

2013 Montana State University Research Plan of Work

Status: Accepted

Date Accepted: 06/13/2012

I. Plan Overview

1. Brief Summary about Plan Of Work

The Montana Agricultural Experiment Station (MAES) and the Montana State University College of Agriculture (COA) remain highly engaged with the agricultural and natural resource communities in many innovative ways. Investigators explore new and enhanced varieties of spring and winter wheat, delve into pest management and continue with leading research in animal health, food safety, and food security. Researchers publish their findings in traditional formats and take advantage of breakthroughs in technology and the internet making them a key component in the advancement of agriculture techniques and productivity throughout the world.

Montana is a unique state boasting its "big sky" and "wide open spaces" both of which are indicative of the value Montanan's place on agriculture. Montana is a rural state with 975,000 people inhabiting 93 million acres which equates to less than 7 people per square mile. Although the population is small, the State's commitment to agriculture is clear with approximately 29,000 farms and ranches comprising more than 66% of Montana lands. Montana prides itself on its agricultural roots and its commitment to leading researchers in the agricultural community. In 1893 the Agricultural College of the State of Montana boasted eight students all of which were male. Now in 2011 the Montana State University College of Agriculture has approximately 1,000 students and half are women. The college also experienced its fifth consecutive year of increased enrollment with student numbers not seen since the early 1980s.

Agriculture experts at MSU have the globe as their classroom through technology and direct participation in diverse overseas experiences. Given the opportunity to extend their learning outside the classroom students and faculty teach and learn in labs, greenhouses, farms and ranches in Montana and around the world. Through collaborative research experiences and cooperation with rural, urban, and scientific communities, investigators are achieving significant impacts and outcomes.

Montana ranks 2nd in the U.S. in acres devoted to agricultural enterprises with annual crop and livestock cash receipts exceeding \$3 billion. Although Montana suffered a cold wet growing season throughout much of the region in 2011 the field crop revenue totaled \$2.4 billion. Wheat was the most significant crop at 5.4 million acres totaling \$1.4 billion in revenue. This was followed by barley with 760,000 acres and revenue of \$159 million. Montana ranks 3rd in the United States for the number of acres devoted to wheat production. The grain supports both the livestock industry in Montana and the export market. Farmers saw an increase in the production of garbanzo beans, potatoes, and canola in 2011. The State ranked 1st in the production of Austrian winter peas; 2nd in lentils, dry edible peas, flaxseed, and safflower; 3rd in the production of barley; 5th in sugar beets, canola, and garbanzo bean; 6th in the production of all hay; and in the top 10 for all dry beans and pinto beans.

Montana is among the top ten producers of beef cows and sheep in the nation and excels in honey production and wool. The value of Montana's livestock exports increased in 2010 to \$1.0 billion, a 14% increase from 2009. Cattle and calves represented 35.6% of the cash receipts in 2010 and was the highest of the livestock products.

Montana plays a key geographical role as the headwaters for the Missouri, Yellowstone, and Columbia Rivers. While Montana remains committed to agriculture it is also keenly tied to tourism and the

recreational activities centered on the waterways. Researchers in Montana work to balance the needs of agriculture and value-added activities with conservation, recreation and environmental issues, so there will be enough water for everyone's needs. The State also plays host to two national parks which provide excellent research opportunities in the areas of climate change and food security.

Native Americans represent the largest group of potentially underserved citizens in Montana and comprise 6.4% of the State's population. MSU works with tribal councils, colleges in the Rocky Mountain region, and educators providing programs and educational opportunities for this group of Montana citizens. Cooperative efforts with MAES provide resources and training to Native Americans in the areas of livestock management, certification, childhood obesity, nutritional recommendations, pasture restoration, environmental stewardship, sustainable agricultural practices, resource and risk management, pesticide certification, and social skill building. American Indian students enrolled in the College of Agriculture comprise about 7% of an increasing number of Native American students earning degrees at MSU.

Researchers at Montana State University COA continue learning as they focus on diversity and efficiency in agricultural operations. MSU is committed to leading the way toward being better stewards of our natural resources and even more effective in developing intellectual and human capital across generations.

Priorities: The Montana agricultural community works together establishing the priorities for the College of Agriculture and the Montana Agricultural Experiment Stations. Investigators and stakeholders facilitate focus groups and community meetings throughout the State ensuring the research priorities are current and valid for the target population. Following is a list of priorities:

- Add value to Montana's high quality crop and livestock systems
- 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

Several priorities overlap as investigators in various departments collaborate and share results to ensure Montana remains on the cusp of the latest agriculture research.

Input Section: The MAES solicits stakeholder input in the strategic planning process and reaffirms the input as investigators fund, develop, implement, and revise the different research programs. 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 Seed Lab Advisory Committee, Montana Wool Growers Advisory Committee, Northern Agricultural Research Center Advisory Committee, Northwestern Agricultural Research Center 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, Western Agricultural Research Center, 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.

Funding: Several sources fund MAES faculty research. They include: BIA, BLM, Canadian provinces, conservation and wildlife groups, 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, grants, overhead investments from sponsored programs, private donations, private industry, the State of Montana, USDA, USEPA, and USFS.

Outcomes and Impacts: MAES and the COA conduct research (integrated with teaching) to enhance economically viable and sustainable agricultural systems relevant to agriculture and producers in Montana with globally transferable solutions. The research focuses on issues and concerns relevant to fields traditionally outside agriculture parameters, but which involve similar advanced knowledge acquisition such as cancer research and energy development. They focus on interdisciplinary studies with far reaching impacts in science, technology, energy development and consumption, food security, safety, and hunger. Investigators in Montana are keenly aware of the environment and the implications of climate change.

Superior instructional programs emphasize student research skills and training in fields critical to the nation's agricultural and natural resources infrastructure so students will be marketable in traditional and emerging job markets. Outreach programs link researchers with educators, stakeholders, producers, and consumers through face-to-face communication, print media, and electronic methods.

Each of the seven agricultural research centers scattered throughout Montana hosts an annual field day in cooperation with USDA-ARS (two Montana locations) and allied communities. At field days the staff share key research programs with members of the agriculture community, stakeholders, producers and those pursuing careers in agriculture and/or research. Staff members facilitate discussion forums where attendees exchange valuable information and ideas. The field days (attended by agricultural clientele, elected officials, and the general public with participation by faculty, staff, and students) are valuable for sharing new and ongoing research efforts.

Maintaining profitable agricultural enterprises while sustaining ecological systems has become a difficult balancing act that often results in changes in agricultural practices and environmental policy. Montana agriculture scientists are vigilant about guarding limited resources, focusing on water issues, and developing crop and livestock systems that improve sustainability. Studies focus on how to produce the high yielding crops with minimal production costs and reduced environmental impact. Researchers in plant sciences continue to investigate crop rotation with winter and spring peas, canola, corn, lentils, mustard, sunflower, triticale, and chickpeas. Oilseed crops represent important new sources of income for farmers and provide opportunities for increasing crop diversity.

Program Areas:

Program #1 Climate Change

Situation: Montana, known for its rugged beauty and wide open ranges, also frequently makes national news because of its harsh and sometimes unpredictable climate. The Continental Divide runs north to south through the State and the rugged mountains often impact weather patterns resulting in very different conditions between the eastern and western parts of Montana. The average frost free zones vary throughout the state from 30 days to 125 days based on location and altitude. This alone plays a key role in crop selection and production in Montana. Researchers are also concerned about areas where

diminished water resources place constraints on crop growth, the impact of rising timberlines on range and croplands.

Priorities: The agricultural community in Montana wants to add value to Montana's high quality crop and livestock systems as ongoing adaptations to climate change. Leaders in the agricultural community have prioritized research exploring new and alternative crop varieties and high yielding cultivars. Researchers are also studying how the climate is affecting native plants, insects, and wildlife as well as carbon sequestration.

Input: Focus groups, multistate research committees and meetings of stakeholders identify climate change strategies in cooperation with investigators.

Research Activities: Knowing that changes in the climate will impact agriculture, researchers at MSU COA and MAES are exploring new varieties of crops and continue introducing new varieties of barley and wheat. Investigators expect barley, one of the most durable cereal crops, to perform exceedingly well in a drier, warmer climate. They are also exploring the vegetation and microbes growing in the thermal pools of the Yellowstone ecosystem. By studying the mechanisms of growth to native plants in geothermal-modified soils they gain a better understanding of limitations and opportunities increasing temperatures may present in agricultural production.

Scientists at MSU COA and MAES are participating in a collaborative research project regarding carbon dioxide. Investigators are looking for the most effective ways to remove CO₂ from the atmosphere, store it in plants, and then release the carbon into the soil where it enhances plant growth.

The changing climate has significantly impacted Montana insects which in turn impact the ecosystem. Researchers are studying the biology, distribution, and systematics of insects. In 2011 they trapped wood boring insects and found a large number of new specimens. Researchers are studying them to determine their impact on agriculture in the State.

The Montana landscape is changing along with the climate, and Montana scientists are concerned about the loss of sagebrush habitat due to conifer encroachment. Researchers are collecting data from three different areas in southwest Montana to determine the relationship between conifer and sagebrush. They are also studying the impact of beaver on aspen groves and how it impacts rangeland management.

MAES and COA researchers understand the direct correlation between agriculture-biofuel production, carbon sequestration, and natural resource conservation, as well as traditional commodity production. By studying these relationships and educating others, Montana agricultural producers can react effectively and sustainably to the demands of climate change.

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. Scientists are also working on processes important to understanding the fate of organic contaminants in soils and the potential for contamination of surface and ground waters. They hope to identify mechanisms by which pesticides and other organics interact in soils. This effort includes the identifying microbial processes responsible for degradation and physical processes responsible for the movement of solutes through soils. The ability to predict the fate and transport of organic chemicals in soils is, to a large degree, dependent on the rates of microbial degradation occurring in soils. The work is focused on factors controlling microbial population dynamics and subsequent degradation of specific compounds present in hydrocarbon contaminated soils.

Program #2 Food Safety

Situation: MAES and COA researchers are committed to helping reduce the incidence of food-borne illnesses and assisting producers in providing a safer food supply. Consumers are demanding healthier, safer foods free of harmful chemicals and pesticides. The global market is also driving changes to the agricultural industry with constraints on grain and animal products.

Animal health is economically essential to livestock producers who work diligently producing high quality, high profit stock. Promoting and maintaining animal health has led to advances in genetics and reproductive science and improved animal performance. Montana prides itself on being home to some of the greatest cattle and sheep operations in the United States, and also as a State with more wildlife than people. This brings about unique research opportunities as scientists balance health concerns of livestock, wildlife and consumers.

Investigators at Montana State University COA are studying animal health and its impact on food safety through numerous studies exploring all aspects of livestock management from genetics research projects, disease identification and prevention, to animal breeding practices, reproductive sciences, and nutrition.

Studying infectious diseases is important to Montana researchers because of both the economic losses for producers and food safety concerns. Immunology and Infectious Diseases (ImID) focuses a great deal of research on animal health, and particularly infectious cattle diseases. ImID and the Animal and Range Sciences department have several joint research projects developing and testing new drugs, vaccines, and diagnostic tools for fighting infectious diseases of livestock, humans, and wildlife, as well as zoonotic diseases that can be transmitted to humans.

Priorities of Research for Food Safety

- Further knowledge and management of insects affecting animals and humans
- Develop effective livestock disease control methods
- Identify and mitigate the transmission of diseases between livestock and wildlife
- Increase wool and lamb competitiveness
- Implement targeted grazing strategies as weed control
- Nutritional impact of grazing on sheep and cattle
- Improve traceability of livestock

Input: Stakeholders provided input for the strategic planning process, and offer valuable input. Stakeholders include advisory committees for the Northern Agricultural Research Center, the Montana Beef Council, Montana Wool Growers, Montana Stockgrowers, USDA-ARS, and other regional research programs.

Research Activities: Scientists with ImID utilize state-of-the-art molecular approaches to address basic and applied problems in infectious disease research. Richard Bessen is investigating agent-host interactions in prion diseases which are fatal neurodegenerative diseases. Prion diseases such as bovine spongiform encephalopathy in cattle, scrapies in sheep, and chronic wasting disease in deer and elk breakdown the central nervous system resulting in death. Researchers want to define the pathway of prion agent infection of skeletal muscle following oral prion infection, so they can better understand how the prion agent spreads within a host.

Montana researchers face the continued challenge of ensuring livestock and wildlife do not pass diseases such as brucellosis between each other. *Brucella abortus* remains a threat to the health and well-

being of livestock in states bordering the Greater Yellowstone Area (GYA). Cohabitation of infected wildlife with cattle has jeopardized Idaho's and Wyoming's brucellosis-free status and now has compromised Montana's brucellosis status. Infected wildlife, including bison and elk, will serve as a reservoir for *B. abortus* unless wildlife and livestock experts can adequately manage the disease. David Pascual, a leading researcher at IIMD, is studying a new vaccine that protected 75% of the treated animals. Previous livestock *B. abortus* vaccines have only been approximately 60% effective in cattle and wildlife. Researchers will continue testing and improving the vaccines and formulating ideal dosages.

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. MAES and COA scientists are investigating new vaccines that may effectively control these agents.

Sheep production is a valuable component of Montana agriculture and investigators are starting several new projects aimed at increasing the health, productivity, and profitability of the sheep industry. Working closely with the Montana Wool Growers Association, MSU researcher Dr. Gary Johnson is launching an investigation aimed at protecting sheep from the mosquito borne illness called Cache Valley Virus and also Bluetongue which is becoming a growing problem for sheep producers. Scientists are also continuing to look at the residual feed impact on market and wool lambs. Neonatal lamb mortality is a major source of lost income to the U.S. sheep industry. COA/MAES research has focused on nutritional strategies during late gestation that may impact fetal survival and immune functions. Researchers are also working with area ranchers to better track the genetics of their herds.

Outside of food safety, but still critical to Montana sheep ranchers is the ongoing development of the wool market. Researchers at the MT Wool Lab are making significant advances measuring and sorting high fiber, high quality wool products for a growing consumer demand for wool undergarments. The specialty wool market requires sorting fleece lines finer than 18.5 microns. Research indicates the OFDA2000 measuring system is a very effective tool to measure the size of fibers and to sort out those individual sheep that 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. MAES investigators are ensuring consumers are aware of the quality and health of their products through advancements in the traceability of livestock. John Paterson, lead investigator, provides a systems approach to help beef producers document "best management" practices in raising and marketing calves. This program provides beef quality assurance certification, implements and documents bio-security plans on ranches, and provides educational outreach on topics such as disease management and cow/calf nutrition. Dr. Patterson's electronic identification tags resulted in approximately \$12 per head more income for producers enrolled in the program. The average cost of participating in a source and age verification program was \$3 per head resulting in a \$9.83 per head profit. Montana researchers will continue to develop cost efficient ways to track agricultural products. Tracking provides both source and process verification for easy trace-back in case there is a disease outbreak.

MAES researchers and university professors in the College offer educational programs on beef quality assurance (BQA) practices, voluntary beef cattle marketing options, and ranch management issues throughout the state via meetings and interactive technologies. They have developed programs that focus on management, nutrition, and health maintenance and provide cow-calf producers in Montana with the tools to produce higher quality beef that is healthy and safe for consumption.

A lead researcher with the COA Land Resources and Environmental Sciences Department, Dr. Petersen, is focusing a research program on comparative biological and agricultural risk assessment from biotechnology crops, pesticides, and invasive species. Risk assessment activities in 2011 emphasized pesticides (mosquito insecticides), biotechnology crops, mortality risk in insects, and invasive species and biological control (weeds and biological control agents). Research included human health risk assessments for West Nile virus compared to mosquito insecticides, comparative risk assessments of pest management technologies, and invasive weed and biological control environmental risk assessment. Current and future work will involve more refined assessments of risk, including experimental approaches to generate detailed data on environmental fate and efficacy of insecticides. The primary focus of this work will be on invasive weeds and associated weed management tactics (e.g., herbicides and biological control). There is considerable interest in Montana and in the weed control community regarding the risks associated with noxious weeds and weed control technologies, including biological control. One aspect of this work is to evaluate the environmental risks associated with invasive weeds, and to assess the efficacy of biological control agents using novel criteria, such as plant-physiological impact and other cost-benefit analyses.

Program #3 Global Food Security and Hunger: Integrated Pest Management

Situation: The MSU COA and MAES looks outward with a keen awareness on global food security and a desire to stimulate research in the agricultural industry through dynamic and comprehensive rural leadership programs, technological advancements, and proven scientific and educational practices. The College understands the need for research, education and extension to boost U.S. agricultural production and improve the global capacity to meet the growing food demand. MSU approaches the global food security and hunger program in two areas. The first is integrated pest management, and the second key program area in global food security focuses on plant breeding, genetics, and genomics.

An increase in public concern about food safety, quality, cost, biodiversity, and the sustainability of natural resources such as soil, air, and water quality is pushing scientists to rely less on pesticides and look for more environmentally friendly options. Researchers explored new and improved methods to identify and control insects, weeds, and diseases challenging Montana farmers. MSU investigators studied biological controls as low impact pest control options to promote sustainable practices. Producers and researchers are evaluating these new integrated pest management (IPM) methodologies so they can maintain a competitive position in U.S. and world markets while helping alleviate global hunger.

Montana is a key provider of grains in the United States and also on the global market. Crop success in Montana is important to the global food market. 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: IPM programs optimize grower profitability and natural resource sustainability through the development, selection, and implementation of economically sound and environmentally acceptable pest management strategies. MSU researchers explored less chemically dependent systems and are addressing the economic feasibility and environmental impact of biological controls and growth of organic systems. The COA and MAES taught growers more about crop rotation systems, crop production methods, and water management issues that help produce high quality crops and mitigate pest problems. Researchers are working with the Forest Service studying the impact of ecological and climate changes to pest management. By understanding ecological relationships researchers will implement more biological

controls and science-based systems for pest management.

Input: Summaries of survey information from the Montana weed coordinators identified research needs in the management of invasive plants on private, public, and agency lands. This led to new state funding, research, and educational initiatives aligned with the multi-agency and citizen-supported Montana Weed Management Plan. Funding sources include: Montana crop and animal agricultural groups, Montana Ag Business Association, Montana Department of Agriculture, Montana Fertilizer Advisory Committee, 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. Researchers collected stakeholder input in county and reservation sponsored meetings, listening sessions during pesticide applicator education programs, and during 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: Research focused on how to control troublesome weeds and insects more effectively. Montana sheep researchers studied the impact of targeted grazing on noxious weeds throughout the region. Targeted sheep grazing is an economical and ecologically sustainable tool to manage lands with large infestations of invasive plants such as Dalmatian Toadflax. Investigators with COA and MAES worked with 1,000 private landowners, county weed supervisors, and public agencies to develop new sheep grazing protocols and projects.

While sheep grazing is effective, invasive plant species remain a serious problem on Montana's range and forested lands. Noxious weeds impact productivity and compromise the ecological integrity of all Montana's land. Researchers are investigating the use of biological control for the management of noxious weeds and especially the use of insects. Researchers are introducing natural enemies into the environment in an attempt to control the weeds. The USDA Animal Plant Health Inspection Service approved a specific gall wasp and a gall midge for field release, and investigators released gall midges in Montana and Wyoming. They are currently analyzing the data and rearing more insects for further releases.

Investigators are also studying insects helpful to agriculture as well as the community's greatest pests. They are enhancing their understanding of the diversity, distribution and activities of pollinators, and also making significant advancements in handling troublesome moths and wheat stem sawflies.

Program #4 Global Food Security and Hunger: Animal Health, Production, and Products

Situation: Montana ranchers contributed 4.8% of the U.S. total beef cow production in 2011 and 6.3% of the U.S. lamb crop. As the market becomes more global it is important that agricultural production meets the growing food demand. Research programs at MSU COA and MAES focus on reproductive performance in animals, nutrition, genetic improvements for herds, and developing better animal management systems.

Priorities:

- Enhance reproductive performance of animals
- Evaluate and design better feed systems using the right nutrients
- Evaluate genetics to improve herds
- Study carcass composition

Input: Foreign trade teams, international trade missions, faculty, staff, and students establish funding recommendations and priorities. Stakeholders provided input for the strategic planning process,

and offer valuable input. Stakeholders include advisory committees for the Northern Agricultural Research Center, the Montana Beef Council, Montana Wool Growers, Montana Stockgrowers, USDA-ARS, and other regional research programs.

Research Activities: MAES and COA researchers in the sheep industry clearly understand the USDA-NIFA (2011) definition of sustainable agriculture. NIFA defined sustainable agriculture as an integrated system of plant and animal production practices having a site-specific application that will over the long-term satisfy human food and fiber needs. It also discussed the importance of enhancing environmental quality and the natural resource base essential to the agricultural community.

Researchers at MSU feel little plant/animal integrated systems level research has been done that addresses all of the factors outlined in the USDA definition of sustainable agriculture. In addition, organic certified vegetable, row crop, and animal production enterprises and research have not fully taken advantage of the potential benefits of plant/animal integration and suffer from issues ranging from animal health and finishing (particularly internal parasite control), and alternatives to confinement finishing) to residue and cover crop management, and soil health issues related to extensive tillage commonly used in organic farming programs. Therefore they have designed a research project that will emphasize a combined animal and plant approach. The study will look at the following: I) Reduce tillage intensity in organic crop systems using sheep grazing to terminate cover crops and control weeds; II) Document best management practices that reduce the use of anthelmintic and/or promote strategic, effective use of anthelmintics, and III) Develop low cost alternatives to confinement lamb finishing, as well as systems that provide year-around quality lamb that profit from integrated production systems.

Failure of cows to rebreed after calving significantly decreases reproductive efficiency of beef cattle production. Extended postpartum anestrus is the single most important reason that cows fail to rebreed. This problem is exacerbated by primiparous cows, because they require significantly more time after calving to resume estrus/ovulatory activity than multiparous cows. These factors result in a substantial economic loss to the beef industry in Montana and the U.S. The biostimulatory effect of bulls can accelerate the resumption of ovulatory activity in anovular, postpartum, suckled cows; increasing the likelihood of cows that produce one calf per year and, in turn, increase overall reproductive efficiency and profitability of beef cattle production. Researchers at MSU are trying to determine the physiological mechanism(s) and pheromonal pathways and how they impact fertility in heifers and cows. Scientists are conducting similar biostimulatory research with sheep.

Investigators are also studying the relationship of growth path to carcass composition and meat quality and how to increase the value of beef cattle within Montana. Researchers are looking at the new crops developed in Montana and evaluating them as a potential food source for livestock.

Program #5 Global Food Security and Hunger: Plant Breeding, Genetics and Genomics

Situation: As the third leading producer of wheat products in the United States, Montana, through MAES and COA investigators continued researching new and better varieties of wheat cultivars and made significant advances in both the spring and winter wheat breeding programs. The value of Montana's 2011 all wheat crop was down 2% from 2010 to \$1.3 billion, according to national agricultural statistics. But according to leading investigators with the COA, the yield of winter wheat improved an average of 0.73 bushels per acre per cycle from 2002 to 2011 resulting in improved yield potential of 7.3 bushels per acre since 2002. Researchers will continue developing new cultivars of small grains that are marketed globally.

Priorities: Researchers are investigating high yielding crop varieties resistant to insects and diseases and that will perform well in the Northwest Region. 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, enhancing wheat stem sawfly resistance, and improving dual-purpose end-use quality grains. MSU's intensive genomic research will help Montana producers stay competitive and provide improved cultivars adapted to Montana's climatic conditions and cropping systems. An increased understanding of the molecular biology and biochemistry of cereal grains will lead to the development of products more suited to the requirements of a competitive world market and help alleviate world hunger. Continued productivity of the breeding program will improve the understanding of the genetics from key traits and allow the development of new selection tools. The broader impacts of the work are a larger and higher quality food supply for the world, an improved ability of Montana farmers to compete in a global marketplace, and a strengthening of export markets for U.S. wheat.

Input: Foreign trade teams, international trade missions, faculty, staff, and students establish funding recommendations and priorities. Farmers cooperate by providing dryland and irrigated fields for cultivar trials and by providing associated inputs. The Montana Wheat and Barley Committee competitively awards research proposals. The COA and MAES routinely apply for PVP Title V status on all released wheat and barley cultivars, which then increases revenues for research. 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 Committee, Montana Wheat and Barley Committee, Organic Certification Association of Montana, and state agricultural advisory committees. MAES and the COA will continue to host meetings, interviews, and focus groups to gather information from stakeholders, they will also use computer modeling and surveys to gather and compile data. The agricultural industry, faculty, and other regional institutions have created partnerships among producers that provide outreach activities related to bio-based products. Investigators use input from focus groups and stakeholders to identify strategies for marketing safe agricultural commodities and consumer products.

Research Activities: Investigators are researching several types of winter wheat. For the fifth consecutive year, farmers planted more "Genou" wheat than any other variety, but it continues to be susceptible to stripe rust and the wheat stem sawfly. Researchers made excellent progress selecting more stripe rust resistant lines of wheat. "Yellowstone" yielded the most winter wheat ever in Montana according to lead investigator Dr. Bruckner who also oversaw the planting of "Judee" and "Bearpaw," both solid-stem semi-dwarf cultivars, in the fall of 2011.

Researchers advanced malting barley lines in 2011 and improved feed, hay, and food barley varieties. Research will continue in the hay barley project successfully developed high yielding high straw soluble carbohydrate lines, and researchers purified six lines from each of 30 families in 2011. Researchers have almost completed their food barley breeding effort. With the support of a major U.S. food company they developed several populations of hullless barley using "Prowashonupana" and several land race accessions from USDA's barley collection as donors of the high protein, high grain beta-glucan content trait. In 2011 Dr. Blake and a team of investigators advanced the best of these lines to statewide trials and conducted a large replicated yield trail consisting of 80 lines at the Bozeman Plant Growth Center.

To decrease Montana's primary dependence on small grains and forage crops, researchers are also exploring the feasibility of growing a variety of crops including pulse crops (peas, lentils, chickpeas, and soybeans), herbs, mustard, safflower, sunflower, canola, turf grass, and specialty grains. Increasing crop diversity will improve the economic well-being of dryland agricultural producers in Montana and the Northern Plains. MSU research provides technology that improves plant and animal production systems while adding value and enhancing food security for stakeholders. Initiatives will provide new insights into food safety and risk assessment.

Dry pea is a crop well-suited to the agricultural practices common in Montana and neighboring

states. It provides an economically viable alternative to wheat, barley and canola, and helps condition the soil for these other crops through its ability to add nitrogen, its low water use, and its alternate pests, weeds, and diseases. The recent sequencing of the genome of barrel medic greatly increases the potential for rapid and dramatic improvement in the pea varieties available and the growers ability to manipulate the crop. The current project will take advantage of the recent developments understanding the legume genome to develop new pea varieties specifically adapted to conditions in Montana and the Northern Great Plains.

While producers work diligently to grow quality crops in Montana weeds grow easily and in great abundance. In Montana, about 8 million acres are seriously infested with noxious weeds. Previous research at MSU indicates that sheep and/or goat grazing offers an additional tool in the fight against noxious weeds in an integrated weed management program. Dr. Kott and Dr. Surber are heading a project to develop and implement new management strategies for livestock and land managers for the use of small-ruminants in controlling large infestations of non-native invasive plants while maintaining a production system which is profitable. Targeted grazing is a natural approach to vegetation management and landscape enhancement. Besides providing an ecologically sound and economically feasible tool to manage one of the west's most serious environmental threats, this initiative develops and implements new approaches that improve Montana lamb and wool producers' competitiveness in a world economy. Incorporating targeted grazing in integrated natural resource and weed management programs will create additional income opportunities for rural Montana families. This project falls under plant management systems and animal health.

Program #6 Sustainable Energy

Situation: Corn grain is the major feedstock for fuel ethanol production in the U.S., yet little corn grain is produced in Montana. Therefore, 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 bio-based products. Researchers at MSU focused on how to do more in the agricultural industry with less impact on limited resources. Fuel costs are high throughout the U.S., and due to the geographical dispersion of population centers in Montana, agricultural producers here must develop the most fuel efficient operations. They also are trying to balance the use of chemicals with environmental needs, and focusing on water consumption, a key factor in the semi-arid Rocky Mountain climate.

Priorities: Researchers want 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 bio-based economy, there is a positive effect on manufacturing, product development, rural development, job opportunities, and farm and ranch incomes. MSU COA and MAES are leading this project, providing administration and research expertise for product development, enterprise budgeting and marketing.

Input: Researchers use input from focus groups and stakeholder meetings to identify strategies for marketing higher value agricultural commodities, consumer products, and alternative crops. 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. 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 organizations interested in water quantity and quality issues.

Research Activities: Researchers in the COA and MAES are selecting projects that will ultimately

increase the profitability of Montana agriculture, reduce our reliance on non-renewable energy sources, and help ensure food safety and security in a growing world market. The primary research objective is to develop value-added, agriculturally-based end-use products suitable for production in rural Montana. Researchers here continue to develop products with a competitive edge, and enhance agricultural production approaches through bio-based product education and research, and by conducting outreach activities for producers and agribusiness.

Researchers are exploring new and diverse varieties of barley. Dr. Blake, a leading researcher at Montana State University, stated barley is primarily a public sector crop, because of the limited investment opportunities in the private sector in barley variety development. While barley seed sales typically generate little revenue, it is important to create and identify barley varieties that better utilize Montana's agricultural resources. As mentioned earlier, as climate changes the need for new varieties of crops will increase. Barley, the most durable and adaptable of the cereals, will likely see increased production in a warmer, drier world. The barley varieties the MAES produce are selected to be more productive and to produce higher quality grain in a drier climate.

Water is a valuable resource and with Montana serving as a "Headwaters" state it is essential conservation efforts begin here. As researchers explore drought resistant varieties of barley they strive to find the balance between rain fed and irrigated crop production systems in Montana, Idaho and North Dakota. The U.S. malting industry invested heavily in new malting plants in Montana and Idaho, and the industry demands barley of superb quality. Water is a limiting resource in the Northern Plains, and the plants use a lot of barley produced under rain fed conditions. Montana State University's collaborative program is increasing the reliability of rain fed quality barley production by producing varieties that better withstand drought stress. Researchers are developing barley varieties with genes that tolerate stress during grain fill and winter barley varieties that avoid late-season drought.

New agronomic practices that enhance the survival of winter barley varieties and evaluations of the pest and pathogen resistance of these potential varieties also help MAES release new, improved varieties of barley. In 2009 MSU COA identified and characterized two barley genotypes that produce straw high in fructan, a water-soluble carbohydrate easily digested and fermented by the yeast, *Kluyveromyces marxiana*. Researchers constructed a pilot plant and are developing straw fermentation technology to determine its potential for on-farm fuel ethanol production.

"Hockett" barley is the most rapidly growing barley variety in Montana and the Northern Plains. This variety provides barley producers with lowered risk of rejection by malt barley buyers through its enhanced tolerance to moisture stress. Producers in southern Idaho are growing more winter barley varieties of "Charles" and "Endeavour." Collaborative winter and spring barley testing expanded, and trials of high straw soluble carbohydrate barley varieties permitted development of an estimate of the economic feasibility of on-farm fuel ethanol production utilizing the technology and germplasm developed in this program.

Additional research is focusing on the use of native plants and grasses in the landscaping industry. Researchers are identifying and promoting native plants to consumers for landscaping. This practice promotes a natural ecosystem and requires less water than some of the more common domestic landscape options.

Wheat producers need crop diversity to increase profitability and management options. A COA research project provides safflower as an alternative crop option. This project provides producers with value-added high oleic and high linoleic safflower varieties for commercial production for edible oil, cosmetics, biofuel, birdseed, supplemental fat for livestock rations, and other end-uses for U.S. and foreign markets.

Program #7: Childhood Obesity

Situation: The Montana State University College of Agriculture does not have oversight of the childhood obesity program in Montana. However, researchers at the COA are working on new crops that deliver specific value added products to consumers, often to specific health based consumer groups such as celiac disease sufferers. The development of four new grains, timtana, camelina, montina, and proatina resulted in new grains without new recipes. The recipes followed with input from bakers designated by the gluten free community and celiac sprue associations. This activity led to increased sales and increased acreages of each grain. Sands has been an invited speaker at the last seven national annual meetings of the Celiac Sprue Association. As specific enzyme and DNA tests are now available the number of people that are aware of their celiac disease has increased in the past five years. The four new grains are very welcome in a celiac's restrictive diet.

Montana State University College of Agriculture and the Montana Agriculture Experiment Stations are vested in the agricultural community through their extensive academic and research programs. Investigators are challenging themselves and their staff every day to discover new information, programs, and systems that will enhance quality and productivity, and allow Montana producers to remain key players in the national and global market.

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

| Year | Extension | | Research | |
|------|-----------|------|----------|------|
| | 1862 | 1890 | 1862 | 1890 |
| 2013 | 0.0 | 0.0 | 311.5 | 0.0 |
| 2014 | 0.0 | 0.0 | 311.5 | 0.0 |
| 2015 | 0.0 | 0.0 | 311.5 | 0.0 |
| 2016 | 0.0 | 0.0 | 311.5 | 0.0 |
| 2017 | 0.0 | 0.0 | 311.5 | 0.0 |

II. Merit Review Process

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

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

2. Brief Explanation

Department heads at the MAES and COA review Hatch Projects at the department level. A committee of peers then reviews the project and passes it to the director for final approval. The MAES director's office ensures this process is done as efficiently as possible. 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. Researchers present seminars to the review committee and interested stakeholders, including faculty, staff, students, and constituents. The director requires researchers to propose new projects for a three year period, while researchers with favorably reviewed ongoing projects can have five years. Because there are not any Montana Agricultural Experiment funds allocated outside of the COA, external expert reviews occur with Montana State University faculty external to the COA, as a requirement of the review process. Presenters announce all seminars ensuring broader attendance and input potential. Reviewers provide written recommendations on the following: 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 MAES administrator and department head share the responses with the PI. If the projects do not meet expectations the director will not approve them and will defer them until the researcher meets the key elements satisfactorily. Ultimately, the office staff submits the director-approved projects to USDA-NIFA for final approval.

III. Evaluation of Multis & Joint Activities

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

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

2. How will the planned programs address the needs of under-served and under-represented populations of the 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.

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

To continue receiving State support that is five times the amount of federal support (Hatch, Multistate, and Animal Health), MSU COA and MAES research must demonstrate actual or potential economic impact to Montana's economy and solve local and state level problems. This could be measured as increased crop yields or through advances in crop or animal production efficiency. Deriving additional income from value-added products and new enterprises helps diversify risk and create additional opportunities for income. As a result of the new knowledge created through research activities, there may 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 Montana's 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 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 bison management.

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. Montana stakeholders provide the impetus for continued and growing financial support through MAES programmatic emphases important to the State's 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 include the 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 the geospatial sciences. 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. The College advertises the meetings via news releases, newsletters, individual letters, and announcements at group meetings. Extension agents use county profile information to ensure those invited to the sessions 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. Administrators solicit stakeholder input at the strategic planning process and as programs are developed, implemented, and sometimes redesigned.

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.

The seven agricultural research centers have local advisory groups that meet 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. 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. These committees use a variety of collection methods, but the most common are face-to-face meetings, telephone, and some video conferencing.

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
- Meeting specifically with non-traditional individuals

Brief explanation.

Through direct participation with agricultural stakeholder groups, broad participation in committees, and directed meetings, MAES listens to and considers defined problems or questions that the research programs can address. The Director targets selective meetings with non-traditional groups. Montana has an open meeting law. Therefore, all meetings are open to the public and the organizer must publish an 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, and the COA and MAES clearly set the tone for this interactive environment. The College and the research centers serve as 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 |
| 3 | Global Food Security and Hunger -- Integrated Pest Management |
| 4 | Global Food Security and Hunger: Plant Breeding, Genetics and Genomics |
| 5 | Sustainable Energy |
| 6 | Global Food Security and Hunger: Animal Health, Production, and Products |
| 7 | Childhood Obesity |

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Climate Change

2. Brief summary about Planned Program

Researchers in Montana centered investigations on developing new crops and cultivars suitable to a warmer and drier climate as well as exploring the ecological impact of climate change on natural wildlife habitats in Montana and grazing areas. Montana scientists have taken advantage of their close proximity to Yellowstone National Park to study 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. Scientists at MSU produce and select barley cultivars that are expected to be more productive and produce higher quality grain in drier climates. They are also studying how climate change impacts insects throughout the State.

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 N₂O 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 |
|---------|--|-----------------|-----------------|----------------|----------------|
| 101 | Appraisal of Soil Resources | | | 7% | |
| 102 | Soil, Plant, Water, Nutrient Relationships | | | 22% | |
| 111 | Conservation and Efficient Use of Water | | | 10% | |
| 121 | Management of Range Resources | | | 16% | |
| 122 | Management and Control of Forest and Range Fires | | | 5% | |
| 132 | Weather and Climate | | | 2% | |
| 136 | Conservation of Biological Diversity | | | 12% | |
| 201 | Plant Genome, Genetics, and Genetic Mechanisms | | | 12% | |
| 216 | Integrated Pest Management Systems | | | 12% | |
| 903 | Communication, Education, and Information Delivery | | | 2% | |
| | Total | | | 100% | |

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

1. Situation and priorities

Within the next 100 years, atmospheric CO₂ 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
- Determine impact of climate on integrate pest management programs

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 |
| 2013 | 0.0 | 0.0 | 55.6 | 0.0 |
| 2014 | 0.0 | 0.0 | 55.6 | 0.0 |
| 2015 | 0.0 | 0.0 | 55.6 | 0.0 |
| 2016 | 0.0 | 0.0 | 55.6 | 0.0 |
| 2017 | 0.0 | 0.0 | 55.6 | 0.0 |

V(F). Planned Program (Activity)

1. Activity for the Program

- Develop new crops and cultivars suitable to a warmer and drier climate
- Explore the ecological impact of climate change on Montana wildlife habitats and grazing areas
- Study the impact of a changing climate on insects
- Develop and enhance pest management programs
- Continue investigating crops and management systems that rely on less water consumption
- Complete 10 year carbon sequestration research project

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"> • Workshop • Demonstrations | <ul style="list-style-type: none"> • Newsletters • Web sites other than eXtension |

3. Description of targeted audience

- Crop and livestock producers in Montana
- State agricultural advisory committees
- State of Montana, Montana Department of Agriculture, BLM, 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 (or changes) for Montana |
| 2 | Number of carbon sequestration technologies explored |

Outcome # 1

1. Outcome Target

Number of new drought tolerant crop recommendations (or changes) for Montana

2. Outcome Type : Change in Action Outcome Measure

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 explored

2. Outcome Type : Change in Action Outcome Measure

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

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, ranchers can better manage economically important diseases like coccidiosis, shipping fever, and brucellosis. Montana developed an integrated network to track 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:

Scientists will 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. Researchers will continue to improve the vaccine and investigate ideal dosages for bison and 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 wildlife managers.

Cattle research focuses on disease control, reproductive enhancement, and animal productivity. Scientists will continue investigating vaccines for rotavirus, prion diseases, coccidiosis, herpes viruses, and mastitis in cattle. Researchers are using feed studies with barley, camelina meal, and supplements to evaluate varying rations for calves and cows, and to continue producing superior feeder stock to markets outside of Montana. Scientists are devising research 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.

Researchers in the sheep industry are studying targeted grazing strategies to increase the competitiveness of Montana's lamb and wool in the world market. They are also studying the impact of sheep grazing in weed management programs. Scientists are initiating studies about Blue Tongue and Cache Valley Virus, which are both critical diseases for lamb and sheep populations.

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 | | | 12% | |
| 301 | Reproductive Performance of Animals | | | 5% | |
| 302 | Nutrient Utilization in Animals | | | 11% | |
| 303 | Genetic Improvement of Animals | | | 7% | |
| 305 | Animal Physiological Processes | | | 4% | |
| 306 | Environmental Stress in Animals | | | 2% | |
| 307 | Animal Management Systems | | | 11% | |
| 308 | Improved Animal Products (Before Harvest) | | | 12% | |
| 311 | Animal Diseases | | | 21% | |
| 315 | Animal Welfare/Well-Being and Protection | | | 7% | |
| 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 | | | 1% | |
| 902 | Administration of Projects and Programs | | | 1% | |
| 903 | Communication, Education, and Information Delivery | | | 1% | |
| | Total | | | 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 stakeholders and those who rely on COA recommendations for animal production in the State, the following priorities have been established:

- Develop effective livestock disease control methods
- Improve beef production practices and evaluate genetics to improve herds
- Identify and mitigate the transmission of diseases between livestock and wildlife
- Increase wool and lamb competitiveness
- Implement targeted grazing strategies
- Nutritional impact of grazing on sheep and cattle

- Improve traceability of livestock
- 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 are 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 status as a leading university in animal genetics and rangeland stewardship research
- Provide genomic research to help Montana producers stay competitive
- Provide improved production management recommendations to Montana producers
- Produce safe, nutritious livestock products in sufficient quantity to meet the needs of U.S. and world consumers
 - Improve 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 |

| Year | Extension | | Research | |
|------|-----------|------|----------|------|
| | 1862 | 1890 | 1862 | 1890 |
| 2013 | 0.0 | 0.0 | 73.2 | 0.0 |
| 2014 | 0.0 | 0.0 | 73.2 | 0.0 |
| 2015 | 0.0 | 0.0 | 73.2 | 0.0 |
| 2016 | 0.0 | 0.0 | 73.2 | 0.0 |
| 2017 | 0.0 | 0.0 | 73.2 | 0.0 |

V(F). Planned Program (Activity)

1. Activity for the Program

- Create databases accessible to researchers and producers to share 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
- Integrate, where possible, best practices for beef quality assurance in programs

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"> • Education Class • Workshop • Group Discussion • Demonstrations | <ul style="list-style-type: none"> • Newsletters • Web sites other than eXtension |

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

| O. No | Outcome Name |
|--------------|--|
| 1 | Identify critical infection and resistance processes |
| 2 | Number of ranches per year adopting enterprise management of animal health issues |
| 3 | Number of improvements to vaccines developed |
| 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

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

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 improvements to vaccines developed

2. Outcome Type : Change in Condition Outcome Measure

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

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

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

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

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. 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

MAES scientists initiated alfalfa hay management programs to compare traditional 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. Specialists are assessing the effectiveness of new and existing herbicides on Montana agricultural systems.

Research results indicate the complex interactions 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. 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. 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.

Researchers are also 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 | | | 27% | |
| 212 | Pathogens and Nematodes Affecting Plants | | | 25% | |
| 213 | Weeds Affecting Plants | | | 20% | |
| 215 | Biological Control of Pests Affecting Plants | | | 10% | |
| 216 | Integrated Pest Management Systems | | | 18% | |
| | Total | | | 100% | |

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

1. Situation and priorities

Investigators with the COA and MAES focus on identifying and managing weeds, insects, and diseases, so the agricultural community in Montana can better impact global food security. They are also developing and sharing quality stewardship programs to identify and mitigate noxious weeds and harmful insects. Field crops are an important foundation for the Montana agricultural industry and revenue totaled \$2.4 billion in 2011. The most significant crop in Montana was wheat (5.4 million acres, \$1.4 billion) followed by barley (760k acres, \$159 million). Montana farmers spent approximately \$15 million on fungicide applications in 2011. Although yield benefits/detriments from spraying a fungicide are difficult to estimate, most respondents estimated a 0-20% yield increase. Not spraying resistant varieties of grain saved \$12 million. Stripe rust cost growers \$48 million in 2011. Fungicide application saved growers \$30 million. If the estimated worth of the wheat crop in MT is \$1.6 billion, they saved 2% of the crop. Susceptible varieties sprayed in a timely manner saved approximately \$90 million. Savings due to herbicide and seed costs on 2000 acres of winter wheat totaled approximately \$60,000 and yields of winter wheat averaged approximately 40 bu/A, totaling \$480,000 (est. \$6/bu) in farm revenue.

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.

Researchers with the MSU IPM programs want to:

- Address the economic feasibility and environmental impact of biological control practices
- 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 |
| 2013 | 0.0 | 0.0 | 33.3 | 0.0 |
| 2014 | 0.0 | 0.0 | 33.3 | 0.0 |
| 2015 | 0.0 | 0.0 | 33.3 | 0.0 |
| 2016 | 0.0 | 0.0 | 33.3 | 0.0 |
| 2017 | 0.0 | 0.0 | 33.3 | 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"> • Education Class • Workshop • Demonstrations | <ul style="list-style-type: none"> • Newsletters |

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 pest management |
| 2 | New IPM options discovered, evaluated, or changed/alterd |
| 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 pest management

2. Outcome Type : Change in Knowledge Outcome Measure

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, evaluated, or changed/altered

2. Outcome Type : Change in Action Outcome Measure

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

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

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

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

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 # 4

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% | |
| | Total | | | 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 winter hardiness, 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 |
| 2013 | 0.0 | 0.0 | 40.6 | 0.0 |
| 2014 | 0.0 | 0.0 | 40.6 | 0.0 |
| 2015 | 0.0 | 0.0 | 40.6 | 0.0 |
| 2016 | 0.0 | 0.0 | 40.6 | 0.0 |
| 2017 | 0.0 | 0.0 | 40.6 | 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"> • Education Class • Workshop • Group Discussion • Demonstrations | <ul style="list-style-type: none"> • Public Service Announcement • Newsletters • Web sites other than eXtension • Other 1 (Variety Recommendation Bulletins) |

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, 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 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 | Integration of new molecular techniques into breeding projects to improve outcomes |
| 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

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

Integration of new molecular techniques into breeding projects to improve outcomes

2. Outcome Type : Change in Condition Outcome Measure

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

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

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

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

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

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

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 # 5

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, agro-ecology, 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 |
|---------|---|-----------------|-----------------|----------------|----------------|
| 201 | Plant Genome, Genetics, and Genetic Mechanisms | | | 10% | |
| 202 | Plant Genetic Resources | | | 10% | |
| 203 | Plant Biological Efficiency and Abiotic Stresses Affecting Plants | | | 10% | |
| 204 | Plant Product Quality and Utility (Preharvest) | | | 10% | |
| 205 | Plant Management Systems | | | 10% | |
| 511 | New and Improved Non-Food Products and Processes | | | 30% | |
| 605 | Natural Resource and Environmental Economics | | | 10% | |
| 903 | Communication, Education, and Information Delivery | | | 10% | |
| | Total | | | 100% | |

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

1. Situation and priorities

Research projects strive to increase the profitability of Montana agriculture and reduce reliance on non-renewable energy by the production of biofuels, ethanol, and biolubricants. The primary research objective is to develop value-added, agriculturally-based end-use products that are suitable for production in rural Montana and have are globally competitive. The research priorities are:

- Develop bioenergy alternatives that provide opportunities for renewable biobased products and will reduce 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
- 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, 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 |
| 2013 | 0.0 | 0.0 | 40.3 | 0.0 |
| 2014 | 0.0 | 0.0 | 40.3 | 0.0 |
| 2015 | 0.0 | 0.0 | 40.3 | 0.0 |
| 2016 | 0.0 | 0.0 | 40.3 | 0.0 |
| 2017 | 0.0 | 0.0 | 40.3 | 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"> • Education Class • Workshop • Group Discussion • Demonstrations | <ul style="list-style-type: none"> • Newsletters • Web sites other than eXtension |

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, 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

- 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 new crop options with research trials as biofuels in Montana |

Outcome # 1

1. Outcome Target

Number of new crop options with research trials as biofuels in Montana

2. Outcome Type : Change in Action Outcome Measure

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 # 6

1. Name of the Planned Program

Global Food Security and Hunger: Animal Health, Production, and Products

2. Brief summary about Planned Program

Montana ranchers contributed 4.8% of the U.S. total beef cow production in 2011 and 6.3% of the U.S. lamb crop. As the market becomes more global it is important that agricultural production meets the growing food demand. Research programs at MSU COA and MAES focus on reproductive performance in animals, nutrition, genetic improvements for herds, and developing better animal management systems.

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 |
|---------|---|-----------------|-----------------|----------------|----------------|
| 301 | Reproductive Performance of Animals | | | 15% | 15% |
| 302 | Nutrient Utilization in Animals | | | 12% | 12% |
| 303 | Genetic Improvement of Animals | | | 12% | 12% |
| 304 | Animal Genome | | | 12% | 12% |
| 305 | Animal Physiological Processes | | | 12% | 12% |
| 306 | Environmental Stress in Animals | | | 10% | 10% |
| 307 | Animal Management Systems | | | 12% | 12% |
| 308 | Improved Animal Products (Before Harvest) | | | 15% | 15% |
| | Total | | | 100% | 100% |

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

1. Situation and priorities

Losses due to environmental stresses, diseases, and mortality create the need for an improved understanding of the factors affecting Montana livestock. Promoting and maintaining animal health (cattle, sheep, and wildlife) has led to advances in genetics, performance, and reproduction technology. To address the needs of stakeholders and those who rely on MSU COA recommendations for animal

production in the State, researchers established the following priorities:

- Manage environmental stress in animals during the winter, lower production costs, and improve livestock genetics
- Develop and implement new management protocols and/or pharmaceutical and nutritional regimens to increase fertility of domestic ruminants and cattle
- Determine how factors, such as herd size and supplement intake, influence growth and development of cattle grazing native rangelands

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

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

2. Ultimate goal(s) of this Program

- Maintain 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

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 |
| 2013 | 0.0 | 0.0 | 63.0 | 63.0 |
| 2014 | 0.0 | 0.0 | 63.0 | 63.0 |
| 2015 | 0.0 | 0.0 | 63.0 | 63.0 |
| 2016 | 0.0 | 0.0 | 63.0 | 63.0 |

| Year | Extension | | Research | |
|------|-----------|------|----------|------|
| | 1862 | 1890 | 1862 | 1890 |
| 2017 | 0.0 | 0.0 | 63.0 | 63.0 |

V(F). Planned Program (Activity)

1. Activity for the Program

- Conduct research regarding livestock reproduction and fertility rates and share results timely with producers
- Enhance the value of animal products, primarily sheep and beef cattle
- Explore the nutritional managements systems for livestock and winter grazing
- Continue advanced research for targeted grazing management
- Maintain research on residual feed intake and feed to grain conversion

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"> • Education Class • Workshop • Group Discussion • Demonstrations | <ul style="list-style-type: none"> • Billboards • eXtension web sites • Web sites other than eXtension |

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

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 off-campus educational programs offered |

Outcome # 1

1. Outcome Target

Number of off-campus educational programs offered

2. Outcome Type : Change in Knowledge Outcome Measure

3. Associated Knowledge Area(s)

- 301 - Reproductive Performance of Animals
- 302 - Nutrient Utilization in Animals
- 303 - Genetic Improvement of Animals
- 304 - Animal Genome
- 305 - Animal Physiological Processes
- 306 - Environmental Stress in Animals
- 307 - Animal Management Systems
- 308 - Improved Animal Products (Before Harvest)

4. Associated Institute Type(s)

- 1862 Research

V(J). Planned Program (External Factors)

1. External Factors which may affect Outcomes

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

Description

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

V(K). Planned Program - Planned Evaluation Studies

Description of Planned Evaluation Studies

Evaluation studies will be conducted 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

The Montana State University College of Agriculture does not have oversight of the childhood obesity program in Montana. However, two researchers at the COA are working on projects with knowledge areas that clearly fall under childhood obesity. Dr. Sands is exploring different crops that deliver specific value added products to consumers. Dr. Schmidt, a scientist with ImID, is studying food quality and metabolic parameters influencing development and progression of fatty liver disease.

Dr. Sand's research involves finding needs of the consumer base that are not met by current crops. Through the project scientists intend to continue development of camelina, timtana, proatina and montina, and expand marketability and profitability to farmers. The impacts of Proatina and Timtana products have been considerable in the health food market, because they are gluten free and part of a \$2.5 billion annual market. Acreage of production has risen each year. The laboratory and analytical chemistry resources devoted to this project are a key reason why these products are on the market and contributing to the general health of the gluten intolerant and gluten sensitive population, now comprising about 6% of the population.

Dr. Schmidt's program is studying fatty liver disease (FLD) which impacts tens-of-millions of Americans and can progress to liver cirrhosis. This proposal is aimed at understanding the genetic, metabolic, and systemic physiological processes that underlie FLD. The goal is to understand the pathways leading to FLD and eventually design dietary, food-source, or food supplement protocols that might eliminate or abrogate the physical manifestations of FLD. This work will test whether simple shifts in the nation's food supply or in the USDA's nutritional recommendations might be effective at reducing FLD in the U.S. From an agricultural perspective, this might mean that subtle shifts in production of might increase the general health of Americans.

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

4. Program duration : Medium Term (One to five years)

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 |
|---------|--|-----------------|-----------------|----------------|----------------|
| 701 | Nutrient Composition of Food | | | 30% | |
| 702 | Requirements and Function of Nutrients and Other Food Components | | | 30% | |
| 703 | Nutrition Education and Behavior | | | 30% | |
| 723 | Hazards to Human Health and Safety | | | 10% | |
| | Total | | | 100% | |

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

1. Situation and priorities

While childhood is a growing concern in Montana as well as throughout the United States, research at the COA and MAES does not directly impact childhood obesity. Scientists here do however work with the extension service and other stakeholders to develop grain products for specific target markets. Scientists will continue developing high quality grains critical to healthy diets and investigate disease that might be treated through nutritional changes.

2. Scope of the Program

- In-State Extension
- In-State Research

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

1. Assumptions made for the Program

Scientists in other MSU colleges conduct the majority of research in this program. COA researchers will share information regarding nutritional qualities and potential uses for agricultural products, and researchers at ImID will continue research into liver disease and nutritional impacts on those diseases.

2. Ultimate goal(s) of this Program

The goals of the program are to identify field crops with key nutrient composition and further research into how nutrition impacts diseases such as fatty liver disease.

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 |
| 2013 | 0.0 | 0.0 | 5.6 | 0.0 |

| Year | Extension | | Research | |
|------|-----------|------|----------|------|
| | 1862 | 1890 | 1862 | 1890 |
| 2014 | 0.0 | 0.0 | 5.6 | 0.0 |
| 2015 | 0.0 | 0.0 | 5.6 | 0.0 |
| 2016 | 0.0 | 0.0 | 5.6 | 0.0 |
| 2017 | 0.0 | 0.0 | 5.6 | 0.0 |

V(F). Planned Program (Activity)

1. Activity for the Program

- Conduct research experiments
- Partner with the Extension and other MSU colleges to develop recipes using new grain products
- Publish findings of research involving diseases that might be impacted by nutrition

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"> • Education Class • Workshop • Group Discussion | <ul style="list-style-type: none"> • Newsletters • eXtension web sites |

3. Description of targeted audience

- Specific health based consumer groups
- Domestic and foreign buyers of quality grains
- Farmers, colleagues, and stakeholders
- Grain associations, Montana Department of Agriculture, Montana Wheat and Barley Committee, grain elevators, and state commodity groups
 - Economic development groups
 - Participants in extension and commodity group meetings, conventions, and conferences, and field days
- 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

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 | New crops identified with options for specific health-need based consumers |
| 2 | Relationship between high fat diet and liver-cell turnover |

Outcome # 1

1. Outcome Target

New crops identified with options for specific health-need based consumers

2. Outcome Type : Change in Knowledge Outcome Measure

3. Associated Knowledge Area(s)

- 701 - Nutrient Composition of Food

4. Associated Institute Type(s)

- 1862 Research

Outcome # 2

1. Outcome Target

Relationship between high fat diet and liver-cell turnover

2. Outcome Type : Change in Knowledge Outcome Measure

3. Associated Knowledge Area(s)

- 701 - Nutrient Composition of Food
- 702 - Requirements and Function of Nutrients and Other Food Components

4. Associated Institute Type(s)

- 1862 Research

V(J). Planned Program (External Factors)

1. External Factors which may affect Outcomes

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

Description

V(K). Planned Program - Planned Evaluation Studies

Description of Planned Evaluation Studies

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