.1    | 0.0  |
| 2015 | 0.0       | 0.0  | 339.1    | 0.0  |
| 2016 | 0.0       | 0.0  | 339.1    | 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 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, 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. We have changed the method for data collection on FTE. This accounts for the large change in FTE between last year and this year.

### **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 State(s)?**

Montana has a small population and an even smaller number 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. In 2010, a USDA Civil Rights Review team conducted a MAES audit that was uniformly positive, with some areas for improvement.

#### **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. 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-\$5 million in revenue per year to the Montana economy. 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.

#### **4. How will the planned programs result in improved program effectiveness and/or**

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 State 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, 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. The 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

| S. No. | PROGRAM NAME   |
|--------|--|
| 1      | Climate Change   |
| 2      | Food Safety -- Animal Health   |
| 3      | Food Safety -- Sustainable Agriculture                                   |
| 4      | Global Food Security and Hunger -- Integrated Pest Management            |
| 5      | Global Food Security and Hunger -- Plant Breeding, Genetics and Genomics |
| 6      | Sustainable Energy   |
| 7      | Childhood Obesity  |



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

### **Program # 1**

#### **1. Name of the Planned Program**

Climate Change

#### **2. Brief summary about Planned Program**

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

#### **Research Activities:**

Educational programs are being established as an introduction to the aspects of global climate change and its implications for agriculture. Agriculture has the potential to contribute to mitigation of climate change by sequestering carbon in soils. One MSU project is developing data to produce scientific publications and information for the general public that will improve the ability of public decision-makers to formulate policies regarding climate change and greenhouse gas mitigation. Additional projects are investigating the potential for soil carbon sequestration in rangelands and crops. Studies are in place to learn more about seasonal patterns and cumulative N<sub>2</sub>O emissions from agricultural soils in the Northern Great Plains under different cropping systems, water regimes, crop residue levels, and nitrogen fertility rates. MSU researchers will look at how climate change and human activities have altered fire activity in areas with different climates, especially in sensitive forests in the U.S., Australia, and New Zealand.

**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 |
|---------|--|-----------------|-----------------|----------------|----------------|
| 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

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 climate change. Crop production in the U.S. is especially vulnerable where diminished water resources place constraints on crop growth. Priorities at MSU are established to investigate how climate change may affect crop production, range management, and forestry management over the next fifty years. Models and research projects are being established to evaluate several scenarios to ensure that producers and land managers have timely and accurate information. By 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.

2. Scope of the Program

- In-State Extension
- In-State Research

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

1. Assumptions made for the Program

- Corporate funding organizations, grain and livestock associations, companies, and other agencies will continue to provide input into priorities and activities
- Full-time 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

- Develop drought tolerant crops suitable for growing in warmer and drier climates
- Develop carbon sequestration programs that utilize new technologies
- Identify plant mechanisms that allow plants to grow in geothermally-modified soils

**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 |
| 2012 | 0.0       | 0.0  | 9.7      | 0.0  |
| 2013 | 0.0       | 0.0  | 9.7      | 0.0  |
| 2014 | 0.0       | 0.0  | 9.7      | 0.0  |
| 2015 | 0.0       | 0.0  | 9.7      | 0.0  |
| 2016 | 0.0       | 0.0  | 9.7      | 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 other than eXtension</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)**

NIFA no longer requires you to report target numbers for standard output measures in the Plan of Work. However, all institutions will report actual numbers for standard output measures in the Annual Report of Accomplishments and Results. The standard outputs for which you must continue to collect data are:

- Number of contacts
    - Direct Adult Contacts
    - Indirect Adult Contacts
    - Direct Youth Contacts
    - Indirect Youth Contact
  - Number of patents submitted
  - Number of peer reviewed publications
- Clicking this box affirms you will continue to collect data on these items and report the data in the Annual Report of Accomplishments and Results.

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

#### **1. Output Measure**

- Number of research citations
- Clicking this box affirms you will continue to collect data on these items and report the data in the Annual Report of Accomplishments and Results.

**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**

**2012:1                      2013:1                      2014:0                      2015:1                      2016:0**

**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**

**2012:1                      2013:1                      2014:0                      2015:0                      2016:1**

**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 full-time 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 - Planned Evaluation Studies**

### **Description of Planned Evaluation Studies**

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

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

### **Program # 2**

#### **1. Name of the Planned Program**

Food Safety -- Animal Health

#### **2. Brief summary about Planned Program**

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. 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.

#### **Research Activities:**

Specific projects have been established to investigate diseases and animal productivity in cattle, sheep, and bison. Bison research continues to focus on the development of efficacious brucellosis vaccines. The bacteria that causes brucellosis, *Brucella abortus*, is federally controlled making testing vaccines on large animals difficult. Studies have produced new subunit and live vaccines that are 75% effective in bison and about 70% protective in domestic cattle. A better understanding of the mechanisms involved in the spread of brucellosis directly addresses concerns of cattle producers in areas near YNP and could aid in the management of bison and elk by YNP wildlife managers. MSU investigators are providing use of our research facility to undertake these studies and offering assistance in conducting the immune evaluations.

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. 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. 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.

Methods are being developed that facilitate traceability of livestock at minimal additional expense to the producer while enhancing the benefits associated with participation in animal identification programs. A major effort is being directed to find alternative solutions to reducing the cost of animal identification technology.

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 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.



**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  |                 |                 | 5%             |                |
| 302     | Nutrient Utilization in Animals  |                 |                 | 5%             |                |
| 303     | Genetic Improvement of Animals   |                 |                 | 10%            |                |
| 307     | Animal Management Systems  |                 |                 | 10%            |                |
| 311     | Animal Diseases  |                 |                 | 30%            |                |
| 315     | Animal Welfare/Well-Being and Protection   |                 |                 | 10%            |                |
| 503     | Quality Maintenance in Storing and Marketing Food Products   |                 |                 | 5%             |                |
| 711     | Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources |                 |                 | 5%             |                |
| 902     | Administration of Projects and Programs  |                 |                 | 5%             |                |
| 903     | Communication, Education, and Information Delivery   |                 |                 | 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) 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

Food safety and biosecurity have become concerns for the beef industry at all production levels. 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.

**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
- Full-time 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
- Produce livestock products that are safe, nutritious, and in sufficient quantity to meet the needs of U.S. and world consumers
- Develop traceability methods for livestock producers to comply with mandated requirements in source tracking

**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 |
| 2012 | 0.0       | 0.0  | 124.7    | 0.0  |

| Year | Extension |      | Research |      |
|------|-----------|------|----------|------|
|      | 1862      | 1890 | 1862     | 1890 |
| 2013 | 0.0       | 0.0  | 124.7    | 0.0  |
| 2014 | 0.0       | 0.0  | 124.7    | 0.0  |
| 2015 | 0.0       | 0.0  | 124.7    | 0.0  |
| 2016 | 0.0       | 0.0  | 124.7    | 0.0  |

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

**1. Activity for the Program**

- Create databases that are easily accessible by researchers and producers in order to make research results readily available
- Distribute papers and research results at state nutrition conferences, field days, county meetings, and state conventions
- Prepare research articles, fact sheets, and news releases for scientists and state media
- Hold strategic planning meetings with state agricultural groups
- Develop systems that ensure food safety and agricultural security
- Conduct training in cooperation with Montana BQA 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 other than eXtension</li> </ul> |

**3. Description of targeted audience**

- State agencies, animal health companies, and state commodity groups
- Ranchers, seedstock industry, colleagues, and related stakeholders
- Crop and livestock producers in Montana

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

NIFA no longer requires you to report target numbers for standard output measures in the Plan of Work. However, all institutions will report actual numbers for standard output measures in the Annual Report of Accomplishments and Results. The standard outputs for which you must continue to collect data are:

- Number of contacts
    - Direct Adult Contacts
    - Indirect Adult Contacts
    - Direct Youth Contacts
    - Indirect Youth Contact
  - Number of patents submitted
  - Number of peer reviewed publications
- Clicking this box affirms you will continue to collect data on these items and report the data in the Annual Report of Accomplishments and Results.

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

### **1. Output Measure**

- Number of research citations
- Clicking this box affirms you will continue to collect data on these items and report the data in the Annual Report of Accomplishments and Results.

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

| <b>O. No</b> | <b>Outcome Name</b>  |
|--------------|--|
| 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      |
| 6            | Number of producers that participate in livestock tracking programs                                  |

**Outcome # 1**

**1. Outcome Target**

Identify critical infection and resistance processes

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

**2012:1                      2013:1                      2014:1                      2015:1                      2016:1**

**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**

**2012:10                      2013:10                      2014:10                      2015:10                      2016:10**

**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**

**2012:0                      2013:0                      2014:0                      2015:1                      2016:0**

**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**

**2012:1                      2013:1                      2014:1                      2015:1                      2016:1**

**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**

**2012:1                      2013:1                      2014:1                      2015:1                      2016:1**

**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

**Outcome # 6**

**1. Outcome Target**

Number of producers that participate in livestock tracking programs

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

|                |                |                |                |                |
|----------------|----------------|----------------|----------------|----------------|
| <b>2012:10</b> | <b>2013:20</b> | <b>2014:20</b> | <b>2015:30</b> | <b>2016:30</b> |
|----------------|----------------|----------------|----------------|----------------|

**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.)
- 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 full-time 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 - Planned Evaluation Studies**

### **Description of Planned Evaluation Studies**

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

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

### **Program # 3**

#### **1. Name of the Planned Program**

Food Safety -- Sustainable Agriculture

#### **2. Brief summary about Planned Program**

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. The development of high-value food, feed, and biofuel crops involves close collaboration among research and extension faculty in Montana and in neighboring states.

**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 and 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 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

| KA Code | Knowledge Area  | %1862 Extension | %1890 Extension | %1862 Research | %1890 Research |
|---------|---|-----------------|-----------------|----------------|----------------|
| 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

Montana is a rural state with a land area of 93 million acres and a population of 975,000. It has a strong crop and livestock industry with annual receipts of over \$3 billion. Small grains represent about 68% of the cropped acres. It has limited crop and livestock diversity due to its semi-arid climate, a short growing season, and the potential for long, severe winters. Cattle and sheep are the primary livestock enterprises; small grains, forages, and short season specialty crops make up the bulk of the cropping activity. Agricultural cash receipts in Montana are made up of roughly a 55:45 mix of livestock and crops respectively. In addition, Montana is world-renowned for the quality of its wheat and beef cattle.

A basic principle of sustainable agriculture is to investigate current agricultural practices and find economically feasible and environmentally friendly alternatives to current agricultural practices. These include optimizing the use of chemicals for pest control, using alternative tillage systems, and increasing crop diversity. Goals of sustainable agriculture are to reduce dependence on non-renewable resources (such as fuel, fertilizer and pesticides), to promote stable and more prosperous farming communities, and to provide more farm income. With the continuing rise in fuel prices, farming practices that reduce dependence on fuel will add to the profitability of the enterprise. This factor alone provides incentives to farmers to investigate sustainable agricultural methods. The effects of MSU research in sustainable agriculture have an immediate impact on crop and livestock planning. A shift to more efficient and profitable specialty crops has begun and will continue to generate major interest in the future. The use of the internet for information dissemination has become an increasingly valuable tool in providing stakeholders with materials to assist in their decision-making. While meetings, interviews, and focus groups will continue to be used to gather information from stakeholders, the increasing use of computer modeling and surveys will add to data being collected.

MSU priorities are to:

- Conduct research to determine the feasibility of growing a variety of value-added crops including: pulse crops (peas, lentils, chickpeas, and soybeans), herbs, mustard, safflower, sunflower, canola, turf, and specialty grains
- Create better grazing management in concert with the preservation of riparian habitats, wildlife, and clean water
- Decrease Montana's primary dependence on small grains and forage crops
- Demonstrate innovation in recommended approaches to crop and pest management
- Establish research programs that provide more efficient use of natural resources, especially water
- Find ways through sustainable agriculture to provide more profitable farm enterprises
- Promote stable and prosperous farm families and communities
- Reduce dependence on non-renewable resources (e.g., fuel, fertilizers, and pesticides) and maximize efficiencies
- Research alternative pest control practices, including biological control for pests of forages, potatoes, small grains, and sugar beets

## **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
- Full-time 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 |
| 2012 | 0.0       | 0.0  | 83.6     | 0.0  |
| 2013 | 0.0       | 0.0  | 83.6     | 0.0  |
| 2014 | 0.0       | 0.0  | 83.6     | 0.0  |
| 2015 | 0.0       | 0.0  | 83.6     | 0.0  |
| 2016 | 0.0       | 0.0  | 83.6     | 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>• Workshop</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 extension and commodity group meetings, conferences, and field days

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

NIFA no longer requires you to report target numbers for standard output measures in the Plan of Work. However, all institutions will report actual numbers for standard output measures in the Annual Report of Accomplishments and Results. The standard outputs for which you must continue to collect data are:

- Number of contacts
    - Direct Adult Contacts
    - Indirect Adult Contacts
    - Direct Youth Contacts
    - Indirect Youth Contact
  - Number of patents submitted
  - Number of peer reviewed publications
- Clicking this box affirms you will continue to collect data on these items and report the data in the Annual Report of Accomplishments and Results.

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

#### **1. Output Measure**

- Number of research citations
- Clicking this box affirms you will continue to collect data on these items and report the data in the Annual Report of Accomplishments and Results.

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

| O. No | Outcome Name  |
|-------|---|
| 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**

**2012:2                      2013:2                      2014:2                      2015:2                      2016:2**

**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**

**2012:100                      2013:100                      2014:100                      2015:100                      2016:100**

**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**

**2012:1                      2013:1                      2014:1                      2015:1                      2016:1**

**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**

**2012:30                      2013:30                      2014:35                      2015:35                      2016:35**

**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**

**2012:100                      2013:100                      2014:100                      2015:100                      2016:100**

**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**

**2012:5000                      2013:5000                      2014:5000                      2015:5000                      2016:5000**

**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**

**2012:750                      2013:750                      2014:750                      2015:750                      2016:750**

**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 full-time 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 - Planned Evaluation Studies**

#### **Description of Planned Evaluation Studies**

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

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

### **Program # 4**

#### **1. Name of the Planned Program**

Global Food Security and Hunger -- Integrated Pest Management

#### **2. Brief summary about Planned Program**

Montana's stakeholders need new and improved methods for controlling insects, weeds, and diseases that challenge producers who produce crops under less than ideal conditions. Pesticides are a major expense to producers; however delaying or eliminating pest control measures may not always be an option. An increase in public concern about food quality, natural resource biodiversity, and sustainability of the quality of soil, air, and water is mandating less reliance on traditional pesticides and more research into biological control systems and organic food production. An emphasis on pest monitoring (using decision-making parameters and determining economic injury levels) will optimize the use of pesticides for controlling pests. Foreign trade partners especially want decreased pesticide residues in the wheat and barley exports.

#### **Research Activities**

Alfalfa hay management programs have been initiated to look at traditional use of chemical control methods, biological controls, and cultural management options. Research into forages includes the examination of pest and natural enemy complexes and their interaction. Controlling pests (lygus, aphids, alfalfa weevils) in seed alfalfa without impacting native or managed pollinators, especially leafcutter bees, is a research priority. Improving wheat competitiveness and developing herbicide tolerance through bioengineering are priorities among researchers. Herbicide screening trials are established to assess the effectiveness of new and existing herbicides under the range of environmental and crop conditions representative of Montana agricultural systems. Research results indicate that the complex interactions that occur in managing sawfly make a total systems approach necessary to reduce damage to small grains. MSU is examining the integration of natural enemies, pathogens, and chemicals for management of sawfly and is developing new sources of host plant resistance. Research is ongoing to find additional environmentally friendly solutions for the management of soil-borne plant pathogens. Identifying optimal disease management strategies and establishing biological controls are priorities for producing potatoes, sugar beets, small grains, and other crops in Montana. Increasing management for control of spotted knapweed will enhance rangeland productivity and plant diversity, while enhancing Montana's agricultural economic return and improving wildlife habitat. Continuing research into novel disease management systems for potatoes will reduce a grower's dependence on a single management tool for protection of their crop. Understanding the role of weed diversity and seedbanks in Montana cropping systems will help producers develop more effective weed control programs. Research is being directed toward identifying key mortality factors which contribute to the greatest annual losses of alfalfa leafcutter bee pollinators in Montana. Additional work investigates colony collapse disorder (CCD) of honeybees, especially determining the role that *Nosema ceranae* infections may have in honeybee colonies.

**3. Program existence :** Mature (More than 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 |
|---------|---|-----------------|-----------------|----------------|----------------|
| 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**

In Montana, small grains represent about 68% of the cropped acres. In 2009, Montana ranked 3<sup>rd</sup> in the production of barley and wheat. Wheat and barley represented 44% of the total agricultural receipts for the state in 2009. Montana producers are continually challenged to produce crops with limited resources, especially moisture. The addition of insect, disease, and weed pests creates additional problems challenging producers to remain competitive. Producers have relied on traditional pesticides to reduce economically the direct impact pests have on food and fiber production. The pesticides are costly; however delaying or eliminating pest control options may not always be an option. Biological controls for insects, weeds, and diseases are becoming more important as traditional chemical control methods are limited. The increase in public concern about food quality and safety, natural resource biodiversity, and sustainability of the quality of soil, air, and water is mandating less reliance on traditional pesticides and more research into environmentally friendly systems. Foreign trade partners especially want decreased pesticide residues in the wheat and barley commodities.

IPM programs seek to:

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

**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**

- Adequate moisture (rainfall, irrigation, snowpack) will be available for crops
- Full-time 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, companies, and other agencies will continue to provide input and financially support priorities and activities
  - Program development will proceed as planned without major interruptions

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

- Contribute to the understanding of weed resistance through research that targets plant biochemical processes
  - Develop novel pest management systems that include biological control
  - Improve rangeland management by developing controls for exotic noxious weed species
  - Provide efficacious and cost effective pest control programs for 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 |
| 2012 | 0.0       | 0.0  | 54.2     | 0.0  |
| 2013 | 0.0       | 0.0  | 54.2     | 0.0  |
| 2014 | 0.0       | 0.0  | 54.2     | 0.0  |
| 2015 | 0.0       | 0.0  | 54.2     | 0.0  |
| 2016 | 0.0       | 0.0  | 54.2     | 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)**

NIFA no longer requires you to report target numbers for standard output measures in the Plan of Work. However, all institutions will report actual numbers for standard output measures in the Annual Report of Accomplishments and Results. The standard outputs for which you must continue to collect data are:

- Number of contacts
  - Direct Adult Contacts
  - Indirect Adult Contacts
  - Direct Youth Contacts
  - Indirect Youth Contact
- Number of patents submitted
- Number of peer reviewed publications

Clicking this box affirms you will continue to collect data on these items and report the data in the Annual Report of Accomplishments and Results.

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

**1. Output Measure**

- Number of research citations
- Multidisciplinary journal articles published

- Clicking this box affirms you will continue to collect data on these items and report the data in the Annual Report of Accomplishments and Results.



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

| O. No | Outcome Name  |
|-------|---|
| 1     | Quality in-depth training programs for continuing education 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 education on integrated approaches to pest management

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

**2012:3                      2013:3                      2014:3                      2015:3                      2016:3**

**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 Action Outcome Measure**

**2012:1                      2013:1                      2014:1                      2015:1                      2016:1**

**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**

**2012:1                      2013:1                      2014:1                      2015:0                      2016:1**

**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 # 4**

**1. Outcome Target**

Passing rate percentage for pesticide application licenses

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

**2012:70                      2013:70                      2014:70                      2015:70                      2016:70**

**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**

**2012:1                      2013:1                      2014:1                      2015:1                      2016:1**

**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**

**2012:3                      2013:3                      2014:3                      2015:3                      2016:3**

**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 full-time 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 - Planned Evaluation Studies**

### **Description of Planned Evaluation Studies**

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

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

### **Program # 5**

#### **1. Name of the Planned Program**

Global Food Security and Hunger -- Plant Breeding, Genetics and Genomics

#### **2. Brief summary about Planned Program**

MSU is recognized as an international leader in the development of new cultivars of wheat and barley that are sought by global buyers. An aggressive plant breeding program ensures development of higher yielding, disease- and insect-resistant wheat and barley cultivars. Many new cultivars are licensed with partnering companies, thus ensuring that Montana stakeholders receive maximum benefit from research discoveries.

**Research Activities:** Plant breeding, genetics, and genomics projects tend to be long-term with little change from year to year. Primary emphasis of the winter wheat breeding program is the development of improved cultivars adapted to Montana's climatic conditions and cropping systems. Research is ongoing to develop germplasm with excellent end-use qualities and resistance to important pest and environmental stresses. Researchers will evaluate more efficient screening, selection, and breeding strategies and procedures to maximize efficiency and genetic progress in winter wheat breeding. Research projects will develop new hard red spring wheat cultivars for Montana producers, contribute to the science of wheat breeding and genetics, and improve end-use characteristics. The broader impacts of MSU research are a larger 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. The primary output of the wheat improvement program is release of improved winter wheat cultivars. Cultivar performance data is disseminated to wheat producers via the internet, traditional extension bulletins, and in popular farm press publications.

Barley cultivars with improved feed quality could provide sustainable seed and grain markets for regional grain producers, and provide marketing advantages to regional beef producers. Research is being conducted on the development of lines for the malting, feed, and ethanol industries. The development and distribution of high quality, drought tolerant barley cultivars that provide the highest production potential is a priority of barley breeding programs. We have increased our understanding of the genetic control of traits like winter hardiness, feed quality, malting quality, and drought tolerance. Our multi-state barley research focuses the disciplines of plant breeding, genetics, plant pathology, cereal science, molecular biology, and genomics for barley improvement in Idaho, Montana, and North Dakota. We recently released four feed, forage, and malt barley cultivars that fit Montana's production environments and that provide added value to Montana barley growers and to growers throughout the Northern Plains. MSU is developing multiple pest-resistant dryland alfalfa cultivars with good agronomic traits for Montana. In addition to alfalfa projects, efforts have been made to develop new grass cultivars suitable for Montana.

Several new camelina products are being developed for use in bread, as soil amendments, and to produce omega-3 rich beef and pork. We anticipate that new high-tocopherol lines of safflower will add value to producers in eastern Montana and western North Dakota and provide a more nutritious product.

**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 |
|---------|--|-----------------|-----------------|----------------|----------------|
| 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)   |                 |                 | 15%            |                |
| 205     | Plant Management Systems   |                 |                 | 10%            |                |
| 502     | New and Improved Food Products   |                 |                 | 5%             |                |
| 711     | Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources |                 |                 | 5%             |                |
| 903     | Communication, Education, and Information Delivery   |                 |                 | 5%             |                |
|         | <b>Total</b>   |                 |                 | 100%           |                |

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

**1. Situation and priorities**

An aggressive plant breeding program ensures development of higher yielding disease-resistant and insect-resistant wheat and barley cultivars. Much of the North Dakota/Minnesota Red River Valley malting barley production is moving to Montana and Idaho, increasing the level of research needed to provide cultivars suitable for Montana growing conditions. Additional work in the development of alternative crops continues to produce potential new market opportunities for Montana producers. Commercial buyers from Asian countries assess hard red spring wheats and hard red winter wheats for use in making noodles, steam bread, and loaves. Wheat cultivars developed at MSU and grown commercially by Montana producers continue to rank in the most preferred category by international customers. Producing high quality safe crops in abundant supply requires strict adherence to pesticide laws, to appropriate interfaces with biotechnology, and to timing of the storage and marketing of commodities.

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

- Increase yield potentials and maintain/improve quality
- Improve winterhardiness, wheat stem sawfly resistance, and imidazolinone herbicide tolerance
- Integrate genomic research into breeding programs
- Provide improved cultivars of small grains adapted to Montana climatic conditions and cropping

systems

**2. Scope of the Program**

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

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

**1. Assumptions made for the Program**

- Adequate moisture (rainfall, irrigation, snowpack) will be available for crops
- Funding from industry organizations, grain and livestock associations, companies, and other agencies will provide input into priorities and activities
  - Full-time staff and part-time assistants will be available to maintain appropriate progress
  - Funding and technical support from partnering institutions and agricultural groups will be maintained
  - Montana businesses and state agencies will be interested in commercialization opportunities
  - Program development will proceed as planned without major interruptions

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

- Increase yield potential for small grain production in Montana
- Maintain our role as a leading university in wheat and barley genetics research
- Provide genomic research that will help Montana producers stay competitive
- Provide improved cultivars of wheat and barley to Montana producers
- Produce crops that are safe, nutritious, and in sufficient quantity to meet the needs of U.S. and world consumers
  - Support food risk assessment education and research

**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 |
| 2012 | 0.0       | 0.0  | 60.3     | 0.0  |
| 2013 | 0.0       | 0.0  | 60.3     | 0.0  |
| 2014 | 0.0       | 0.0  | 60.3     | 0.0  |
| 2015 | 0.0       | 0.0  | 60.3     | 0.0  |



| Year | Extension |      | Research |      |
|------|-----------|------|----------|------|
|      | 1862      | 1890 | 1862     | 1890 |
| 2016 | 0.0       | 0.0  | 60.3     | 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
  - 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

**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>• Public Service Announcement</li> <li>• Newsletters</li> <li>• Web sites other than eXtension</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
  - 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)**

NIFA no longer requires you to report target numbers for standard output measures in the Plan of Work. However, all institutions will report actual numbers for standard output measures in the Annual Report of Accomplishments and Results. The standard outputs for which you must continue to collect data are:

- Number of contacts
  - Direct Adult Contacts
  - Indirect Adult Contacts
  - Direct Youth Contacts
  - Indirect Youth Contact
- Number of patents submitted
- Number of peer reviewed publications

Clicking this box affirms you will continue to collect data on these items and report the data in the Annual Report of Accomplishments and Results.

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

#### **1. Output Measure**

- Number of foreign trade teams in Montana
- Number of foreign trade teams at MSU
- Number of research citations

Clicking this box affirms you will continue to collect data on these items and report the data in the Annual Report of Accomplishments and Results.

**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   |
| 7     | Number of programs established to enhance global food biosecurity  |
| 8     | Number of new food products created from Montana crops   |

**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**

**2012:100                      2013:100                      2014:100                      2015:100                      2016:100**

**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**

**2012:1                      2013:1                      2014:1                      2015:1                      2016:1**

**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**

**2012:0                      2013:0                      2014:0                      2015:1                      2016:0**

**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**

**2012:100                      2013:100                      2014:100                      2015:100                      2016:100**

**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**

**2012:5                      2013:5                      2014:5                      2015:5                      2016:5**

**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**

**2012:3                      2013:3                      2014:3                      2015:3                      2016:3**

**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

**Outcome # 7**

**1. Outcome Target**

Number of programs established to enhance global food biosecurity

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

**2012:1                      2013:1                      2014:1                      2015:1                      2016:1**

**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 # 8**

**1. Outcome Target**

Number of new food products created from Montana crops

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

**2012:1                      2013:1                      2014:1                      2015:1                      2016:1**

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

- 205 - Plant Management Systems
- 502 - New and Improved Food Products
- 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

- 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 full-time 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 - Planned Evaluation Studies**

#### **Description of Planned Evaluation Studies**

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 the Montana Wheat and Barley Committee.



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

### Program # 6

#### 1. Name of the Planned Program

Sustainable Energy

#### 2. Brief summary about Planned Program

The development of bioenergy alternatives will provide opportunities for renewable biobased products and will help to reduce the current dependence on fossil fuels. Crops designated for biodiesel production include canola, camelina, and mustard. In addition to being widely adapted to Montana growing conditions, input costs for camelina are approximately one third those of the other crops, making it the most likely candidate for fuel production. Additional initiatives will provide new insights into the use of vegetable oils as feedstock for fuel cells and non-corrosive biobased de-icers, and the optimization of ethanol production from various feedstocks. Increases in ethanol production from corn and unrest in oil-producing areas of the world have fueled interest in alternative energy sources. Lines and cultivars of barley, spring wheat, and durum are evaluated for starch yield and ethanol production.

**Research Activities:** New oilseed crops and cropping systems are being researched to produce low cost feedstocks for biodiesel production. MSU projects are evaluating various cool and warm season cereal crops for yield potentials in Montana and developing production systems to maximize biomass production. Technologies for storing, processing, and conversion of cellulosic feedstocks to biofuel will be examined and optimized. In some cases, depending upon the availability of raw materials, processed engineered fuels may be produced from a combination of bio-materials and fossil-fuels, including crop residues, coal chips, and coal dust. MSU's new, innovative undergraduate major in Sustainable Food and Bioenergy Systems (SFBS) adds new education and research opportunities to students and faculty. The SFBS interdisciplinary degree program promotes sustainable production, distribution, and consumption of nutritious food and bioenergy by growing a new generation of leaders through collaborative learning and hands-on experience. SFBS students will explore various aspects of food and bioenergy systems as well as career opportunities in the Sustainable Food Systems, Agroecology, and Sustainable Crop and Livestock Production Options. The SFBS Program combines classroom learning, research opportunities, and meaningful field experiences to prepare students for careers that will impact the future of food and energy production.

**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 |
|---------|--|-----------------|-----------------|----------------|----------------|
| 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

Research projects strive to increase the profitability of Montana agriculture and reduce our reliance on non-renewable energy by the production of biofuels, ethanol, and biolubricants. 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.

- Develop bioenergy alternatives that will provide opportunities for renewable biobased products and will help to reduce the current dependence on fossil fuels
- Expand development and production of value-added products in Montana
- Provide expertise to growers, researchers, and agricultural businesses

2. Scope of the Program

- In-State Extension
- In-State Research

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

1. Assumptions made for the Program

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

2. Ultimate goal(s) of this Program

- Build a biobased economy that provides manufacturing, product development, rural development, job opportunities, and an opportunity to raise farm and ranch incomes
- Develop sustainable fuels that incorporate Montana commodities

**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 |
| 2012 | 0.0       | 0.0  | 6.6      | 0.0  |
| 2013 | 0.0       | 0.0  | 6.6      | 0.0  |
| 2014 | 0.0       | 0.0  | 6.6      | 0.0  |
| 2015 | 0.0       | 0.0  | 6.6      | 0.0  |
| 2016 | 0.0       | 0.0  | 6.6      | 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 other than eXtension</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)**

NIFA no longer requires you to report target numbers for standard output measures in the Plan of Work. However, all institutions will report actual numbers for standard output measures in the Annual Report of Accomplishments and Results. The standard outputs for which you must continue to collect data are:

- Number of contacts
  - Direct Adult Contacts
  - Indirect Adult Contacts
  - Direct Youth Contacts
  - Indirect Youth Contact
- Number of patents submitted
- Number of peer reviewed publications

Clicking this box affirms you will continue to collect data on these items and report the data in the Annual Report of Accomplishments and Results.

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

#### **1. Output Measure**

- New business partnerships created
- Number of research citations

Clicking this box affirms you will continue to collect data on these items and report the data in the Annual Report of Accomplishments and Results.

**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**

**2012:1                      2013:0                      2014:1                      2015:1                      2016:1**

**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**

**2012:1                      2013:1                      2014:0                      2015:0                      2016:1**

**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

**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 - Planned Evaluation Studies**

#### **Description of Planned Evaluation Studies**

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

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

**Program # 7**

**1. Name of the Planned Program**

Childhood Obesity

**2. Brief summary about Planned Program**

No activities planned.

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

**4. Program duration :** Short-Term (One year or less)

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

**6. Expending other than formula funds or state-matching funds :** No

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

1. Program Knowledge Areas and Percentage

| KA Code | Knowledge Area     | %1862 Extension | %1890 Extension | %1862 Research | %1890 Research |
|---------|--------------------|-----------------|-----------------|----------------|----------------|
| 607     | Consumer Economics |                 |                 | 100%           |                |
|         | <b>Total</b>       |                 |                 | 100%           |                |

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

**1. Situation and priorities**

N/A

**2. Scope of the Program**

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

**1. Assumptions made for the Program**

N/A

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

N/A

**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 |
| 2012 | 0.0       | 0.0  | 0.0      | 0.0  |
| 2013 | 0.0       | 0.0  | 0.0      | 0.0  |
| 2014 | 0.0       | 0.0  | 0.0      | 0.0  |
| 2015 | 0.0       | 0.0  | 0.0      | 0.0  |
| 2016 | 0.0       | 0.0  | 0.0      | 0.0  |

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

**1. Activity for the Program**

N/A

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

**Extension**

| Direct Methods | Indirect Methods |
|----------------|------------------|
|                |                  |

**3. Description of targeted audience**

N/A

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

NIFA no longer requires you to report target numbers for standard output measures in the Plan of Work. However, all institutions will report actual numbers for standard output measures in the Annual Report of Accomplishments and Results. The standard outputs for which you must continue to collect data are:

- Number of contacts
    - Direct Adult Contacts
    - Indirect Adult Contacts
    - Direct Youth Contacts
    - Indirect Youth Contact
  - Number of patents submitted
  - Number of peer reviewed publications
- Clicking this box affirms you will continue to collect data on these items and report the data in the Annual Report of Accomplishments and Results.

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

#### **1. Output Measure**

- Clicking this box affirms you will continue to collect data on these items and report the data in the Annual Report of Accomplishments and Results.

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

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

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

**Description**

N/A

**V(K). Planned Program - Planned Evaluation Studies**

**Description of Planned Evaluation Studies**

N/A