# 2018 Montana State University Combined Research and Extension Annual Report of Accomplishments and Results

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## I. Report Overview

### 1. Executive Summary

The Montana State University (MSU) College of Agriculture (COA), Montana Agricultural Experiment Station (MAES) and the Montana State University Cooperative Extension Service (Extension) are pleased to present this joint 2018 Annual Report of Accomplishments and Results. Throughout 2018, MSU celebrated its 125th anniversary with a myriad activities to reflect on its history of engagement across Montana, the region, nationally and internationally. This report highlights annual accomplishments, as well as the breadth and depth of MSU Extension and COA/MAES science, outreach, education and innovation over time. Leading the state in cutting-edge research and delivering timely, applied science and information to stakeholders has always been the mission of Montana State University and its agencies.

In Fall 2018, the COA had an enrollment of 1242 students including 198 graduate students. The college has six departments: Agriculture and Ag Economics (joint with College of Letters and Science), Agricultural Education, Animal and Range Sciences, Microbiology and Immunology (joint with College of Letters and Science), Land Resources and Environmental Sciences, and Plant Sciences and Plant Pathology. The College is also home to the Division of Agricultural Education. MSU, along with University of Idaho and Utah State University, are partners with Washington State University in the Washington-Idaho-Montana-Utah (WIMU) Regional Program for Veterinary Medicine. The College also hosts MSU's Peace Corp Prep program.

The MAES has faculty and staff conducting research and outreach in crop and animal production methods, market growth opportunities, pest management, and environmental quality issues. In addition to the main Bozeman, MT campus, which represents the location of approximately 80% of MAES faculty, MAES has seven off-campus Research Centers (Northern Ag Research Center, Havre; Central Ag Research Center, Moccasin; Eastern Ag Research Center, Sidney; Northwestern Ag Research Center, Kalispell; Southern Ag Research Center, Huntley; Western Ag Research Center, Corvallis; and Western Triangle Ag Research Center, Conrad) and local campus farms (Bozeman Agricultural Research and Teaching Farm, Arthur H. Post Agronomy Farm, Lutz Farm, Red Bluff Research Ranch, Fort Ellis Research Farm, and Horticulture Farm).

Extension has always had a grassroots structure with agents living and working across the state to ensure deep engagement with producers, families, businesses and communities; and specialists primarily based on-campus who connect the university and Extension network with communities. Many projects are born directly from the challenges and desires of the state's people. Often, projects have tremendous impact locally, though from a quantitative viewpoint, the impacts may not seem large on a federal level. For instance, the creation of eight FTE jobs in a community of 400 people has a ripple effect far beyond eight new jobs in a market of thousands. For management and leadership purposes, the state is divided into three regions, East, Central and West, with department heads leading each region. Extension leverages Smith-Lever dollars with county contributions to support salary and operations for Montana's 88 County and Reservation Extension Agents. State dollars, grant and other funding covers the expenses for the 54 campus-based specialists who translate applied research to deliver impactful programs to Montana's diverse demographics. Extension's main program areas are: Ag and Natural Resources, Family and

Consumer Sciences, 4-H Youth Development, and Community Development.

Many MSU faculty members have appointments that span teaching, research and outreach with their FTE split between COA, MAES and Extension. Collectively, Hatch, Smith-Lever, State of Montana and county and local funding continue to allow MSU's faculty scientists to meet the changing needs of Montana, explore unique solutions to pressing questions, and solve global problems. These funds provide a foundation for COA/MAES and Extension to successfully compete for complimentary grant funding.

During 2018, MSU was selected in a competitive bid process to be the hosting institution for the Western Sustainable Agricultural Research and Education (SARE) program through Fall of 2023 ($27.5 million total for annual grants and operational budget). SARE is a USDA program that operates with competitive grants conducted cooperatively by farmers, ranchers, researchers and ag professionals to advance farm and ranch systems that are profitable, environmentally sound, and good for communities. All SARE-funded projects are required to include research, education and outreach components in their design. In June of 2018, Western SARE announced funding of approximately $5.5 million for 45 projects located in 13 states and protectorates. At the end of 2018, MSU had four active SARE grants.

**Tribal Partnerships in 2018**

Montana is home to eight land-grant institutions, the most of any state in the nation. Of the eight, only Montana State University, which includes MAES through the Hatch Act and Extension through the Smith-Lever Act, is part of the original Morrill Act of 1862. The other seven are tribal colleges that received land-grant designation through the Elementary and Secondary Education Reauthorization Act of 1994. These institutions and their tribal affiliations are; Aaniiih Nakoda College (Gros Ventre and Assiniboine), Blackfeet Community College (Blackfeet), Chief Dull Knife College (Northern Cheyenne), Fort Peck Community College (Sioux and Assiniboine), Little Big Horn College (Crow), Salish Kootenai College (Bitterroot Salish and Pend d'Oreille, Kootenai of the Flathead Nation) and Stone Child College (Chippewa-Cree).
Having eight land-grants is a source of pride for Montana as there are increasing numbers of partnerships that create comprehensive connections among them and elevate all citizens through the tripartite mission of research, education and outreach. The 1994 tribal colleges serve primarily American Indian populations located in remote, under-served communities that otherwise lack access to higher education. They are critically important to the people they serve and include culturally-relevant curriculum and programs that enhance cultural and historical identity. In addition to adopting the land-grant mission in 1994, four of the reservations also partner with MSU Extension through the Federally Recognized Tribal Extension Program (FRTEP). The Blackfeet, Flathead, Fort Belknap and Fort Peck reservations all have Extension agents who live and work in the community and perform duties much like county agents. In addition, the Northern Cheyenne reservation has an externally-funded Extension office.

Each of the seven 1994 institutions is found on a unique Montana reservation: Blackfeet, Crow, Flathead, Fort Belknap, Fort Peck, Northern Cheyenne, and Rocky Boy. The seven reservations collectively span nine percent of Montana's land and include 12 federally-recognized sovereign tribal nations. These are: Assiniboine, Blackfeet, Chippewa, Cree, Crow, Gros Ventres, Kootenai, Little Shell, Northern Cheyenne, Pend d'Oreille, Salish, and Sioux. The reservation's sovereign and tribal governments establish services for their citizens. There are also many Indian people who live off-reservation in communities across Montana.

The Montana constitution, created in 1972, includes in Article X, section 1(2): "The state recognizes the distinct and unique cultural heritage of the American Indians and is committed in its educational goals to the preservation of their cultural identity." In 1999, the Montana Legislature passed the "Indian Education for All" law as a way of being more intentional about fulfilling this constitutional obligation (§ Mont. Code Annotated 20-1-501). Every public agency and all education personnel are called to work cooperatively with Montana tribes when providing instruction and implementing educational goals, and to include

information specific to the cultural heritage and contemporary contributions of American Indians.

The COA, MAES and Extension cooperatively design and implement programs that best align with Montana's sovereign Indian Nations. Because this demographic is largely underserved and underrepresented, programs and goals were targeted to generate strong and beneficial interactions regarding respective Montana reservation struggles, priorities and needs. COA/MAES and Extension worked with tribal councils and colleges across the Rocky Mountain region, and agents and educators provided a variety of academic programs and opportunities within tribal communities. Cooperative efforts provided resources and training in livestock management, childhood obesity, food preservation and safety, horticulture, pasture restoration, environmental stewardship, sustainable agricultural practices, resource and risk management, pesticide certification, 4-H youth development, healthy living and more. American Indians and other minorities regularly participated in MAES and Extension programming not on reservations or targeted toward tribal needs, as well. Cultural sensitivity and inclusiveness remain an institutional priority for all COA, MAES and Extension programming.

Montana is also home to about 50 Hutterite colonies (population 5,200) and a small number of African Americans (.5%), Asians (.5%), and Hispanic/Latino (4.8%) citizens. Recent growth and recession in some natural resource extraction communities has increased the number of migratory and transient workers in some areas.

**Leadership**

Both the COA/MAES and Extension underwent nationwide searches for new leaders during 2018. Vice President of Agriculture Charles Boyer retired effective December 2018. Dr. Sreekala Bajwa was hired as his successor and began work on January 14, 2019. Bajwa came from North Dakota State University where she was the chair of the Department of Agricultural and Biosystems Engineering and professor of agricultural engineering since 2012. Bajwa is a highly regarded researcher of precision agriculture and has provided international leadership into research and education for applying remote sensing and unmanned aerial systems to agricultural systems.

Dr. Cody Stone was named the permanent executive director of Extension in August. He had served as interim director since June 2017, and as the associate director from 2014-2017. From 2005-2014 he was the director and in other development roles for the Montana 4-H Center for Youth Development. Prior to coming to Montana, he worked for Texas Cooperative Extension as an agent, program specialist and regional program director.

**Agriculture**

The USDA 2018 Montana Agricultural Statistics Report (data primarily from 2017) provides a summary of the states' agricultural footprint:

- Montana land in farms and ranches totaled 59.8 million acres (65.8% pasture and range, 28.5% cropland, 4.4% woodland and 1.4% other), ranked 2$^{nd}$ in the United States.
- There were 27,100 farms and ranches averaging 2,207 acres (2$^{nd}$ in the U.S.), with total farm and ranch assets valued at $58.4 billion.
- The value of crop production decreased to $1.48 billion, down $501.6 million or 25% from 2016.
- The value of livestock decreased to $1.5 billion, down $34.4 million from 2016.
- Overall agriculture industry receipts were down 6.8%.
- Montana ranked 1st in the U.S. in production of garbanzo beans and lentils.
- Montana ranked 2nd in the U.S. in production of barley, dry edible peas, flaxseed, and durum wheat.
- Montana ranked 3rd in the U.S. in production of Canola, alfalfa hay, safflower and other spring wheat; as well as in honey production.

• Montana ranked 7th in the U.S. in calf crop and beef cows, 5th in lamb crop and 6th in breeding sheep and lambs and wool production.

These statistics highlight some of Montana agriculture's challenges. Crop production values decreased 25% primarily due to international trade policies, such as retaliatory tariffs placed by India, China, Canada, Mexico, European Union, among others. Many producers and families faced diminishing margins and real difficulty in maintaining their operations. It is the passion and duty of COA/MAES and Extension to work with Montana producers, landowners and stakeholders to continuously provide cutting-edge and practical research, education and outreach to reduce the negative impacts from drought and fire, economic instability, and other challenges, while improving productivity and sustainability.

Five of the eight program areas highlighted throughout this report directly address the needs of Montana agriculture and natural resources. These include: Animal Sciences; Plant and Soil Sciences; Integrated Pest Management; Farm, Ranch and Business Management; and Energy and Natural Resources.

**Additional Priorities**

While agriculture is a cornerstone of work prioritized by COA/MAES and Extension; it is not the only priority. Four Grand Challenges for Montana State University are identified in the 2019-2024 MSU Strategic Plan, Choosing Promise. These include:

• Caring for our environment: environmental science, design, engineering, architecture and social structure;
• Promoting wellness in our communities: access and equity in education and health outcomes, community-based participatory research, biomedical sciences and entrepreneurship;
• Food and fuel security: sustained food systems, precision agriculture, energy production, transmission and storage;
• Securing the future of Montana: cybersecurity, photonics and optics, defense, governance and public policy.

The final three program areas included in this report encompass these Grand Challenges. These are: Community Development; Healthy Living, Nutrition and Food Safety; and Youth and Family Development.

It is noted that frequently projects within these program areas overlap, demonstrating both an interdisciplinary and multidimensional focus. Further, with new leadership on board in both COA/MAES and Extension, the new MSU Strategic Plan, and NIFA's new Plan of Work structure, it is anticipated that these program areas will be re-evaluated, with stakeholder input, to make sure that the highest priorities of the people of Montana continue to be met through COA/MAES and Extension.

The opportunity to share these highlights, while recognizing there are more stories to be told, is appreciated. It is with much pride that this report is submitted for approval.

**Report Highlights**

1. ANIMAL SCIENCES

Animal health research is of primary importance not only to Montana's beef producers, but for the larger global safety of Montana's food and product exports. Animal Sciences encompasses research priorities in animal health in direct correlation with humans, livestock, or food products. Primary research veins reflective of these areas are; vaccinations, nutrient utilization, reproductive performance, animal physiology, zoonotic diseases, external parasites, animal diseases, genetic improvement of animals and management of range resources. Producing the highest quality animals and obtaining the highest profit potential are essential for Montana.

2018 accomplishments in promoting and maintaining animal health have led to advances in genetics, reproductive science and improved animal performance. Scientists continued to investigate vaccines for rotavirus, strangles, respiratory diseases, and mastitis. Researchers used feed studies with barley, camelina meal, and supplements to evaluate varying rations for calves and cows, for continued production of superior feeder stock to markets outside of Montana. Another study advanced work to understand how nutrition, health and performance of livestock animals are impacted by microbes occupying the regions of the animal's gastrointestinal tract.

MSU Research and Extension partnered with producers to address issues and needs of Montana's agricultural industry in a variety of animal health topics, largely the reproductive performance in animals, nutrition, genetic improvements for herds, and developing better animal management systems. The majority of the research program focused on pre-harvest research and investigation; namely neo-natal health of livestock, disease resistance and best breeding practices. Food safety and security continued as important concerns for the beef industry at all production levels. Via meetings, one-on-one discussions and interactive technologies, COA/MAES and Extension helped to ensure consumers are aware of the quality and health of their products through advancements in educational programs on beef quality assurance (BQA) practices, voluntary beef cattle marketing options, and ranch management issues.

Extension specialists and agents in counties and reservations statewide provided ration analysis, water and soil testing and farm management analysis to assist individual ranchers, as well as communities, in improving profitability. They visited rangeland to advise on topics ranging from weeds to wildlife management and fire mitigation. Their advice was individualized and specific, taking data from devices such as GPS and monitoring systems and making it personal and practical. Youth learned animal quality assurance through 4-H and FFA projects. Extension agents also provided services to ranchers related to sheep and wool production and information and knowledge related to raising chickens and horses, particularly on smaller acreages.

Noxious weeds continue to be a problem in Montana.  In Valley County, risk from narrowleaf hawksbeard infestation prompted the local agent and MAES partners to become experts in management strategies. Following Extension workshops, 48 participants completed surveys indicating they were managing 109,350 cropland acres (of 189,000) they owned or managed. They estimated that without the management techniques taught by MSU they would have experienced an estimated loss of $63/acre, representing a total potential loss of revenue to hawksbeard of more than $6.1 million. The Extension agent who earned conducted the workshops was recognized by the National Association of County Agricultural Agents as an Excellence in Crop Production Award winner.

## 2. PLANT AND SOIL SCIENCES

2018 research accomplishments in Plant and Soil Sciences spoke to the plant science, genomics and pathology that have a direct impact on increasing yield potential, improving winter hardiness, enhancing disease resistance, and improving dual-purpose end-use quality grains, particularly within a changing climate that leads to a longer growing season in warmer temperatures. MSU's intensive genomic research helped Montana producers stay competitive and provided improved cultivars adapted to Montana's climatic conditions and cropping systems. Continued productivity of breeding programs improved the understanding of the genetics from key traits and produced the development of new selection tools.

Broader impacts of the plant and soil science department and it's work in leading, sustaining and enhancing Montana's crop industry and growing a robust research profile include broad impacts including a larger and higher quality food supply for the world, an improved ability of Montana farmers to compete in a global marketplace, and strengthening of products to meet the desires of export markets for U.S. wheat.

MSU faculty and researchers continued to garner national notoriety in their horticulture research in biology, chemistry, plant materials and physiology, plant pathology, plant reproduction and arboriculture.
Early in 2018, MAES publicly released the first a pea variety specifically designed for Montana, currently called, MT457. The variety will be available commercially in 2020. In addition, early in 2020, there were public releases of two winter wheat varieties, one spring wheat variety, and one dryland malt barley variety. http://www.montana.edu/news/17552/msu-releases-green-pea-variety-12-years-in-the-making

COA, MAES and Extension faculty conducted and led programs in cereal quality, genetics, cropping systems, molecular and conventional approaches to plant improvement, plant breeding, molecular genetics, biochemistry, agronomy, precision agriculture and soil acidification. Much of the current research conducted in campus labs and in fields across the state was centered on disease resistance through genetics, bacterial diseases and the biochemistry and molecular genetics of plant diseases. Many research projects were and remain problem-oriented and pertain to major plant pathological problems in the state. MSU Extension's horticulture programs, publications and links provided expert yard, garden and urban integrated pest management resources for individuals and businesses throughout Montana.
During the growing season, calls to MSU Extension offices are often between 50 and 90 percent horticulture related. Extension administers the Master Gardener program statewide and also provides regular programming and one-on-one assistance to clientele including small acreage landowners, urban home owners, renters, non-profit and business managers. Agents provide assistance on everything from planning shelterbelts to community gardens to turfgrasses, flower beds and herb gardens.

3. FARM, RANCH AND BUSINESS MANAGEMENT

COA/MAES and Extension faculty again supported Montanans in managing their farms, ranches and similar enterprises as businesses in 2018. Collectively, the faculty capacity ensured best practices, contracts and estate planning, marketing from an ag perspective, taxation, accounting, operational planning, budgeting, agricultural policy and commodity support programs, risk management and decision support software for Montana. MSU Extension faculty and specialists ensured Montana producers understood implications and changes within the Farm Bill and MSU agricultural economics faculty continued evaluating, engaging and researching federal agricultural policy that directly affects regional producers.

Faculty have worked together to create a comprehensive website with extensive online tools to help producers with decisions including appropriate insurance, whether on-farm oilseed and biodiesel production makes sense for an operation, comparison of current and historical commodity prices, calculating equitable pasture lease rates and more.
Frequently work by MAES agricultural economists is multidisciplinary and could be demonstrated within several program areas. This is apparent through work published this year related to Wheat Stem Sawfly and large-scale semiarid agricultural systems likely to be impacted by climate change. These projects bring together several disciplines to develop practical economic analysis and state-of-the-art econometric methods to assist producers and agribusinesses in decision-making.

4. INTEGRATED PEST MANAGEMENT

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. In 2018, researchers continued to explored new and improved methods to identify and control insects, weeds, and diseases challenging Montana farmers and studied biological controls as low impact pest control options to promote sustainable practices. Producers and researchers continued to evaluate these new integrated pest management (IPM) methodologies so that Montana growers can maintain a competitive position in U.S. and world markets. 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. COA/MAES and Extension professionals continued quality in-depth training programs for integrated pest management education to discover, evaluate or change new IPM priorities and projects. Additional outcomes included increased passing rate percentage for pesticide application licenses and implementation of broad-ranging stewardship practices. Integrated pest management remains a critical field as invasive plant and pest species continue to threaten Montana's agricultural economy as well as the global safety of the state's food exports.

MSU Extension's IPM Programs including the Schutter Diagnostic Laboratory provide training and outreach in detecting new diseases and protecting crop exports destined for international trade. Detecting seedborne diseases in pulse crops including peas, dry beans, chickpeas and lentils is a priority. MSU's Regional Pulse and Diagnostic Laboratory tests pulse crop seeds for pathogens and provides tests to ensure seed health and safety. The Lab is supported by APHIS-PPQ Farm Bill Section 10007, the U.S. Dry Pea and Lentil Council, the Montana Department of Agriculture's Specialty Crop Block Grant and others.
In 2018, Bob Peterson, a professor in Land Resources and Environmental Sciences whose research program is focused on agricultural and biological risk assessment, was elected as the president of the U.S. Entomological Society.

5. ENERGY & NATURAL RESOURCES

Across Montana in 2018, energy and natural resource studies again became increasingly necessary as major environmental changes accelerated. According to the Montana Department of Commerce, Montana has more potential for energy development from existing and untapped diversified sources than any other state in the nation. From coal deposits, oil, wind farms and geothermal energy potential, energy and natural resources have played a vital role in Montana's history and continue to be a priority for Extension and MAES. COA/MAES and Extension faculty continued to recruit competitive grant dollars and personnel to bolster current and forecasted research faculty lines, undergraduate and graduate students, programs and labs, as they relate indirectly and directly to the field of energy and natural resources. Many projects are interdisciplinary in nature - as they speak to research areas impacted by rapid environmental change and natural resource and energy development. The agricultural community in Montana wants to add value to Montana's high-quality crop and livestock systems in ongoing adaptations in regard to the state's energy and natural resource base.
Montana has a long history of mineral and oil extraction, boom and bust cycles, and boom towns that turned into ghost towns. A new Hatch project has been implemented that will analyze factors that impact the ability to convert mineral and oil booms into long and short-run economic growth, development of agricultural and manufacturing sectors, and population growth. This research will be relevant for Montana businesses, farmers and policy makers interested in anticipating the broad economic effects of future commodity boom/bust cycles.
During 2018, faculty prioritized research exploring watersheds and climate change. COA/MAES and Extension professionals continued to make advancements in this critical research agenda and excelled in the discovery and communication of how natural and managed environments and their elements function in an era of global climate change. With more than 60,000 miles of perennial streams providing irrigation, drinking water and recreation, Extension and MAES partnered with communities and citizens to involve local people with data collection to better understand surface and groundwater issues. In addition, forests cover large areas and contribute to the economic base of the state while also serving as a critical natural resource for wildlife, recreation, tourism and cultural purposes. Extension and MAES provide unbiased, science-based research, education and outreach related to preserving and supporting the best use and management of these resources.

6. YOUTH AND FAMILY DEVELOPMENT

MSU Extension continues to provide extensive resources and support to Montana's youth and families. Focused on citizenship, healthy living and science, Montana 4-H is a trusted source of education, skill building and activities for youth and volunteers. In addition, Extension supports youth through afterschool programming and nutrition, financial and other educational opportunities. Family support is provided through e-Parenting, the Grandparent's Raising Grandchildren Program, Powerful Tools for Caregiving and other opportunities that vary from town to town in order to meet specific needs.

MSU Extension's financial education programs continued to be instrumental in assisting families with topics ranging from estate planning, to understanding loan financing and/or health savings programs to utilizing web apps for financial planning. MSU Extension's family economics specialist, Marsha Goetting, earned the 2017 Western Region Excellence in Extension Award from Cooperative Extension, the U.S. Department of Agriculture's (USDA) National Institute of Food and Agriculture (NIFA), and the Association of Public and Land-grant Universities (APLU).

Housing programs continued to provide training for Extension educators, public health professionals, and tribal housing/health entities to address issues such as mold and moisture, radon gas detection, hazardous waste disposal, home asthma triggers and more.

7. HEALTHY LIVING, NUTRITION & FOOD SAFETY

Food insecurity and hunger in Montana is real. The USDA Map and Meal Gap reports that 20.9 percent of Montana's children struggle with hunger, meaning they regularly have concern over whether they will have enough to eat. Access to enough food, and to healthy food specifically, is complicated by the great distances between grocery stores and sometimes poor availability of fresh fruits and vegetables. MSU Extension continues to provide nutrition education through the Supplemental Nutrition Assistance Program (SNAP-ed), and the Expanded Food and Nutrition Education Program (EFNEP). Part of these programs, as well as others, is teaching how to budget, how to utilize less expensive cuts of meat and how to safely store and preserve food, etc. MSU Extension also provides ServSafe food handling education statewide.

Another focus of MSU Extension continues to be healthy living. As the cost of healthcare climbs, staying healthy has to be a priority and nearly every county and reservation offers education and programming to help families manage chronic diseases and remain independent longer by improving their diet and exercise habits.

8. COMMUNITY DEVELOPMENT

MSU Extension is continuing to work in communities across the state to educate elected officials, provide training to board members, offer support to Rural Community Foundations and act as organizers for a wide range of community needs. From building a new community kitchen to assist entrepreneurs with adding value to agricultural products, to fundraising to bring 3-phase power to an airport thus creating new jobs, MSU Extension faculty who live in the communities they work in are often central to bringing community groups together to meet objectives. On several reservations, the Extension faculty have worked alongside elders, youth and others to create gardens, trading posts and transportation plans to bring native fruits and vegetables to place-bound neighbors. Extension is also involved in research to understand how oil and gas boom and bust cycles impact communities; specifically, how to determine the local share of the economic benefits and how to assess actual local costs. Finally, Extension is working with the MSU Center for Mental Health Research and Recovery, One Montana, Stone Child College and Little Big Horn College to increase training in Mental Health First Aid and become facilitators of the Youth Aware of Mental Health program.

**Conclusion**

While only a fraction of the work of Extension and MAES/COA is highlighted in this report, it is clear that the formula funds delivered to Montana State University through Hatch and Smith-Lever are leveraged multiple times to the benefit of the people of Montana and beyond.

**Total Actual Amount of professional FTEs/SYs for this State**

| Year: 2018 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| Plan | 174.0 | {No Data Entered} | 268.0 | {No Data Entered} |
| Actual | 155.5 | 0.0 | 292.0 | 0.0 |

## II. Merit Review Process

### 1. The Merit Review Process that was Employed for this year

- Internal University Panel
- External University Panel
- External Non-University Panel
- Combined External and Internal University Panel
- Combined External and Internal University External Non-University Panel
- Expert Peer Review
- Other (Dept. Head External to PI's Dept. )

### 2. Brief Explanation

Department heads with the MAES and COA review Hatch Projects at the departmental 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 continue for five years. External expert reviews occur with Montana State University faculty outside 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.

MSU Extension requires county and reservation agents and specialists to complete Engagement Plans (EP) that include a community needs assessment, stakeholder input, required inputs and planned outputs,

as well as a plan for evaluation and data collection. Annually, these professionals report against their EPs. The Engagement Results include direct and indirect contacts, actual evaluation process used and actual measured outcomes, impact statements and a summary that includes the problem addressed, the action taken and the results or impacts of the work. These EPs and results are evaluated by county supervisors as well as Extension administration and used to validate and support the importance of the work locally, regionally, statewide and nationally. Internal editors carefully read each section for content, grammar and overall quality review.

## III. Stakeholder Input

### 1. Actions taken to seek stakeholder input that encouraged 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
- Targeted invitation to selected individuals from general public
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Survey of the general public
- Survey specifically with non-traditional groups
- Survey specifically with non-traditional individuals
- Survey of selected individuals from the general public
- Other (Educational outreach programs)

**Brief explanation.**

Personal contact is one of the most successful ways for Extension to gain stakeholder participation. Clientele regularly provide input about which issues are important to them, their families and communities. In addition, Extension professionals reach out to others by staying in regular contact with commodity associations, various government agencies and other partners to assure they are aware of and understand the most current needs and concerns of clients.

Extension agents are located within Montana communities and are an active part of the day-to-day functions of towns, cities, counties and reservations. Agents are often members of community foundations and boards (such as county or tribal weed boards, chamber boards, school boards) and use the knowledge and information they gain in this capacity, as well as face-to-face meetings, to prioritize and strategize the best use of their time, dollars and other resources.

Many specialists spend an abundant portion of their time in fields, gardens, feedlots and town halls with the people they serve. They know that they must have a close relationship with key stakeholders to receive honest feedback and be considered as a valuable resource.

Radio, newsletters, newspapers, social media and electronic distribution lists are also used to inform clientele about the opportunity to make requests for Extension assistance. Informational booths are set up at agricultural trade shows, home and garden shows and health fairs, allowing for discussions with people who are not regular clientele of Extension. This kind of conversation reveals concerns and issues that might not be heard in the usual process. When common issues surface through these methods and the advisory process, they will be incorporated into Extension planning.

MAES and COA obtain stakeholder input on research priorities and programs through a small, yet well-connected group that represents the myriad interests in Montana agriculture. Stakeholder committees include the sustainable agriculture focus group, MAES State Advisory Council, Ag Coalition and other state and local groups. Agriculture interest groups consist 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. Representatives meet periodically 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. 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. Local advisory committees to the research centers also provide annual and long-term guidance to the College and MAES. MAES scientists routinely participate with these groups and Natural Resources Conservation Service to provide training and expertise in many program areas.

**2(A). A brief statement of the process that was 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
- Use Internal Focus Groups
- Use External Focus Groups
- Open Listening Sessions
- Needs Assessments
- Use Surveys

**Brief explanation.**

The seven agricultural research centers have local advisory groups that meet multiple times through the year. In addition, a State Advisory Council meets three times each year to discuss program focus and direction, Montana legislative priorities, and productivity/impact. These meetings are open to the public. Administrators and faculty in COA/MAES 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.

The Montana Extension Advisory Council (MEAC) is a statewide group who meets annually to discuss the overall direction and priorities for MSU Extension. Membership on MEAC is based on geographic representation, areas of interest, including a tribal representative and an elected 4-H ambassador, and previous relationship with Extension. Recruitment from specific sectors such as healthcare, government agencies and community development are also targeted. County agents and state specialists, Extension program leaders and regional department heads are asked to make recommendations for membership to MEAC. Those who are elected serve a three-year term.

Many counties also have local advisory groups. Membership on these boards is achieved by sending an invitation to traditional stakeholder groups requesting the name of an individual who can represent views and provide input for Extension programming. A similar invitation is sent to

nontraditional groups. In cases where a group may not be familiar with Extension, personal contact is made to explain the role of the representative.

**2(B). A brief statement of the process that was 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
- Survey of traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals
- Survey of traditional Stakeholder individuals
- Meeting with the general public (open meeting advertised to all)
- Survey of the general public
- Meeting specifically with non-traditional groups
- Survey specifically with non-traditional groups
- Meeting specifically with non-traditional individuals
- Survey specifically with non-traditional individuals
- Meeting with invited selected individuals from the general public
- Survey of selected individuals from the general public

**Brief explanation.**

The most common method of gathering stakeholder input is from interaction with regular clientele of MSU Extension. Often this occurs in intentional program planning sessions to which these people are invited, requested to attend or are required to be present by their role or position. Examples of groups that may fall into this category are county/reservation 4-H Councils, livestock associations, weed boards, human resource coalitions, local and state agricultural organizations, Ag Research Center Advisory Committees and special interest groups. Some of these groups have officers or directing boards who are asked for specific input.

County and state advisory committees are also used to gather input. Advisory groups are generally comprised of a cross section of leadership and citizens in the county. Efforts are made to involve the underserved and underrepresented clientele by contacting agencies and organizations that regularly work with a particular audience. They are asked for input and/or for names of people who could provide input directly. Local Extension agents follow up with personal conversations to explain the goals and process.

At the state level, one of the most valuable sources of input is from the Montana Association of Counties (MACo). Extension makes presentations during MACo's Annual Meeting, followed by an open session for mutual dialogue. These types of discussions also happen during the newly elected county commissioners' orientation and have proven very beneficial. Extension administration, through regional department heads (RDHs), also gathers stakeholder information from county commissioners.

Through direct participation with agricultural stakeholder groups, broad participation in committees, and directed meetings, MAES listens to and considers defined problems or questions that research programs can address. COA/MAES considers the voice of public stakeholders at every turn and works closely alongside various producer groups to critique and share applied research and methodology. It is common for many of Montana's public and private agricultural groups to hold

meetings in COA/MAES facilities on campus, or for state-wide producers to volunteer a portion of their acreage for research studies. The director targets selective meetings with nontraditional groups. Montana has an open meeting law. Therefore, all meetings are open to the public and the organizer must publish an agenda.

During programs targeted at certain audiences such as Expanded Food and Nutrition Education Programs (EFNEP) and Supplemental Nutrition Assistance Program-Education (SNAP-Ed), attendees are asked directly for input or may be asked to serve on a specific advisory committee for the program area.

Occasionally, broad surveys or requests for information are made.

**3. A statement of how the input will be considered**

- In the Budget Process
- To Identify Emerging Issues
- Redirect Extension Programs
- Redirect Research Programs
- In the Staff Hiring Process
- In the Action Plans
- To Set Priorities
- Other (Create a basis for additional resources )

**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, MAES and Extension clearly set the tone for this interactive environment. The College, research centers and Extension serve as the primary conduit for connection and delivery of education and new knowledge in activities throughout rural Montana.

An example of how MSU COA/MAES and Extension have used stakeholder input is the work being done in Mental Health Research. Montana has led the nation in suicide for many of the last 30 years and has always been ranked in the top five nationally. Every county has mental health provider shortages. As part of the USDA-NIFA and Montana Mental Health Trust Fund grant, Extension was able to have four county faculty certified to teach the adult version of Mental Health First Aid. This 8-hour program is based on the format of regular first aid. In this case, participants learn mental health literacy, what to do in the event of a mental health crisis, and how to link people in need of mental health services to such professionals. This is in response to many communities recognizing mental health as a critical need through community health needs assessments. In addition, Extension is partnering in research to expand resources for youth through offering the Youth Aware of Mental Health training across the state. Extension is in the position to begin conversations around mental health and to start community capacity building on the issue in communities across the state.

**Brief Explanation of what you learned from your Stakeholders**

Stakeholders play a key role in our programs, and they are pleased with the direction the COA/MAES and Extension are going. During recent legislative hearings key stakeholders repeatedly testified about COA/MAES and Extension accomplishments from integrated pest management and wheat breeding programs, to youth development STEM, service and leadership activities and horticulture and gardening education.

In addition, Extension and MAES/COA address concerns of Montana stakeholders in a wide range of issues much like those receiving attention across the nation. Many Montanans worry about job security and accessing healthcare in their rural community. Rural families wonder if local schools will remain open, or conversely if overcrowding or transiency will cause issues. In those areas where education can help address the issue, Montanans look to MSU Extension and MAES as an unbiased resource that can help them make choices and decisions that are best for their families, businesses and communities.

## IV. Expenditure Summary

| 1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS) | | | |
|---|---|---|---|
| Extension | | Research | |
| Smith-Lever 3b & 3c | 1890 Extension | Hatch | Evans-Allen |
| {No Data Entered} | {No Data Entered} | {No Data Entered} | {No Data Entered} |

| 2. Totaled Actual dollars from Planned Programs Inputs | | | | |
|---|---|---|---|---|
| | Extension | | Research | |
| | Smith-Lever 3b & 3c | 1890 Extension | Hatch | Evans-Allen |
| Actual Formula | 1303335 | 0 | 2912475 | 0 |
| Actual Matching | 0 | 0 | 15311968 | 0 |
| Actual All Other | 1427609 | 0 | 13764486 | 0 |
| Total Actual Expended | 2730944 | 0 | 31988929 | 0 |

| 3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous | | | | |
|---|---|---|---|---|
| Carryover | 0 | 0 | 0 | 0 |

# V. Planned Program Table of Content

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

**Program # 1**

**1. Name of the Planned Program**

Animal Sciences

☑ Reporting on this Program

**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 | 10% | | 10% | |
| 302 | Nutrient Utilization in Animals | 5% | | 10% | |
| 303 | Genetic Improvement of Animals | 5% | | 5% | |
| 305 | Animal Physiological Processes | 0% | | 5% | |
| 306 | Environmental Stress in Animals | 5% | | 10% | |
| 307 | Animal Management Systems | 5% | | 5% | |
| 308 | Improved Animal Products (Before Harvest) | 5% | | 5% | |
| 311 | Animal Diseases | 10% | | 5% | |
| 312 | External Parasites and Pests of Animals | 0% | | 10% | |
| 315 | Animal Welfare/Well-Being and Protection | 10% | | 5% | |
| 603 | Market Economics | 5% | | 5% | |
| 604 | Marketing and Distribution Practices | 5% | | 5% | |
| 722 | Zoonotic Diseases and Parasites Affecting Humans | 0% | | 10% | |
| 902 | Administration of Projects and Programs | 0% | | 5% | |
| 903 | Communication, Education, and Information Delivery | 35% | | 5% | |
| | **Total** | 100% | | 100% | |

## V(C). Planned Program (Inputs)

**1. Actual amount of FTE/SYs expended this Program**

| Year: 2018 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 3.0 | 0.0 | 71.6 | 0.0 |
| **Actual Paid** | 4.5 | 0.0 | 62.5 | 0.0 |
| **Actual Volunteer** | 0.8 | 0.0 | 0.0 | 0.0 |

### 2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 120975 | 0 | 646535 | 0 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 0 | 0 | 4122877 | 0 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 33755 | 0 | 5381226 | 0 |

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

• Meet one-on-one with producers, landowners and consumers to identify and address individual problems and solutions
• Encourage email and phone conversations with members of the public
• Offer classes, workshops, group discussions, demonstrations, field tours/trials, webinars
• Share information at farmer's markets, county fairs and other community events
• Attend and present information at professional conferences, county meetings and state conventions
• Prepare and distribute public service announcements, newsletters, MONTGuides, Television (Montana PBS Montana Ag Live), eXtension, listservs, blogs, radio and other media
• Create readily available and easily accessible databases for producers and researchers
• Prepare research articles, fact sheets and news releases for scientists and statewide media
• Host strategic planning meetings with state agricultural groups
• Develop systems that ensure food safety and agricultural security
• Integrate best practices for beef quality assurance in programs

### 2. Brief description of the target audience

• Livestock producers
• Commodity Associations
• Land managers/owners (small and large)
• Weed Control Professionals
• State Agencies
• County Weed Boards
• Colleagues and related stakeholders
• Animal health businesses
• Legislators, county commissioners and other elected officials
• Rodeo team and related partners
• Tribal land managers
• Rural large-animal veterinarians

### 3. How was eXtension used?

MSU utilized the Community of Practices for Livestock and Poultry Environmental Learning Center and the

Niche Meat Processors Assistance Network, including by contributing resources. eXtension was also used by agents and specialists to both ask and answer general questions.

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

**1. Standard output measures**

| 2018 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 9684 | 97000 | 1508 | 4000 |

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

**Patent Applications Submitted**

| | |
|---|---|
| Year: | 2018 |
| Actual: | 0 |

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

| 2018 | Extension | Research | Total |
|---|---|---|---|
| **Actual** | 0 | 0 | 72 |

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

**Output Target**

**Output #1**

**Output Measure**

- Number of research citations

| Year | Actual |
|---|---|
| 2018 | 42 |

**Output #2**

**Output Measure**

- Number of publications on infectious disease and vaccines research
  Not reporting on this Output for this Annual Report

**Output #3**

**Output Measure**

- Number of presentations on infectious disease research
  Not reporting on this Output for this Annual Report

**Output #4**

**Output Measure**

- Number of undergraduate and graduate students trained in animal science and biotechnology

| Year | Actual |
|---|---|
| 2018 | 700 |

**Output #5**

**Output Measure**

- Number of producers attending beef cattle workshops and clinics

| Year | Actual |
|---|---|
| 2018 | 9684 |

**Output #6**

**Output Measure**

- Number of Native American Youth receiving Junior Ag Loans
  Not reporting on this Output for this Annual Report

**V(G). State Defined Outcomes**

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Extension and MAES Beef Cattle Programs -Increase the number of producers using Extension and MAES information to successfully manage animal health and well-being issues. -Increase the number of producers who successfully utilize Extension and MAES programs to improve profitability. -Increase the number of producers who successfully utilize Extension and MAES to improve environmentally sustainable practices. |
| 2 | Extension and MAES Sheep Programs -Improve profitability of producers in the sheep and wool market through increased participation in and knowledge gained from seminars, classes and other educational opportunities; and expanding wool pools, wool delivery and marketing. |
| 3 | Identification of critical infection and disease resistance |
| 4 | Number of improvements in vaccines developed |
| 5 | Identification of genetic correlations and other factors influencing residual feed intake and feed efficiency; and education of producers and industry leaders with the latest scientific information |
| 6 | Conduct basic and applied infectious disease research -Increase the quality of meat, milk and fiber products -Reduce non-predator deaths in calves |

## Outcome #1

### 1. Outcome Measures

Extension and MAES Beef Cattle Programs -Increase the number of producers using Extension and MAES information to successfully manage animal health and well-being issues. -Increase the number of producers who successfully utilize Extension and MAES programs to improve profitability. -Increase the number of producers who successfully utilize Extension and MAES to improve environmentally sustainable practices.

### 2. Associated Institution Types

- 1862 Extension
- 1862 Research

### 3a. Outcome Type:

Change in Condition Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2018 | 0 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Beef cattle production results in the greatest share of agriculture receipts in Montana. The 2018 Montana Agriculture Statistics report by the USDA indicates that Montana's cattle and calves industry was valued at $1.5 billion. The cost of supplementing feed and nutritional supplements for a beef cow herd are between 50-70% of the cash costs of producing calves in Montana. Challenges for Montana producers include high nitrate levels which can cause decreased weight gain, decreased milk yield, abortion and death; and a lack of understanding of the science behind grazing rotations.

**What has been done**
Classes, seminars, AgAlerts, MontGuides, Montana Ag Live television and various newsletters, websites and social media are used to educate Montana producers in making cost-effective feeding decisions based on cow nutritional needs, timing and alteration of grazing rotations, and more. Because each ranch has a unique set of available feed and forage, producer knowledge, and experience, Extension often utilizes one-on-one, in the field/pasture/barn interactions with producers. Offices offer feed testing and ration balancing assistance. During 2018, Extension faculty reported offering 104 presentations, attended by 9,684 adults and 1,508 youth.

**Results**
- Stillwater County: Due to one of the toughest winters on record, ranchers needed to use lower quality forage. Forty-two ranchers used Extension to develop rations for cattle and sheep that would supply appropriate nutrients. Death loss during calving and lambing was held to less than 10% on more than 92% of the ranches. The agent worked with five producers to evaluate ranch

and grazing ground for production and carrying capacity related to purchasing decisions.
- Broadwater County: The number of nitrate tests completed doubled to 43. Of these 53% showed high or moderately high levels of nitrates. The agent advised further testing and/or reducing use of the forage, thus limiting potential economic loss due to nitrate poisoning.
- Valley County: Tested 56 forage samples, representing 32,500 ton of hay, for nitrates and/or relative feed value. The agent provided one-one-one guidance in each situation to mitigate potential losses and maximize profitability.
- Prairie County: Tested 30 feed samples, 29% tested high enough in nitrates that delaying cutting or diluting rations was necessary to avoid loss.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 301 | Reproductive Performance of Animals |
| 302 | Nutrient Utilization in Animals |
| 303 | Genetic Improvement of Animals |
| 305 | Animal Physiological Processes |
| 306 | Environmental Stress in Animals |
| 307 | Animal Management Systems |
| 308 | Improved Animal Products (Before Harvest) |
| 311 | Animal Diseases |
| 315 | Animal Welfare/Well-Being and Protection |
| 603 | Market Economics |
| 604 | Marketing and Distribution Practices |
| 903 | Communication, Education, and Information Delivery |

**Outcome #2**

**1. Outcome Measures**

Extension and MAES Sheep Programs -Improve profitability of producers in the sheep and wool market through increased participation in and knowledge gained from seminars, classes and other educational opportunities; and expanding wool pools, wool delivery and marketing.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|

| | |
|---|---|
| 2018 | 0 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**

Montana State University has been directly tied with the sheep industry since its founding in 1893. Extension, COA and MAES have been deeply involved in generations-long breeding programs, expansive grazing and weed control initiatives and concentrated, strategic efforts to make Montana wool more competitive in the world market. Impactful engagement at all levels has enhanced the industry which supports 215,000 sheep, earning Montana a current ranking of 8th in all sheep and lamb production and 6th in wool production nationally. For various reasons, including turnover and position vacancies, the Northern Great Plains region has a significant need for expertise in sheep and wool programming.

**What has been done**

In October of 2018, a new Extension Sheep Specialist was hired to provide educational and research leadership for the MSU Sheep and Wool Program including activities at MAES Red Bluff, MAES Fort Ellis, Montana Wool Lab and programs and research at the state, regional and national level. Through the end of the year this specialist provided 18 presentations directly reaching 494 producers and faculty and students within Extension, MAES and COA. Education included the following topics: improving wool quality and information to improve profitability; intense, hands-on instruction on sheep shearing; predator control; multi-species grazing, nutrition; lamb processing and more.

**Results**

- Cooperated with the US Sheep Experiment Station and Texas A&M on two research projects concerning new technology uses for analyzing wool and clean wool genetics
- Analyzed 9,000 wool samples for 124 growers for genetic improvement and/or quality factors important in value-added processing (Montana Wool Lab)
- Trained 55 learner and beginning shearers, including from four Hutterite Colonies, through three days of intense, hands-on instruction. This training will help fill the nationwide shortage of qualified shearers, and reached an under-served population.
- Marketed over 98,000 pounds of wool for 84 producers from five smaller wool pools through the Eastern Montana Wool Pool Market, resulting in an increase of 8.5% for the combined clip, which sold for $273,292.14.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 301 | Reproductive Performance of Animals |
| 302 | Nutrient Utilization in Animals |
| 303 | Genetic Improvement of Animals |
| 307 | Animal Management Systems |
| 308 | Improved Animal Products (Before Harvest) |
| 315 | Animal Welfare/Well-Being and Protection |
| 603 | Market Economics |
| 604 | Marketing and Distribution Practices |

903 Communication, Education, and Information Delivery

**Outcome #3**

**1. Outcome Measures**

Identification of critical infection and disease resistance

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
The factors affecting nutrition, health and performance of livestock animals overlap and collectively underpin the economic performance of all livestock operations. Each of these important factors is significantly impacted by microbes occupying the different regions of the animal's gastrointestinal tract. Microbial species that produce metabolites, have the potential to produce metabolites, or who correlate with health and production traits must be isolated and characterized. These microbes can then be assessed for use in novel non-antibiotic, consumer-acceptable direct microbial interventions that optimize neonatal health and productivity and improve product quality.

**What has been done**
Researchers have worked to combine modern molecular approaches to assess composition, functional potential, and small molecule metabolite dynamics with longitudinally collected measures of health and productivity to better understand microbial species. Next steps will involve testing microbial strains for their ability to stimulate immune function in neonatal animals and to promote productivity. Private funding has been secured to look at microbial detoxification of the major larkspur toxin methyllycaconitine, which is responsible for numerous cases of morbidity and mortality among range cattle.

**Results**
Results of work so far have:
- Shown that feed efficiency involves microbes in the rumen, small intestine and hind gut
- Shown that feed efficiency involves microbial taxa associated with healthy phenotypes
- Shown that maternal microbial reservoirs make major and important contributions to the neonatal gut microbiome

- Demonstrated that an animal's immunological development corresponds, and may therefore be at least partially, dependent on the succession of the ruminant gut microbiota.
- Identified several microbial taxa that show strong correlative relationships to animal productivity
- Identified several microbial taxa that show strong correlative relationships to immunological development

This work has been shared through three publications, the W4177 annual meeting and in two invited talks. To date these results are mostly of value to the research community, though the intent is ultimately intended to target producers, processors, policy makers and consumers.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 301 | Reproductive Performance of Animals |
| 302 | Nutrient Utilization in Animals |
| 303 | Genetic Improvement of Animals |
| 305 | Animal Physiological Processes |
| 308 | Improved Animal Products (Before Harvest) |
| 311 | Animal Diseases |
| 315 | Animal Welfare/Well-Being and Protection |

**Outcome #4**

**1. Outcome Measures**

Number of improvements in vaccines developed

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Tens-of-millions of Americans have fatty liver disease (FLD) and an estimated 8 million of these will progress to liver cirrhosis. Most cases of FLD are caused by excessive consumption of either calories or alcohol, and therefore nearly all attempts to treat are behavioral. Since this has not proven to be effective, better understanding is needed as a to whether there are genetic,

metabolic and systemic physiological processes that underlie FLD. The goal is to understand the metabolic pathways leading to FLD such that one might design dietary, food-source, or food supplement protocols that might eliminate or abrogate the physical manifestations of FLD even in people who continue to partake in high-risk behaviors for FLD.

**What has been done**
Most of the work in 2018 was writing, reviewing, revising and preparing papers and journal articles to extend this study. The PI and participating graduate students also focused on professional development to better prepare them for next steps in the research.

**Results**
Five new papers have been published and several more are in review, revision or preparation. Most importantly, this study led to the discovery that metazoan animals, including mammals, have a previously unrecognized disulfide reductase system that can protect cells against severe oxidative exposures that might incapacitate both the TrxR1- and the Gsr-driven systems. This system, which is fueled entirely by methionine, an essential amino acid that must be provided in the diet, was unexpected and does not exist in the simple systems that have informed our current understanding of cellular antioxidant systems. The implications of this on both chronic and acute exposure to liver toxins or stresses, and how this might impact FLD, are large. Ongoing work will include investigation into dietary supplements, hepato-active pharmacologics, and altered dietary compositions on the ability of the liver to sustain homeostasis and organismal health under conditions that compromise TrxR1 and Gsr.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 302 | Nutrient Utilization in Animals |
| 303 | Genetic Improvement of Animals |
| 306 | Environmental Stress in Animals |
| 311 | Animal Diseases |
| 315 | Animal Welfare/Well-Being and Protection |
| 722 | Zoonotic Diseases and Parasites Affecting Humans |

**Outcome #5**

**1. Outcome Measures**

Identification of genetic correlations and other factors influencing residual feed intake and feed efficiency; and education of producers and industry leaders with the latest scientific information

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2018 | 0 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
The extensive use of grazing systems for beef cattle and the high variation in forage quality throughout the year has an important impact on production. A change in feed quality and availability alters the nutritional and physiological status of animals during gestation. Nutrient restriction during this crucial time plays a large role in cow efficiency. Therefore, it is important to better understand the impact of these changes in energy use by the whole animal or by specific tissue, throughout the year. Since no studies have been conducted using the gestating range beef cow as a model, research in this area is needed.

**What has been done**
One objective of a study on how feed quality fluctuations impact an animals energy was to characterize the changes in temporal concentrations of fibroblast growth factor 21 (FGF21) in beef heifers. This has been completed and data analysis is being finalized. Preliminary reports were previously published in 2016 and 2017. Another objective was to determine the effects of nutrition on nutrient-sensing neuronal circuitry. This was completed as well, and a manuscript is being finalized for publication.

**Results**
The results from this study are being used to design a future project that will evaluate the effects of different feed supplements and the timing that those supplements are offered during gestation, on changes of body condition and perhaps on how the pattern of secretion of FGF21 is altered. Having a different pattern of secretion may contribute to the cow returning to normal estrous cycling sooner after calving.

Finally, strategies were developed to better manage offspring exposed to intrauterine malnutrition. Further funding for this project was secured through AFRI-USDA-NIFA and animal work was initiated. Two presentations were given at the Northern Ag Research Center updating producers on this work, with 220 people attending.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 301 | Reproductive Performance of Animals |
| 302 | Nutrient Utilization in Animals |
| 303 | Genetic Improvement of Animals |
| 305 | Animal Physiological Processes |
| 306 | Environmental Stress in Animals |
| 307 | Animal Management Systems |
| 308 | Improved Animal Products (Before Harvest) |
| 315 | Animal Welfare/Well-Being and Protection |

**Outcome #6**

**1. Outcome Measures**

Conduct basic and applied infectious disease research -Increase the quality of meat, milk and fiber products -Reduce non-predator deaths in calves

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
The top livestock species produced in Montana are beef and sheep, which account for almost five percent of the U.S. production value of these species. One of the greatest challenges for livestock production is capturing some of the added value for the cow/calf and feeder lamb operations in the state. The increase in ranchers participating in alliances, where end product is important, has led to a greater interest in the effect of production and management decisions on the final product than in the past. Many alliances seek to guarantee meat tenderness to differentiate themselves from commodity beef. The lamb industry needs to identify the rearing practices that result in stronger lamb flavor or off-flavors if lamb consumption is to be expected to grow.

**What has been done**
The objective of beef research is to evaluate the differences in the expression of transcription factors as the animal approaches the end of the growth curve, and compare this to measurements of tenderness to see if there is a specific set of biochemical processes that occur that impact tenderness. The objective of the sheep study is to determine if age, breed or finishing diet increases or decreases the occurrence of specific off-flavors associated with sheep meat. Fifteen steers were finished to the designated endpoints of Standard, Select, and Choice quality grades. At harvest samples of muscle and adipose tissue were collected and flash frozen for RNAseq analysis.

Six sheep were harvested and carcass data and cut weights were recorded. Flavor work is in progress.

**Results**
Choice carcasses weighed significantly more than select or standard. Fat thickness was significantly higher from animals classified as Choice and Select than from Standard. KEGG (Kyto Encyclopedia of Genes and Genomes) is a collection of curated databases dealing with

genomes, biological pathways, diseases, drugs and chemical substances. KEGG revealed that the greatest differences in pathway enrichment was seen in adipose tissue between the Choice and Standard grades. Further KEGG indicated some overlap and interaction between different genes that would suggest opposite effects. No genes currently associated with muscle growth were observed. More research is needed to clarify what these changes mean to determining quality grade.
The information was presented at the 66th International Congress of Meat and Science Technology, 11-15 August 2018, Melbourne, Australia. One student completed a Masters thesis based on the objective that looked at carcass weight as an indicator of Standard, Select and Choice rating.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 302 | Nutrient Utilization in Animals |
| 303 | Genetic Improvement of Animals |
| 305 | Animal Physiological Processes |
| 306 | Environmental Stress in Animals |
| 307 | Animal Management Systems |
| 308 | Improved Animal Products (Before Harvest) |
| 603 | Market Economics |
| 604 | Marketing and Distribution Practices |

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

**External factors which affected outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Populations changes (immigration, new cultural groupings, etc.)
- Other (high cost of fuel, fertilizer)

**Brief Explanation**

MSU Extension only had one Beef Cattle Specialist throughout the year. The second specialist has been hired and will begin in 2019. MSU's Sheep Specialist position was vacant from January through August.
The Communications Specialist for MAES resigned at the end of 2018 leaving a gap in knowledge of MAES projects for this report.

## V(I). Planned Program (Evaluation Studies)

**Evaluation Results**

Beef cattle production results in the greatest share of agriculture receipts in Montana. The 2018 Montana Agriculture Statistics report by the USDA indicates that Montana's cattle and calves industry was valued at $1.5 billion. In 2018, Montana was the largest seedstock

producer in the U.S., and 1 out of 6 Angus bulls comes out of Montana. The Montana Angus Association donated 50 prebred Angus heifers (with another 50 promised in a year) to develop highly applied research across multiple areas (genetics, nutrition, etc.)
During 2018, Extension faculty reported offering 104 beef cattle related presentations , attended by 9,684 adults and 1,508 youth.

- Stillwater County: Due to one of the toughest winters on record, ranchers needed to use lower quality forage. Forty-two ranchers used Extension to develop rations for cattle and sheep that would supply appropriate nutrients. Death loss during calving and lambing was held to less than 10% on more than 92% of the ranches.
- Valley County: Tested 56 forage samples, representing 32,500 ton of hay, for nitrates and/or relative feed value. The agent provided one-one-one guidance in each situation to mitigate potential losses and maximize profitability.
- Prairie County: Tested 30 feed samples, 29% tested high enough in nitrates that delaying cutting or diluting rations was necessary to avoid loss.

In October of 2018, a new Extension Sheep Specialist was hired to provide educational and research leadership for the MSU Sheep and Wool Program including activities at MAES Red Bluff, MAES Fort Ellis, Montana Wool Lab and programs and research at the state, regional and national level.

- Analyzed 9,000 wool samples for 124 growers for genetic improvement and/or quality factors important in value-added processing (Montana Wool Lab)
- Trained 55 learner and beginning shearers, including from four Hutterite Colonies, through three days of intense, hands-on instruction. This training will help fill the nationwide shortage of qualified shearers, and reached an underserved population.
- Marketed over 98,000 pounds of wool for 84 producers from smaller wool pools through the Eastern Montana Wool Pool Market, resulting in an increase of 8.5% for the combined clip which sold for $273,292.14.

Animal nutrition: Nutrition, health and performance of livestock are important factors that are significantly impacted by microbes occupying the different regions of the animal's gastrointestinal tract. These microbes can then be assessed for use in novel non-antibiotic, consumer-acceptable direct microbial interventions that optimize neonatal health and productivity and improve product quality. Results of work so far have:

- Shown that feed efficiency involves microbes in the rumen, small intestine and hind gut; and is associated with healthy phenotypes
- Shown that maternal microbial reservoirs make major and important contributions to the neonatal gut microbiome
- Demonstrated that an animal's immunological development corresponds, and may therefore be at least partially, dependent n the succession of the ruminant gut microbiota.
- Identified several microbial taxa that show strong correlative relationships to animal productivity and immunological development

**Key Items of Evaluation**

Added value: One of the greatest challenges for livestock production is capturing some of the added value for the cow/calf and feeder lamb operations in the state. The objective of beef research is to evaluate the differences in the expression of transcription factors as the animal approaches the end of the growth curve and compare this to measurements of tenderness to see if there is a specific set of biochemical processes that occur that impact tenderness.
KEGG (Kyto Encyclopedia of Genes and Genomes) revealed that the greatest differences in

pathway enrichment was seen in adipose tissue between the Choice and Standard grades. Further KEGG indicated some overlap and interaction between different genes that would suggest opposite effects. No genes currently associated with muscle growth were observed. More research is needed to clarify what these changes mean to determining quality grade.

Fatty Liver Diseases: Tens-of-millions of Americans have fatty liver disease (FLD) and an estimated 8 million of these will progress to liver cirrhosis. Understanding is needed as a to whether there are genetic, metabolic and systemic physiological processes that underlie FLD that could lead to dietary, food-source, or food supplement protocols that might eliminate or abrogate the physical manifestations of FLD. Five new papers have been published and several more are in review, revision or preparation. Most importantly, this study led to the discovery that metazoan animals, including mammals, have a previously unrecognized disulfide reductase system that can protect cells against severe oxidative exposures that might incapacitate both the TrxR1- and the Gsr-driven systems.

Grazing systems: The extensive use of grazing systems for beef cattle and the high variation in forage quality throughout the year has an important impact on production. A change in feed quality and availability alters the nutritional and physiological status of animals during gestation. Nutrient restriction during this crucial time plays a large role on cow efficiency. One objective of this study was to characterize the changes in temporal concentrations of fibroblast growth factor 21 (FGF21) in beef heifers. This has been completed and data analysis is being finalized. Preliminary reports were previously published in 2016 and 2017. Another objective was to determine the effects of nutrition on nutrient-sensing neuronal circuitry. This was completed as well, and a manuscript is being finalized for publication.

Strategies were developed to better manage offspring exposed to intrauterine malnutrition. Further funding for this project was secured through AFRI-USDA-NIFA and animal work was initiated. Two presentations were given at the Northern Ag Research Center updating producers on this work, with 220 people attending.

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

**Program # 2**

**1. Name of the Planned Program**

Plant and Soil Sciences

☑ Reporting on this Program

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

1. Program Knowledge Areas and Percentage

| KA Code | Knowledge Area | %1862 Extension | %1890 Extension | %1862 Research | %1890 Research |
|---|---|---|---|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships | 10% | | 10% | |
| 104 | Protect Soil from Harmful Effects of Natural Elements | 10% | | 5% | |
| 111 | Conservation and Efficient Use of Water | 0% | | 5% | |
| 112 | Watershed Protection and Management | 10% | | 5% | |
| 132 | Weather and Climate | 15% | | 10% | |
| 141 | Air Resource Protection and Management | 0% | | 5% | |
| 201 | Plant Genome, Genetics, and Genetic Mechanisms | 0% | | 10% | |
| 203 | Plant Biological Efficiency and Abiotic Stresses Affecting Plants | 0% | | 10% | |
| 204 | Plant Product Quality and Utility (Preharvest) | 10% | | 5% | |
| 205 | Plant Management Systems | 10% | | 10% | |
| 206 | Basic Plant Biology | 0% | | 10% | |
| 502 | New and Improved Food Products | 0% | | 10% | |
| 503 | Quality Maintenance in Storing and Marketing Food Products | 5% | | 0% | |
| 601 | Economics of Agricultural Production and Farm Management | 10% | | 0% | |
| 903 | Communication, Education, and Information Delivery | 20% | | 5% | |
| | **Total** | 100% | | 100% | |

## V(C). Planned Program (Inputs)

**1. Actual amount of FTE/SYs expended this Program**

| Year: 2018 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 3.0 | 0.0 | 110.3 | 0.0 |
| **Actual Paid** | 6.5 | 0.0 | 140.4 | 0.0 |

| | | | | |
|---|---|---|---|---|
| **Actual Volunteer** | 9.7 | 0.0 | 0.0 | 0.0 |

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 116439 | 0 | 1268478 | 0 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 0 | 0 | 7065682 | 0 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 204579 | 0 | 5203935 | 0 |

## V(D). Planned Program (Activity)

**1. Brief description of the Activity**

- Develop new crops and cultivars suitable to a warmer and drier climate
- Explore the ecological impact of climate change on Montana grazing areas
- Study the impact of a changing climate on insects
- Continue investigating crops and management systems that rely on less water consumption
- Meet one-on-one with producers, landowners and consumers to identify and address individual problems and solutions
- Encourage email and phone conversations with members of the public
- Offer classes, workshops, group discussions, demonstrations, field tours/trials, webinars
- Share information at farmer's markets, county fairs and other community events
- Attend and present information at professional conferences, county meetings and state conventions
- Prepare and distribute public service announcements, newsletters, MONTGuides, Television (Montana PBS Montana Ag Live), eXtension, listservs, blogs, radio and other media
- Create readily available and easily accessible databases for producers and researchers
- Prepare research articles, fact sheets and news releases for scientists and statewide media
- Host strategic planning meetings with state agricultural groups and Extension advisory groups
- Develop systems that ensure food safety and agricultural security
- Support FIFRA Section 18c products labeling requests
- Release germplasm, new cultivars, and new genomics tools and techniques
- Develop value-added, agriculturally based end-use products
- Enhance partnerships among faculty across Montana institutions, producers, agricultural industry and other educational institutions
- Enhance agricultural production practices to enhance product quality
- Investigate and educate producers on crops and management systems that consume less water

**2. Brief description of the target audience**

- Crop and livestock producers
- State agricultural advisory committees
- State and federal government agencies

- Commodity associations
- Weed control professionals and County Weed Boards
- Small acreage landowners
- Tribal councils and Native American producers
- Crop protection companies registration and research personnel
- Private and commercial pesticide applicators
- Domestic and foreign buyers of wheat
- Montana Wheat and Barley Committee, grain elevator operators

**3. How was eXtension used?**

Extensin faculty utilized eXtension to provide webinars and programming, communicate with producers, share fact sheets, evaluate courses and programs (Moodle), conduct interviews, create Extension documents and as a general resource for a wide range of information. Specialists use the platform to promote services and resources and also to answer "Ask an Expert" questions.

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

**1. Standard output measures**

| 2018 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 12144 | 200000 | 1189 | 7000 |

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

**Patent Applications Submitted**

| | |
|---|---|
| Year: | 2018 |
| Actual: | 0 |

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

| 2018 | Extension | Research | Total |
|---|---|---|---|
| **Actual** | 0 | 0 | 162 |

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

**Output Target**

**Output #1**

**Output Measure**

- Number of research citations

| Year | Actual |
|---|---|
| 2018 | 83 |

**Output #2**

**Output Measure**

- Number of producers participating in Field Days

| Year | Actual |
|---|---|
| 2018 | 1500 |

**Output #3**

**Output Measure**

- Number of people participating in range monitoring programs
  Not reporting on this Output for this Annual Report

**Output #4**

**Output Measure**

- Number of requests to identify or record new weeds and pests

| Year | Actual |
|---|---|
| 2018 | 2500 |

**Output #5**

**Output Measure**

- Number of foreign trade teams
  Not reporting on this Output for this Annual Report

**Output #6**

**Output Measure**

- Number of new wheat lines developed

| Year | Actual |
|---|---|
| 2018 | 3 |

**V(G). State Defined Outcomes**

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Crops: Increase in number of producers who implement nutrient cycling, weed control, variety selection and alternative crop possibilities. Increase in number of farm operators who implement best practices to increase profitability and enhance long-term sustainability |
| 2 | Number of new stress-tolerant crop recommendations or changes for Montana. Number of new or improved cultivar recommendations provided to Montana producers to maintain dominance in small grain markets |
| 3 | Number of new molecular techniques incorporated into breeding projects to improve outcomes |
| 4 | Increase average per bushel yield of Montana grains while maintaining product quality |
| 5 | Increase agricultural resilience to short-term weather fluctuations by improving soil health and minimizing soil erosion. |

## Outcome #1

### 1. Outcome Measures

Crops: Increase in number of producers who implement nutrient cycling, weed control, variety selection and alternative crop possibilities. Increase in number of farm operators who implement best practices to increase profitability and enhance long-term sustainability

### 2. Associated Institution Types

- 1862 Extension
- 1862 Research

### 3a. Outcome Type:

Change in Action Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2018 | 0 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Montana is a large state with more than 145,000 square miles. Agriculture is the largest segment of the state economy with crops valued at $1.48 billion in 2017. Horticulture is also important throughout the state. Providing relevant and timely information related to growing crops, gardens and landscaping; while being connected with producers, growers, homeowners, community managers and more is a primary function of MAES and Extension.

**What has been done**
During 2018, Extension faculty reported offering 235 educational programs that were attended by 12,144 individuals. These were created in cooperation with stakeholders to meet the specific needs of unique audiences. Topics included herbicide resistance, farm management, pest identification, crop rotation, marketing, controlling noxious weeds, cultivar selection, soil and water quality and more.

**Results**
- MonDak Pulse Day: (n=125) 49% of attendees were very experienced in growing pulse crops, and 5% first timers. 59% had not used the nitrogen credit supplied by legume crops. 88% of participants said they would incorporate new management practices learned from the seminar, 100% said they would attend again. 74% said they would maintain the same amount of pulse acres and 15% said they would increase their pulse acres. This program was awarded the National Association of County Agriculture Agents award for Sustainable Agriculture.
- Prairie County Houndstongue Project: six landowners and commercial contractors applied recommended herbicides to 182.75 acres of houndstongue and 125.25 acres of Canada Thistle. Extension helped secure $7,859 in grant funds to cost share herbicide and application costs.
- Yellowstone Valley programming: 58% said they would implement what they learned; three

farmers decided to plant the NS PRESSER COP variety of spring wheat, a new variety that outperformed other spring wheat varieties by 2-6 bushels per acre on a three-year average, an increase in revenue of $10=$30/acre. 80.75 acres of alfalfa or grass were certified noxious weed free.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships |
| 104 | Protect Soil from Harmful Effects of Natural Elements |
| 111 | Conservation and Efficient Use of Water |
| 112 | Watershed Protection and Management |
| 132 | Weather and Climate |
| 141 | Air Resource Protection and Management |
| 201 | Plant Genome, Genetics, and Genetic Mechanisms |
| 203 | Plant Biological Efficiency and Abiotic Stresses Affecting Plants |
| 204 | Plant Product Quality and Utility (Preharvest) |
| 205 | Plant Management Systems |
| 206 | Basic Plant Biology |
| 502 | New and Improved Food Products |
| 503 | Quality Maintenance in Storing and Marketing Food Products |
| 601 | Economics of Agricultural Production and Farm Management |
| 903 | Communication, Education, and Information Delivery |

**Outcome #2**

**1. Outcome Measures**

Number of new stress-tolerant crop recommendations or changes for Montana. Number of new or improved cultivar recommendations provided to Montana producers to maintain dominance in small grain markets

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Maintenance and characterization of germplasm resources is essential to ensuring current and future plant breeding efforts will be successful. For example, the legume breeding program at Montana State is highly dependent on having genetic variation for traits of interest to use in crosses to develop new breeding populations. The major goals of this program are to document the usage of plant genetic resources in the western 13 states, interact with user communities and follow through with suggestions and recommendation to improve the operation of Western Regional Plant Introduction System (WRPIS) in management and utilization of plant genetic resources and associated information. The second goal is to apply available molecular tools and techniques to assess genetic diversity, identify taxa that were difficult to classify and associate DNA polymorphism.

**What has been done**
The research team documented the use of genetic resources in terms of species, types of experiments and purpose of studies and recorded how germplasm was being used. Many of the requests were for material for basic research to identify allelic variants of genes impacting individual traits of interest or simply to enlarge a germplasm pool for breeding projects. Individual basic research involved characterizing the genetic variation in genes impacting wheat growth and development and those that impact product quality traits. The ability to provide the most accurate and reliable data to the breeding programs to ensure development of high-end product quality varieties is critical. This data is instrumental in providing the information necessary to ensure that new varieties will perform as expected in terms of milling and baking quality. This in turn helps to satisfy wheat export markets.

**Results**
This study documented specific alleles and germplasm sources for traits such as reduced wheat noodle darkening, reduced wheat and barley pre-harvest sprouting, and increased wheat amylose content. Two PhD students and four undergraduate students have received training through this program. There were three conference papers and one journal article published in 2018, and two additional journal articles are under review and awaiting publication respectively.
Various research studies were completed including those involved with testing different varieties for usefulness in improving milling yield and baking quality. The primary outcome is the release of new spring and winter wheat varieties having high end product quality. In another study, allelic variation in genes that impact wheat milling and baking quality were identified.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 201 | Plant Genome, Genetics, and Genetic Mechanisms |
| 204 | Plant Product Quality and Utility (Preharvest) |
| 601 | Economics of Agricultural Production and Farm Management |
| 903 | Communication, Education, and Information Delivery |

**Outcome #3**

**1. Outcome Measures**

Number of new molecular techniques incorporated into breeding projects to improve outcomes

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Root lesion nematode (Pratylenchus neglectus) and Fusarium crown rot (F. pseudograminearum) are two important disease problems facing wheat production in Montana. Locally adapted hard red wheat germplasm with resistance to these two important diseases should be developed. Use of these lines will result in more stable and improved yield, and also enhance the yields of subsequent crops that follow in rotation. In addition, molecular markers will be identified that will assist in the future selection of resistance in wheat cultivars for Montana and the United States.

**What has been done**
Advanced spring wheat crown rot resistant lines are in the second year of agronomic evaluations. Several of these lines are displaying superior performance relative to parental lines. This establishes proof of concept for trait selection and intogression strategies. This procedure will be repeated with different spring wheat backgrounds.

**Results**
Winter wheat lines with good resistance to root lesion nematodes have been identified in greenhouse trials and will now be evaluated for agronomic performance. Reassessment of root lesion nematode impacts in Montana have demonstrated the power of diverse rotations on management of these root pests as populations are dramatically lower than previously reported. Results have been disseminated through four events with a combined audience of approximately 120. One doctoral student defended his thesis and three undergraduates have received training. One journal article was published.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|

| | |
|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships |
| 201 | Plant Genome, Genetics, and Genetic Mechanisms |
| 203 | Plant Biological Efficiency and Abiotic Stresses Affecting Plants |
| 204 | Plant Product Quality and Utility (Preharvest) |
| 205 | Plant Management Systems |
| 206 | Basic Plant Biology |

**Outcome #4**

**1. Outcome Measures**

Increase average per bushel yield of Montana grains while maintaining product quality

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Rapid population growth, increased globalization, and unprecedented environmental conditions have increased pressure to improve the efficiency of food production to ensure food and water security. Global food demand is expected to increase 35% by 2030 (www.farmingfirst.org). Attempts to meet these challenges through conventional agriculture that includes application of high rates of fertilizers and pesticides have had unintended environmental impacts. There is increasing awareness in agriculture of the importance of transition to sustainable agroecosystems that can meet production goals with few negative ecological effects.

**What has been done**
Work is being done to evaluate microbial inoculants and soil amendments for potential benefits to dryland crops and to evaluate the use of new small grain varieties for performance in central Montana.
Microbial inoculant trials were established to evaluate inoculants for winter wheat and spring wheat. Seed treatments included inoculant strains considered as general plant beneficial bacteria and potential plant pathogen protection along with chitosan, a bioproduct considered to have protective properties against fungal pathogens.

**Results**

Agronomic data collected included plant counts, plant height, test weight, yield and protein. Average yield of winter wheat was 71.4 bu/acre with 11.9% protein. Average spring wheat yield was 54.1 bu/acre with 10.9% protein. Differences in yield and other agronomic traits were not significantly different between the biological treatments and a commercial fungicide control indicating that biological treatments were effective. These findings suggest that under some conditions, biological treatments may be an effective option in place of chemical seed treatment. Central Montana farmers were contacted throughout the reporting period to discuss on-farm research projects. These communication efforts led to the establishment of an on-farm soil inoculant trial.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships |
| 104 | Protect Soil from Harmful Effects of Natural Elements |
| 111 | Conservation and Efficient Use of Water |
| 201 | Plant Genome, Genetics, and Genetic Mechanisms |
| 203 | Plant Biological Efficiency and Abiotic Stresses Affecting Plants |
| 204 | Plant Product Quality and Utility (Preharvest) |
| 205 | Plant Management Systems |
| 206 | Basic Plant Biology |
| 502 | New and Improved Food Products |

**Outcome #5**

**1. Outcome Measures**

Increase agricultural resilience to short-term weather fluctuations by improving soil health and minimizing soil erosion.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Montana ranks 6th in the nation in sugarbeet production. The sugar industry in eastern Montana contributes substantially to the regional economy. Conventional tillage, which consists of five or more passes across a field for plowing or ripping, leveling and ridging, is still widely used by sugarbeet growers. This tillage has many unintended consequences for soils and the environment. Eastern Montana has high wind in the fall and spring and the conventional operation sometimes creates heavy dust storms which blow away fertile surface soil and damage sugarbeet seedlings and reduce traffic safety. Reducing tillage in sugarbeet production is a high research priority.

**What has been done**

During 2018, researchers 1) conducted a sugarbeet field experiment that compared strip tillage and no-till planting to conventional tillage 2) conducted on- and off-station winter wheat, spring wheat, durum wheat and barley variety trials under dryland and irrigation conditions, 3) conducted multi-location pulse crop variety evaluation trials at 12 Montana locations and 4) conducted multi-location sugarbeet variety evaluation study.

**Results**

Three college students and four high school students worked on this project. A dryland farm field day was held in June, 2018 with 60 participants and an irrigated farm field day in July with 90. Pulse crop research results were published in the 2018 Montana Cool-season Spring Pulse Variety Evaluation Annual report which was delivered to growers in Montana and neighboring states. Sugarbeet and pulse crop research results were presented at the 2018 ASA-CSSA International Annual Meeting in November 2018. Six journal articles were published from this work in 2018.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships |
| 104 | Protect Soil from Harmful Effects of Natural Elements |
| 111 | Conservation and Efficient Use of Water |
| 132 | Weather and Climate |
| 201 | Plant Genome, Genetics, and Genetic Mechanisms |
| 205 | Plant Management Systems |
| 206 | Basic Plant Biology |
| 903 | Communication, Education, and Information Delivery |

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

### External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Other (High cost of fuel, fertilizer)

### Brief Explanation

The Communications Specialist for MAES resigned at the end of 2018 leaving a gap in knowledge of MAES projects for this report.

## V(I). Planned Program (Evaluation Studies)

### Evaluation Results

During 2018, MAES publicly released the first ever pea variety specifically designed for Montana. The variety, currently named MT457, was released in February 2018 and will be commercially available in 2018.
Early in 2019, two winter wheat varieties, one spring wheat variety, and one dryland malt barley variety were publicly released.
-MonDak Pulse Day planners received the National Association of County Agricultural Agents award for Sustainable Agriculture. Participants learned how to use the nitrogen credit supplied by legume crops.
-Yellowstone Valley educational programming: three farmers decided to plant the NS PRESSER COP variety of spring wheat, a new variety that outperformed other spring wheat varieties by 2-6 bushels per acre on a three-year average which will result in increased profit of $10-30/acre.
-Specific alleles and germplasm sources for traits such as reduced wheat noodle darkening, reduced wheat and barley pre-harvest sprouting, and increased wheat amylose content were discovered. Two PhD students and four undergraduate students received training, three conference papers and one journal article was published and two more are under review.
-Winter wheat lines with good resistance to root lesion nematodes were identified in greenhouse trials and will now be evaluated for agronomic performance. Reassessment of root lesion nematode impacts in Montana have demonstrated the power of diverse rotations on management of these pests is dramatically lower than previously reported.
-Agronomic data including plant height, test weight, yield and protein led to the determination that in some conditions, biological treatments may be an effective option in place of chemical seed treatment.
-An on-farm soil inoculant trial began in October due to communication efforts throughout Central Montana.
-The 2018 Montana Cool-season Spring Pulse Variety Evaluation Annual Report included research from MAES and was distributed to growers in Montana and surrounding states.

### Key Items of Evaluation

Extension and MAES work extensively to support horticulture needs for lawns and gardens.

Annually, nearly 700 Master Gardeners provide 12,000 volunteer hours managing community gardens and vegetation in boulevards and parks; providing education at farmer's markets; creating school gardens, etc. at a value to local communities of more than $230,000 in services.
Powell County: Six inmates built six handicap accessible garden beds for their volunteer hours to become Master Gardener Level 1 certified. A fourth grade class learned about plants and then planted sunflowers and marigolds in community beds, and green beans that they sold at the farmers' market.
Valley County: Extension continues to maintain the fruit orchard planted in 2014 as part of the heritage orchard research program. The program is also investigating cold hardy grape varieties in demonstration plots and is assessing the suitability of hops and haskaps for the climate. The local agent completed the Montana Master Beekeeper program and is offering pollinator and beekeeping education.
Cascade County: Master Gardeners and the local agent field more than 7000 phone calls and make more than 600 on-site visits annually to meet horticulture needs in the county. The MG volunteers contributed almost 16,000 hours of volunteer time during 2018.
Extension and MAES also work extensively across the state to assist producers and businesses with agritourism opportunities. The Flathead County agent assisted in the drafting and passing of the limited liability law for agritourism operators in 2017.
The Flathead County agent has been investigating the economic feasibility of commercial hops in northwest Montana for several years. She worked with a willing collaborator to design a research study and earned three grants to fund the project which included infrastructure, irrigation, plants and harvesting equipment. She connected the collaborator with the idea of making an oil from the hops flower for processing and connected him with Northwest Ag Experiment Station to experiment on a small still, and then with local mint farmers who could process larger quantities. The value-added product, Hopzoil, was demonstrated and received outstanding reviews at the BrauBeviale (largest beer/beverage trade show in the world) in November of 2018.
MAES has active projects on soil acidification, a serious, emerging issue, and precision agriculture, an interdisciplinary focus with engineering and computer science.

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

**Program # 3**

**1. Name of the Planned Program**

Farm, Ranch and Business Management

☑ Reporting on this Program

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

1. Program Knowledge Areas and Percentage

| KA Code | Knowledge Area | %1862 Extension | %1890 Extension | %1862 Research | %1890 Research |
|---|---|---|---|---|---|
| 112 | Watershed Protection and Management | 5% | | 0% | |
| 121 | Management of Range Resources | 5% | | 0% | |
| 122 | Management and Control of Forest and Range Fires | 0% | | 5% | |
| 307 | Animal Management Systems | 5% | | 0% | |
| 601 | Economics of Agricultural Production and Farm Management | 30% | | 20% | |
| 602 | Business Management, Finance, and Taxation | 5% | | 5% | |
| 609 | Economic Theory and Methods | 5% | | 15% | |
| 610 | Domestic Policy Analysis | 5% | | 25% | |
| 611 | Foreign Policy and Programs | 0% | | 15% | |
| 903 | Communication, Education, and Information Delivery | 40% | | 15% | |
| | **Total** | 100% | | 100% | |

## V(C). Planned Program (Inputs)

**1. Actual amount of FTE/SYs expended this Program**

| Year: 2018 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 1.5 | 0.0 | 13.5 | 0.0 |
| **Actual Paid** | 4.0 | 0.0 | 7.1 | 0.0 |
| **Actual Volunteer** | 0.3 | 0.0 | 0.0 | 0.0 |

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 92762 | 0 | 181115 | 0 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 0 | 0 | 809234 | 0 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 182252 | 0 | 116096 | 0 |

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

COA, MAES and Extension worked one-on-one and in groups with producers, landowners and consumers to identify and address individual and industry challenges and solutions. They regularly answered specific questions through workshops, phone calls, email and personal consultations. Faculty, agents and specialists offered classes, workshops, group discussions, demonstrations, field tours/trials and more. Along with volunteers they disseminated knowledge at every available chance via community events and meetings. MSU Extension utilized PSA's, newsletters, MontGuides, television, eXtension, listserves and other media. Additional priorities were to:

- Publish peer reviewed articles contributing to the field
- Create and maintain outreach programs
- Provide improved information and research in relation to farm, ranch and agribusiness management
- Contribute to the understanding of financial and management decisions
- Provide informational training and programs related to the environment
- Provide on-farm planning for success workshops

### 2. Brief description of the target audience

- Farmers/Ranchers/Ag producers
- Land Managers/Owners
- Livestock/Crop producers and related stakeholders
- Private forest land owners and public land managers
- Small acreage land owners
- Tribal farm and ranch managers
- Agribusiness owners and managers
- Agricultural educators

### 3. How was eXtension used?

eXtension resources were used for planning and evaluation of programming, nationwide resources and curriculum development. Moodle was used for testing.

## V(E). Planned Program (Outputs)

**1. Standard output measures**

| 2018 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 7471 | 29600 | 3837 | 600 |

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

**Patent Applications Submitted**

Year: 2018

Actual: 0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

| 2018 | Extension | Research | Total |
|---|---|---|---|
| **Actual** | 0 | 0 | 26 |

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

**Output Target**

**Output #1**

**Output Measure**

- Number of producers attending Extension and MAES presentations

| Year | Actual |
|---|---|
| 2018 | 7471 |

**Output #2**

**Output Measure**

- Number of peer-reviewed journal articles

| Year | Actual |
|---|---|
| 2018 | 26 |

**Output #3**

**Output Measure**

- Number of non-credit instruction events

| Year | Actual |
|---|---|
| 2018 | 123 |

**V(G). State Defined Outcomes**

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Number of new or improved management recommendations provided to and adopted by Montana producers. |
| 2 | Increase in number of producers, small and large acreage landowners who are aware of current programs and information related to farm and ranch business management, and make timely management decisions as a result. |
| 3 | Increase in number of producers/farm and ranch managers who implement range monitoring activities which lead to improvement in resource management strategies. |
| 4 | Blackfeet Reservation Tribal Farmer and Rancher Productivity and Management |
| 5 | Impact of money-laundering-prevention bank regulations on small and rural banks that have legalized marijuana. |
| 6 | Objective, research-based, economic information regarding the impacts of changes in market and policy conditions has never been more important. Agricultural producers and agribusinesses need this information to make more informed management decisions and to assist policy makers in crafting efficient, cost-effective legislation. |

## Outcome #1

### 1. Outcome Measures

Number of new or improved management recommendations provided to and adopted by Montana producers.

### 2. Associated Institution Types

- 1862 Extension
- 1862 Research

### 3a. Outcome Type:

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2018 | 400 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Agricultural pest and disease problems cost producers and consumers billions of dollars annually in the United States alone. The role of technological innovation in addressing these issues is important, yet often overlooked for several reasons. The payoffs to this type of investment are often slow in arriving, as crop-based agricultural research often takes a substantial amount of time to complete and up-front costs are often in the millions of dollars. This study aims to demonstrate the rates of return on these investments are high and the benefits that flow from the research far outweigh the costs.

**What has been done**
Using a combination of budget comparisons and economic welfare analysis, a team including growers, pest control advisers, and plant breeders worked to determine the economic value of Potato Virus Y and the value of the Montana seed potato certification program. A paper has been drafted but not yet submitted. Data from the Agricultural Resource Management Survey data in economics research was presented at the Western Ag Econ Association Meetings. The project director attended and chaired the graduate student Extension presentation at the Agricultural and Applied Economics Association meeting in August 2018.

**Results**
Published, "Genetic Engineering and Risk in Varietal Selection of Potatoes," in the American Journal of Agricultural Economics. Presented findings to over 400 people including university researchers in the field of economics and plant science, agricultural producers, Extension faculty, and readers of agricultural economics journals. Tools that are being created from this work will be accessible to a wide range of users. This project is on track to meet the major goals of increasing the understanding of both the costs and benefits from research addressing agricultural pest and disease problems, as well as information that can be useful to growers and policy makers alike in

deciding whether to adopt new technology and/or to fund its research.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 601 | Economics of Agricultural Production and Farm Management |
| 602 | Business Management, Finance, and Taxation |
| 609 | Economic Theory and Methods |
| 903 | Communication, Education, and Information Delivery |

**Outcome #2**

**1. Outcome Measures**

Increase in number of producers, small and large acreage landowners who are aware of current programs and information related to farm and ranch business management, and make timely management decisions as a result.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
MSU Extension and COA economists work together to provide Montana stakeholders with tools and resources to enable them to best manage their farms and ranches. Issues they tackle are generally stakeholder and/or market driven. Recent decreases in commodity prices have reduced margins and led to requests centered on the need for innovative Ag Econ outreach tools and resources on agricultural land leasing, insurance, estate planning and more.

**What has been done**
MSU Extension and COA economists created a website for Agricultural Land Leasing (www.msuextension.org/aglease). The site includes lease rates and many additional resources. During 2018, the website received 4,543 visits from 3,433 users. Eight presentations were delivered to 91 participants. Additional AgEcon tools on such topics as nitrogen application rates, tracking wheat prices and basis, and calculating grazing lease rates received 5,832 page views from 1,632 users in 2,201 sessions.

**Results**
Participants of leasing classes said they gained the ability to compare the features of different types of leases, identify the elements of a good lease, identify what is required versus desired in a leasing situation, determine the types of leases and lease provisions that advance personal and business goals and how to locate rental rates in the area that is desired to lease. Thirty producers who had been denied credit from mainline financial institutions were provided the opportunity to apply for FSA loans by completing Extension FSA Borrower Training classes.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 601 | Economics of Agricultural Production and Farm Management |
| 602 | Business Management, Finance, and Taxation |
| 609 | Economic Theory and Methods |
| 610 | Domestic Policy Analysis |
| 611 | Foreign Policy and Programs |
| 903 | Communication, Education, and Information Delivery |

**Outcome #3**

**1. Outcome Measures**

Increase in number of producers/farm and ranch managers who implement range monitoring activities which lead to improvement in resource management strategies.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Rangelands comprise 70% of Montana's 93 million acres and rangelands provide much of what makes Montana a special place, including clean air and water, scenic open spaces and abundant wildlife. Rangelands also support Montana's second largest industry - range/livestock agriculture. According to the Montana Department of Agriculture, range/livestock production is second only to cropland agriculture and contributes more to the state's economy than tourism, mining, oil and

gas, or forest products.

**What has been done**
During 2018, MSU Extension's rangeland specialist presented 32 workshops with 874 adult and 1633 youth participants and provided information and updates for the U.S. Senate Energy and Natural Resources Committee, the staff of U.S. Senators John Tester and Steve Daines, and to the staff of U.S. Secretary of the Interior Ryan Zinke. Classes covered rangeland resource management issues included: living with brucellosis, winter grazing, grazing management on rangeland after fire, livestock grazing to control weeds, annual grasses and rangeland ecology, grazing decisions during and after drought and more.

**Results**
-Valley County: 48 producers indicated they would have had an estimated loss of $63/acre on 109,350 cropland acres for more than $6.1 million loss, had they not used techniques they learned from MSU Extension.
-Rosebud and Treasure County Extension: 92 producers received access to county predator control measures by signing and returning a formal letter to Extension; 54 producers had their water, forage and or soil tested, and received individualized guidance on operational decisions; and two producers created wills following estate planning classes. These measures all increased the sustainability and profitability of operations by reducing input costs and increasing efficiency and creating a transition plan.
-Carbon County Extension: Several producers approached the Extension office with concerns about nitrates in cover crops and recommendations for grazing these alternative crops. Extension tested the crops and provided information on best practices for grazing these crops. These services saved producers thousands of dollars and decreased the likelihood of a nitrate poisoning event in livestock in the area.
Yellowstone County: One landowner planned to invest $12,800 to spray sagebrush; however Extension concluded the spraying wasn't necessary, but the money could be directed instead toward water improvements to improve the pasture.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 112 | Watershed Protection and Management |
| 121 | Management of Range Resources |
| 122 | Management and Control of Forest and Range Fires |
| 307 | Animal Management Systems |
| 601 | Economics of Agricultural Production and Farm Management |
| 602 | Business Management, Finance, and Taxation |
| 609 | Economic Theory and Methods |
| 903 | Communication, Education, and Information Delivery |

**Outcome #4**

**1. Outcome Measures**

Blackfeet Reservation Tribal Farmer and Rancher Productivity and Management

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 435 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
The Blackfeet Tribe did not have an Agriculture Resources Management Plan (ARMP). Leadership was needed to direct an interdisciplinary team to strategize how to assess current natural and ag resources, identify the goals of the Blackfeet people and aid in development of policy and regulations to manage ag land, water and livestock holistically. In addition, many tribal members did not have access to updated, unbiased agricultural research or a forum to discuss information about insurance, marketing or ag business opportunities.

**What has been done**
Extension provided leadership, in cooperation with others, to write a funding proposal to complete the ARMP. The Blackfeet Nation Stock Growers Association was reorganized and the Extension agent served as secretary/treasurer. Extension offered education through the annual farm and ranch management seminar, private pesticide applicator certification training, ranch record keeping workshops and more. Following severe winter snow storms that killed hundreds of cattle, calves and horses, Extension organized information sessions about how to access assistance from the USDA Livestock Indemnity Program and Emergency Livestock Assistance Programs. Extension worked with the Blackfeet Ag Committee to help organize the Blackfeet Ag Summit for producers and the public from the entire Blackfeet Confederacy made up of the Blackfeet tribe and three tribes of Canada, the Kainai, Siksika and Northern Peigan.

**Results**
The tribe obtained a $340,000 grant to hire a program manager and staff to complete the Blackfeet ARMP. The draft is in final review and will soon be presented to the Tribal Council for approval. The newly organized Blackfeet Nation Stock Growers Association had 44 paid memberships and fundraised $20,000 for predator control (wolf, coyote, bear) and $4,500 for 4-H youth scholarships. Approximately 1000 calves were sold at about $900,000. The Blackfeet Ag

Summit was attended by 80 members and began the conversation about how to work together to create improved business opportunities, such as potentially a bison/beef processing plant. Discussion are ongoing. Seventy-five producers learned about utilizing the Integrated Resources Management Red Book making the eligible for federal disaster programs. Following workshops 45 producers completed paperwork and received $500,770 to offset livestock losses from the storms.
Participants in workshops reported greater understanding of cattle diseases and nutrition to improve animal health, including hay storage and management of forage toxicity before feeding. These skills resulted in healthier animals and increased profitability.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 112 | Watershed Protection and Management |
| 121 | Management of Range Resources |
| 122 | Management and Control of Forest and Range Fires |
| 307 | Animal Management Systems |
| 601 | Economics of Agricultural Production and Farm Management |
| 602 | Business Management, Finance, and Taxation |
| 609 | Economic Theory and Methods |
| 610 | Domestic Policy Analysis |

**Outcome #5**

**1. Outcome Measures**

Impact of money-laundering-prevention bank regulations on small and rural banks that have legalized marijuana.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Following the legalization of marijuana in numerous states, the U.S. implemented money-laundering-prevention bank regulations. Research was needed to determine how these

regulations impacted smaller and rural banks.

**What has been done**
Research was initiated and a thesis completed that utilized data envelopment in estimating the effects of the regulation on the relative competitiveness of small and rural banks in states with legalized marijuana.

**Results**
The study found that the money-laundering-prevention regulations decreased the competitiveness of small and rural banks relative to larger commercial banks. Further study is needed to determine whether this results in acceleration in the rate at which smaller and rural banks are consolidated and/or acquired by larger banks.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 610 | Domestic Policy Analysis |

**Outcome #6**

**1. Outcome Measures**

Objective, research-based, economic information regarding the impacts of changes in market and policy conditions has never been more important. Agricultural producers and agribusinesses need this information to make more informed management decisions and to assist policy makers in crafting efficient, cost-effective legislation.

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
An ongoing Hatch project has four goals to meet the broad objective of creating rigorous economic analysis and state-of-the-art econometric methods to provide research-based economic information regarding the impacts of changes in market and policy conditions. These include: estimate market supply, demand, price, marketing infrastructure and landscape, and basis relationships related to domestic agricultural input, commodity and processed food markets; assess and stimulate the effects of domestic agricultural policies and regulatory policies on the

efficiency of input and output markets; evaluate the degree to which technological innovations can improve food production, marketing and distribution in the northern Great Plains and the U.S; and effectively communicate the results.

**What has been done**

An ongoing Hatch project has four goals to meet the broad objective of creating rigorous economic analysis and state-of-the-art econometric methods to provide research-based economic information regarding the impacts of changes in market and policy conditions. These include: estimate market supply, demand, price, marketing infrastructure and landscape, and basis relationships related to domestic agricultural input, commodity and processed food markets; assess and stimulate the effects of domestic agricultural policies and regulatory policies on the efficiency of input and output markets; evaluate the degree to which technological innovations can improve food production, marketing and distribution in the northern Great Plains and the U.S; and effectively communicate the results.

**Results**

The publication, "Modeling Joint Dependence of Invasive Pests: The Case of the Wheat Stem Sawfly" assessed the economic impacts and optimal farm technologies and strategies for managing one of the most costly pests for northern Great Plains wheat producers. The researchers combined knowledge from the economics and entomology disciplines to develop a unique farm level dataset to estimate the expected losses and evaluate management strategies. The finding was that strategies that minimize long-run infestation levels are preferred over those that seek to maximize yield potential in exchange for higher risk infestation.
Another paper, "Vulnerability of dryland agricultural regimes to economic and climatic change" was also an interdisciplinary effort, this time including ecology, sociology and agricultural economics. Through a combination of qualitative and quantitative assessment measures, the researchers found that although farmers perceived few alternative agronomic options for adopting to drought, strategies for adaption to high input prices were more plentiful. In addition, researchers learned that during periods of high-stress, high price variability and limited soil moisture, farmers are least likely to adopt new technologies and farm management techniques.

## 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 601 | Economics of Agricultural Production and Farm Management |
| 602 | Business Management, Finance, and Taxation |
| 609 | Economic Theory and Methods |
| 610 | Domestic Policy Analysis |
| 611 | Foreign Policy and Programs |
| 903 | Communication, Education, and Information Delivery |

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

### External factors which affected outcomes

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

### Brief Explanation

The Communications Specialist for MAES resigned at the end of 2018 leaving a gap in knowledge of MAES projects for this report.

## V(I). Planned Program (Evaluation Studies)

### Evaluation Results

-Published: Genetic Engineering and Risk in Varietal Selection of Potatoes, in the American Journal of Agricultural Economic and presented the findings to 400 people including university researchers, agricultural producers, Extension faculty and readers of journals. Tools from this research will be widely available.
-Published: Modeling Joint Dependence of Invasive Pests: The Case of the Wheat Stem Sawfly, which assessed the economic impacts and optimal farm technologies and strategies for managing one of the most costly pests for northern Great Plains wheat producers. Findings indicated that strategies that minimize long-run infestation levels are preferred over those that seek to maximize yield potential in exchange for higher risk infestation.
-Published: Vulnerability of dryland agricultural regimes to economic and climatic change- found that although farmers perceived few alternative agronomic options for adopting to drought, strategies for adaption to high input prices were more plentiful. IN addition, researchers learned that during periods of high-stress, high price variability and limited soil moisture, farmers are least likely to adopt new technologies and farm management techniques.
-Created a website for Agricultural Land Leasing http://www.msuextension.org/aglease that was viewed 4,543 times in 2018 by 3,433 users.
-In Valley County, 48 producers indicated they would have had an estimated loss of $63/acre on 109,350 cropland acres for more than $6.1 million loss if they had not used techniques they learned from MSU Extension to mitigate risk from narrowleaf hawksbeard infestation.
-A study found that the money-laundering-prevention regulations implemented following the legalization of marijuana in numerous states found that the competitiveness of rural and smaller banks was decreased relative to larger commercial banks.

### Key Items of Evaluation

The Blackfeet Tribe did not have an Agriculture Resources Management Plan (ARMP). Extension provided leadership to connect an interdisciplinary team to strategize how to assess current ag and natural resources, identify the goals of the Blackfeet people, and aid in the development of policy and regulations to manage ag land, water and livestock

holistically. Together the tribe was able to earn a $340,000 grant to hire a program manager and staff to complete the ARMP. The Blackfeet Nation Stock Growers Association was restarted with 44 paid members. They raised $20,000 for predator (wolf, coyote, bear) control and $4,500 for youth scholarships. The Blackfeet Ag Committee, including the Extension Agent, helped organize the Blackfeet Ag Summit for producers and the public from the entire Blackfeet Confederacy, made up of the Blackfeet Tribe and three tribes of Canada, the Kainai, Siksika and Northern Peigan. The Summit was attended by 80 producers and began the discussion of how to create improved business opportunities, including potentially a bison/beef processing plant.
The agent provided 75 producers with education about utilizing the Integrated Resources Management Red Book. This training made them eligible for federal disaster programs. Following the workshop, 45 producers completed the paperwork. Collectively they received $500,770 to offset livestock losses from storms.

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

**Program # 4**

**1. Name of the Planned Program**

Integrated Pest Management

☑ Reporting on this Program

**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 | 0% | | 10% | |
| 212 | Diseases and Nematodes Affecting Plants | 10% | | 10% | |
| 213 | Weeds Affecting Plants | 15% | | 10% | |
| 214 | Vertebrates, Mollusks, and Other Pests Affecting Plants | 0% | | 10% | |
| 215 | Biological Control of Pests Affecting Plants | 15% | | 10% | |
| 216 | Integrated Pest Management Systems | 25% | | 10% | |
| 314 | Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals | 0% | | 5% | |
| 601 | Economics of Agricultural Production and Farm Management | 5% | | 5% | |
| 603 | Market Economics | 0% | | 5% | |
| 711 | Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources | 5% | | 5% | |
| 712 | Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins | 0% | | 10% | |
| 721 | Insects and Other Pests Affecting Humans | 0% | | 5% | |
| 903 | Communication, Education, and Information Delivery | 25% | | 5% | |
| | **Total** | 100% | | 100% | |

## V(C). Planned Program (Inputs)

**1. Actual amount of FTE/SYs expended this Program**

| Year: 2018 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 3.0 | 0.0 | 62.0 | 0.0 |
| **Actual Paid** | 10.2 | 0.0 | 33.9 | 0.0 |

| | | | | |
|---|---|---|---|---|
| **Actual Volunteer** | 0.1 | 0.0 | 0.0 | 0.0 |

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 130342 | 0 | 383136 | 0 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 0 | 0 | 1054110 | 0 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 404057 | 0 | 1341578 | 0 |

## V(D). Planned Program (Activity)

**1. Brief description of the Activity**

• Meet one-on-one with producers, landowners and consumers to identify and address individual problems and solutions
• Encourage email and phone conversations with members of the public
• Offer classes, workshops, group discussions, demonstrations, field tours/trials, webinars
• Share information at farmer's markets, county fairs and other community events
• Attend and present information at professional conferences, county meetings and state conventions
• Prepare and distribute public service announcements, newsletters, MONTGuides, Television (Montana PBS Montana Ag Live), eXtension, listservs, social media, radio and other media
• Create readily available and easily accessible databases for producers and researchers
• Prepare research articles, fact sheets and news releases for scientists and statewide media
• Host strategic planning meetings with state agricultural groups
• Develop systems that ensure food safety and agricultural security
• Integrate best practices for pests and disease management in parallel programs

**2. Brief description of the target audience**

• Agricultural producers in Montana facing current and future threats relating to invasive plants, plant diseases and pests.
• University faculty scientists conducting research in integrated pest management
• Extension outreach personnel and statewide agents
• University economic development research programs
• Montana USDA state statistician and agricultural economics faculty
• Montana grain producers and associated committees, groups, and boards

**3. How was eXtension used?**

eXtension was primarily used for evaluation and planning tools.

## V(E). Planned Program (Outputs)

### 1. Standard output measures

| 2018 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| Actual | 8508 | 55000 | 523 | 100 |

### 2. Number of Patent Applications Submitted (Standard Research Output)

**Patent Applications Submitted**

Year: 2018

Actual: 0

**Patents listed**

### 3. Publications (Standard General Output Measure)

**Number of Peer Reviewed Publications**

| 2018 | Extension | Research | Total |
|---|---|---|---|
| Actual | 0 | 0 | 67 |

## V(F). State Defined Outputs

**Output Target**

**Output #1**

**Output Measure**

- Number of samples processed by Schutter Diagnostic Laboratory.

| Year | Actual |
|---|---|
| 2018 | 1054 |

**Output #2**

**Output Measure**

- Number of certified and re-certified pesticide applicators.

| Year | Actual |
|---|---|
| 2018 | 5500 |

**Output #3**

**Output Measure**

- Number of volunteers helping to trap wheat stem sawflies and other pests
  Not reporting on this Output for this Annual Report

**V(G). State Defined Outcomes**

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Range: Increase in number of producers and small acreage landowners who are aware of the identification of pest infestations, and quickly identify new problems so they can make timely management decisions. |
| 2 | Weed and Pest Control: Increase in the number of applicators who are certified and employ safety precautions and risk management strategies while using pesticides in the most environmentally and economically effective manner. Increased number of county agents trained to identify pests, limiting number of samples that have to be sent to Schutter Diagnostic Lab. Timely follow up by agents or SDL staff and specialists to identify pests, disease and plants and follow-up with appropriate recommendations. |
| 3 | Develop, enhance and distribute pest management programs to increase knowledge and ability to manage pests and diseases affecting producers. |
| 4 | Develop seasonal management programs and applied pest and disease management research that leads to improved management practices. |
| 5 | Increase the number of producers/ranch managers who implement range monitoring activities which lead to improvement in resource management strategies. |

## Outcome #1

### 1. Outcome Measures

Range: Increase in number of producers and small acreage landowners who are aware of the identification of pest infestations, and quickly identify new problems so they can make timely management decisions.

### 2. Associated Institution Types

- 1862 Extension
- 1862 Research

### 3a. Outcome Type:

Change in Action Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2018 | 0 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Invasive weeds threaten rangeland health. Ecological impacts include altered structure, organization, and function of rangeland plant communities. Economically, people spend billions of dollars on control and livestock and wildlife carrying capacity are reduced. Containing existing populations and restoring rangeland severely degraded by weeds is critical for the ecology and economics of Montana agriculture. In particular, understanding how to refine revegetation of weed-infested rangeland and the integrated management of two rangeland weeds: downy brome (or cheatgrass) and tall buttercup, is needed.

**What has been done**
During 2018, research into these questions advanced via gaining knowledge in revegetation outcomes, specifically how timing of planting of native bluebunch wheatgrass (Pseudoroegneria spicata) influences establishment during revegetation and invasion by non-native weedy species. Research on the utility of a soil-borne fungal pathogen Pyrenophora semeniperda (PYSE) as a biological control for downy brome was also completed. Finally, participation in a coordinated distribution study that suggested another potential biological control for downy brome, Pseudomonas fluorescens, showed it would not be effective in Wyoming and Montana.

**Results**
The result is knowledge gained regarding managing invasive plants on rangelands. Specifically, new information on how to improve revegetation of invasive-plant infested rangelands by defining the best time to plant seeds of desired grasses and testing the efficacy of potential biological controls for downy brome. These accomplishments will help improve management of invasive plants in rangeland settings, thus increasing and protecting the agricultural and ecological services offered by healthy rangelands.

Rangeland weed managers appear to have a relatively large window of opportunity, that is from late fall through early spring, to seed native grasses like bluebunch wheatgrass as a means for revegetating invasive plant-infested sites. These results were presented by a graduate student at a professional conference and incorporated into her thesis with manuscript to follow. The biocontrol of downy brome was shown not to be effective in Montana.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 211 | Insects, Mites, and Other Arthropods Affecting Plants |
| 213 | Weeds Affecting Plants |
| 215 | Biological Control of Pests Affecting Plants |
| 216 | Integrated Pest Management Systems |
| 601 | Economics of Agricultural Production and Farm Management |
| 603 | Market Economics |
| 711 | Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources |
| 721 | Insects and Other Pests Affecting Humans |
| 903 | Communication, Education, and Information Delivery |

**Outcome #2**

**1. Outcome Measures**

Weed and Pest Control: Increase in the number of applicators who are certified and employ safety precautions and risk management strategies while using pesticides in the most environmentally and economically effective manner. Increased number of county agents trained to identify pests, limiting number of samples that have to be sent to Schutter Diagnostic Lab. Timely follow up by agents or SDL staff and specialists to identify pests, disease and plants and follow-up with appropriate recommendations.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

The Montana Private Applicator Training (PAT) Program is coordinated by MSU Extension through a Memorandum of Agreement with the Montana Department of Agriculture. The PAT Program provides certification and training to approximately 5,500 private applicators across Montana. Private Pesticide Applicator certification allows individuals and/or their employees to apply Restricted Use Pesticides (RUPs) to land they own, rent or lease for the purpose of growing an agricultural commodity. To be certified, a private applicator must show practical knowledge of pest problems and pest control practices associated with their agricultural operations; proper storage, use, handling, disposal and containers; and their related legal responsibility.

**What has been done**

During 2018, the MSU Extension Pesticide Education Specialist provided 38 trainings including a Fumigant Training Tour, Pest Management Tour, and a Pesticide Education Program Update. These presentations included seven core subject areas: private applicator license, reading the label, IP, pesticide safety, pesticide laws, calibration of spray equipment and pesticides in the environment. The specialist also provides training for 56 MSU Extension agents and one statewide coordinator. These individuals provided an additional 107 training programs. In addition, the specialist created a new program called, "Why isn't my pesticide working?" Using interactive Turning Point data this effective and interactive presentation reached 600 people in 16 locations.

**Results**

- Fumigant Training Tour: 100 fumigant applicators surveyed pre- and post- tour indicated they improved their understanding of fumigants from 2.9 (1=poor, 2=fair, 3=good and 4= excellent) to 4.1.
- Pesticide Education Program Update: 100% of 20 trainers who attended gained knowledge from the event. These trainers were prepared to provide regulatory, technical and scientific pesticide training to clients in their own pesticide programs.
- Pesticide Management Tour: 202 applicators responded to a survey that showed increased knowledge from pre- to post- tour as follows: Pest ID 87.7%/96.1%; Monitor/Scout 74.8%/86.4%; Decision-making 82.6%/90.3%; Intervention 78.1%/85.7%; and Evaluation 55.5%/76.6%
- "Why isn't my pesticide working?" 86% of attendees said they would use the information provided to increase profits through the use of surfactants, checking water quality and calibrating pesticide spray equipment.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 211 | Insects, Mites, and Other Arthropods Affecting Plants |
| 212 | Diseases and Nematodes Affecting Plants |
| 213 | Weeds Affecting Plants |
| 214 | Vertebrates, Mollusks, and Other Pests Affecting Plants |
| 215 | Biological Control of Pests Affecting Plants |
| 216 | Integrated Pest Management Systems |
| 314 | Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals |
| 601 | Economics of Agricultural Production and Farm Management |
| 603 | Market Economics |

| | |
|---|---|
| 711 | Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources |
| 712 | Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins |
| 721 | Insects and Other Pests Affecting Humans |
| 903 | Communication, Education, and Information Delivery |

**Outcome #3**

**1. Outcome Measures**

Develop, enhance and distribute pest management programs to increase knowledge and ability to manage pests and diseases affecting producers.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Insect pests are an economic and aesthetic concern for many, including homeowners, arborists, landscape professionals, hotel owners, agribusiness professionals, bee keepers, landlords, regulatory agencies at state and federal levels, and others. Education, assistance with identification, and management tools related to insects are needed. Timely insect pest identification in agriculture is also critical to reducing related challenges.

**What has been done**
During 2018, 18 Extension teaching activities related to urban insects were offered directly reaching 1063 individuals and indirectly, through 15 Ag Alerts, five Montana Ag Live television appearances, 15 urban alerts, newsletters and MontGuides, more than 50,000 Montanans were connected with related information.

**Results**
Schutter Diagnostic Lab completed 839 arthropod diagnoses
- First report of the gulf coast tick, Amblomma maculatium, in Montana; of the banded ash borer, Neoclytus caprea on ash firewood in Fort Peck, MT; and of the small hive beetle, Aethina tumida from honey bee hives in Gallatin county
- New records of spotted wing Drosophila on raspberries and blackberries

- New county record of Monochamus clamator in Big Horn County
- Spider sample submissions decreased 51% from 2015 to 2018, likely a result of education and outreach
- 65% of attendees at a bed bug workshop said they would make monitoring or management changes as a result of the education
- Carpenter ants, garden millipedes and earwigs were identified and confirmed for four suspected termite cases, preventing unnecessary treatment costs
- Insect identification helped protect several important museum artifacts including books, textiles, Native American artifacts, repositories for western artists and contemporary art.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 211 | Insects, Mites, and Other Arthropods Affecting Plants |
| 212 | Diseases and Nematodes Affecting Plants |
| 214 | Vertebrates, Mollusks, and Other Pests Affecting Plants |
| 216 | Integrated Pest Management Systems |
| 603 | Market Economics |
| 711 | Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources |
| 721 | Insects and Other Pests Affecting Humans |
| 903 | Communication, Education, and Information Delivery |

**Outcome #4**

**1. Outcome Measures**

Develop seasonal management programs and applied pest and disease management research that leads to improved management practices.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Managing weeds in croplands is one of the most difficult tasks faced by agricultural producers. Agricultural weeds cause economic losses that can be limited using integrated weed management. Integrated weed management requires knowledge about biology and ecology of crops and weeds that includes interaction with farming practices and the environment. Integrated weed management using diversified methods helps limit negative impacts of herbicides to the environment, and impacts associated with the evolution of herbicide resistance.

**What has been done**
A new cropland weed specialist began in August of 2018. In the last part of the year, he conducted seven presentations with 550 attendees and completed five peer reviewed papers on agricultural ecology or non-native weeds. He also led a study abroad program for MSU students to Morocco where they attended the International Food Legume Research Conference and worked with the community of Zaouiat Ahansal on agricultural issues and STEM education.

**Results**
Workshops were rated a 4.6/5.0. Seminar participants learned basic weed ecology and biology. In addition, participants learned about herbicide carryover, and the symptoms of herbicide injury in the context of modes of action.

Individual agents also offered management programs that lead to improved practices. In Teton County, the Extension office certified 457 acres of Noxious Weed Seed Free Hay for 15 producers. These acres produced 769 acres of premium hay, which returned an additional estimated $38,450 to the producers. The office also facilitated the order and delivery of 5,000 trees and shrubs for conservation purposes in the county in cooperation with the Montana Conservation Seedling Nursery. This project will save the county $11,700 in inputs and result in increased property value due to long-term enhancements.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 211 | Insects, Mites, and Other Arthropods Affecting Plants |
| 212 | Diseases and Nematodes Affecting Plants |
| 213 | Weeds Affecting Plants |
| 214 | Vertebrates, Mollusks, and Other Pests Affecting Plants |
| 215 | Biological Control of Pests Affecting Plants |
| 216 | Integrated Pest Management Systems |
| 314 | Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals |
| 601 | Economics of Agricultural Production and Farm Management |
| 603 | Market Economics |
| 711 | Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources |
| 712 | Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins |
| 721 | Insects and Other Pests Affecting Humans |
| 903 | Communication, Education, and Information Delivery |

**Outcome #5**

**1. Outcome Measures**

Increase the number of producers/ranch managers who implement range monitoring activities which lead to improvement in resource management strategies.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Healthy range is a necessary component of ensuring a sustainable supply of beef. Ranching is also a vital part of the economy of northeast Montana. Environmental conditions such as low average precipitation, soil health, and availability of forages can limit the carrying capacity of land. Factors such as drought, noxious weed invasion and predation can significantly increase challenges of the rancher to manage land. Successful range improvement programs, including noxious weed control, water quality and riparian area protections, improving the quality of the range, as well as the carrying capacity, are necessary.

**What has been done**
In Roosevelt County where a large percent of the ranchers are smaller operators with fewer than 200 head, a needs assessment revealed that producers wanted to learn about improving range conditions, understanding nutrition needs of cattle at all stages, and developing strategies to deal with challenges of drought. As a result, the Roosevelt County Range Tour was conducted with partners from the USDA, NRCS, and Roosevelt County weed district. Four area producers provided comments as well. Education topics included identification of range weeds, bio-controls for range weeds, and range monitoring.

**Results**
All of the attendees (n=14) strongly agreed that the tour provided helpful new information that increased their knowledge of range management, while 83% said they learned something they would incorporate into their operations. Attendees were most likely to implement bale grazing and bio-control for spurge as a result of the tour. One attendee stopped in after the workshop to share he was putting in infrastructure that would allow him to begin bale grazing in a pasture where he was struggling to limit erosion. Overall, attendees rated the program an average of 4.75 of a possible 5.0. Due to the success of the program, the county is working to make it an annual

event.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 213 | Weeds Affecting Plants |
| 215 | Biological Control of Pests Affecting Plants |
| 216 | Integrated Pest Management Systems |
| 314 | Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals |
| 601 | Economics of Agricultural Production and Farm Management |
| 603 | Market Economics |
| 711 | Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources |
| 712 | Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins |
| 721 | Insects and Other Pests Affecting Humans |

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

### External factors which affected outcomes

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

### Brief Explanation

The Communications Specialist for MAES resigned at the end of 2018 leaving a gap in knowledge of MAES projects for this report.

## V(I). Planned Program (Evaluation Studies)

### Evaluation Results

Numerous Hatch projects are underway to improve integrated pest management. Results include:
-Used genome-wide transcriptome studies on wheat-Puccinia interactions to identify dozens of wheat genes that were significantly up-regulated during rust colonization in the susceptible cultivar "Scholar" starting from 3 days post inoculation when the pathogen is successfully established in the host. Researchers knocked down the 12 selected genes using barley stripe mosaic virus. They observed resistance phenotypes in the leaves where the target gene was silenced, while the non-silenced leaves were susceptible.
-Providing diagnostics, education and practical management strategies to farmers: tested seed treatment fungicides against several fungal species including Botrytis cinereal and related species. This work is being published.
-Received a $3.3 million grant from USDA-SCRI for "Building a Better Lentil from the Ground Up" that includes seed treatment fungicide trials on lentil in seven locations in

Montana and North Dakota over three years.
-Russian Knapweed: Eight sites were monitored for the gall midge and wasp, as well as plant density and cover. Analysis is still underway. Generally, populations of the gall midge were slightly greater this year probably due to the wet spring. Wasp populations were significantly down in Broadwater, Carbon and Philips Counties, but abundant in Bighorn, Chouteau and Rosebud Counties.
-Tansy ragwort: Both Swiss and hybrid beetles increased tansy ragwort mortality (by 42 and 45%, respectively), and reduced fecundity of surviving plants (by 44 and 72%, respectively). Beetle densities and mortality of larger plants were greater at sites with hybrids present. These results suggest that hybridization of ragwort flea beetles at high elevation sites may improve biological control of tansy ragwort, and that intraspecific hybridization of agents could benefit biological control programs.
-Eastern health snail: preliminary snail surveys indicated the presence of multiple size class individuals from small immature snails to reproducing adults. Techniques are being developed to more effectively rear snails and to conduct oviposition.
-Rush skeletonweed: monitoring of moth populations and possible impact on plant density and plant size continues. Although moth populations have declined, a slight decline in skeletonweed density, cover and size has been observed; indicating possible impact on the plant. Plant density has declined from 29.1 plants/.25 m2 to 7.0 plants in 2018. Preliminary analysis of data indicate that feeding may be impacting larger diameter rush skeletonweed roots, leaving plants with small diameter roots.

**Key Items of Evaluation**

The Schutter Diagnostic Laboratory provides identification of plant diseases, insects, insect damage, weeds and other plants, abiotic problems and mushrooms. Annually the SDL receives about 2500 samples. In 2018 they were: plant disease diagnosis (37.8%), insect (17.4%), plant identification (20.9%), turf disease (5.1%), other plant disorders (8.67%), spider (5.6%), mushroom (2%) and other (4%).
SDL clients report: 85% say SDL services are extremely and very useful; 88% say the SDL adequately addressed their sample question or crop issue; 93% said they felt the SDL report/recommendation positively impacted their ability to identify their pest problem in the future; and 93% felt the SDL report/recommendation positively affected their confidence in taking corrective action by increasing overall knowledge of the pest situation.
A testimonial from Valley County: "Through proper identification of a new invasive weed by the Schutter Laboratory in 2010, we have been able to research management options and provide growers with strategies for reducing populations and conserving crop yield. Growers have changed their management practices, increased scouting and have been able to save over $6 million locally and over $200 million in the MonDak area from crop yield losses that would have been incurred from this weed.

In 2018 the rangeland weed specialist gave 31 presentations across Montana, held a 3-day weed management workshop, distributed 12 weed posts and published three Extension publications and four peer-reviewed journal articles. At one event, she, along with MAES and Montana Department of Agriculture speakers improved the overall understanding of integrated pest management principles (pest identification, monitoring and scouting, decision-making, intervention, and evaluation) by an average of 11.3% (n=202). At the 3-day weed management workshop scores improved from pre- to post- test by 23% (n=31).

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

**Program # 5**

**1. Name of the Planned Program**

Energy and Natural Resources

☑ Reporting on this Program

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

1. Program Knowledge Areas and Percentage

| KA Code | Knowledge Area | %1862 Extension | %1890 Extension | %1862 Research | %1890 Research |
|---|---|---|---|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships | 5% | | 10% | |
| 104 | Protect Soil from Harmful Effects of Natural Elements | 5% | | 10% | |
| 111 | Conservation and Efficient Use of Water | 0% | | 10% | |
| 112 | Watershed Protection and Management | 5% | | 10% | |
| 122 | Management and Control of Forest and Range Fires | 5% | | 5% | |
| 123 | Management and Sustainability of Forest Resources | 10% | | 5% | |
| 124 | Urban Forestry | 5% | | 0% | |
| 131 | Alternative Uses of Land | 5% | | 5% | |
| 132 | Weather and Climate | 5% | | 10% | |
| 135 | Aquatic and Terrestrial Wildlife | 5% | | 5% | |
| 136 | Conservation of Biological Diversity | 5% | | 5% | |
| 141 | Air Resource Protection and Management | 0% | | 5% | |
| 402 | Engineering Systems and Equipment | 5% | | 0% | |
| 605 | Natural Resource and Environmental Economics | 5% | | 10% | |
| 903 | Communication, Education, and Information Delivery | 35% | | 10% | |
| | **Total** | 100% | | 100% | |

## V(C). Planned Program (Inputs)

**1. Actual amount of FTE/SYs expended this Program**

| Year: 2018 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 4.5 | 0.0 | 22.9 | 0.0 |
| **Actual Paid** | 2.5 | 0.0 | 37.8 | 0.0 |
| **Actual Volunteer** | 0.8 | 0.0 | 0.0 | 0.0 |

### 2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 33368 | 0 | 393812 | 0 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 0 | 0 | 1953859 | 0 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 59682 | 0 | 1680868 | 0 |

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

COA, MAES and Extension will work one-on-one and in groups with landowners and consumers to identify and address individual and industry struggles and solutions. They will regularly answer specific questions through workshops, phone calls, email and personal consultations to address topics such as forest and rangeland stewardship and water quality.

COA, MAES and Extension will partner with local and state associations and organizations that are concerned about natural resource issues. In particular, they will engage with leaders concerned about natural resources to find ways to provide meaningful education and research while collaborating to solve problems and create strategies for future growth and development. Agents and specialists will offer classes, workshops, group discussions, demonstrations, online resources and field tours/trials. Agents, specialists and volunteers will disseminate knowledge via community events and meetings, websites and social media. MSU Extension and MAES will utilize PSA's, newsletters, MONTGuides, television, eXtension, listservs, social media, and other sources to share information.

### 2. Brief description of the target audience

- Private forest and rangeland owners and public land managers
- Farmers/Ranchers/Ag Producers
- Small acreage landowners
- Community leaders
- Professional loggers/foresters/rangeland managers
- Environmental scientists
- State economists

### 3. How was eXtension used?

eXtension was used for research and to create presentations. eXtension was also used to share information through fact sheets and answer Ask an Expert questions via the Rangeland Stewardship and Health Community of Practice (COP). Questions for Ask an Expert are also used to assess clientele nees and help guide programming.

## V(E). Planned Program (Outputs)

### 1. Standard output measures

| 2018 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 2108 | 4169 | 43 | 1500 |

### 2. Number of Patent Applications Submitted (Standard Research Output)

**Patent Applications Submitted**

Year: 2018

Actual: 0

**Patents listed**

### 3. Publications (Standard General Output Measure)

**Number of Peer Reviewed Publications**

| 2018 | Extension | Research | Total |
|---|---|---|---|
| **Actual** | 0 | 0 | 91 |

## V(F). State Defined Outputs

**Output Target**

**Output #1**

**Output Measure**

- Number of research citations

| Year | Actual |
|---|---|
| 2018 | 60 |

**Output #2**

**Output Measure**

- Number of people attending forest stewardship programming

| Year | Actual |
|---|---|
| 2018 | 263 |

**Output #3**

**Output Measure**

- Number of people attending water quality programming, including workshops and seminars to learn about watersheds and environmentally sustainable best practices.

| Year | Actual |
|---|---|
| 2018 | 60 |

**Output #4**

**Output Measure**

- Number of participants attending training through the Weatherization Center

| Year | Actual |
|---|---|
| 2018 | 214 |

**V(G). State Defined Outcomes**

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Increased number of private forest owners who create and implement forest stewardship plans that allow them to continue to provide economic, environmental and social benefits to Montanans. Increased number of people who gain knowledge about forestry management and sustainability issues and contribute to forest health. |
| 2 | Increased number of homeowners regularly testing wells and managing them for safe consumption and environmental soundness. Increased number of Montanans who utilize online Extension and other resources related to watershed protection, drinking water safety and other water quality topics. |
| 3 | Energy Efficiency and Alternatives: Increased number of consumers accessing and utilizing Extension resources and participating in training to improve efficiency, reduce environmental impacts and lower costs. |
| 4 | Natural Resource Development: Increased number of collaborations with partners in eastern Montana to explore benefits and challenges as a result of the Bakken Oil Field and related issues. Increase in the number of landowners who are educated and make sound decisions about water and mineral rights. |
| 5 | Bio-energy research: Continued examination of the potential for greater utilization of hazardous forest fuels as a source of alternative carbon neutral liquid fuel production. |
| 6 | Increased knowledge and use of best management practices for successfully integrating livestock grazing with fish and wildlife resources. |
| 7 | Increased knowledge and practice of sustainable livestock grazing practices on forests, rangeland and pastures. |
| 8 | Increased awareness about how communities can best address challenges and opportunities related to oil and gas development. |
| 9 | Increase understanding of cheatgrass invasion in the Northern Great Plains |

## Outcome #1

### 1. Outcome Measures

Increased number of private forest owners who create and implement forest stewardship plans that allow them to continue to provide economic, environmental and social benefits to Montanans. Increased number of people who gain knowledge about forestry management and sustainability issues and contribute to forest health.

### 2. Associated Institution Types

- 1862 Extension

### 3a. Outcome Type:

Change in Action Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2018 | 0 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Montana has 25 million acres of forest, of which 4.4 million are owned by over 52,000 private individuals (who own 5+ acres). Historically these family-owned forests have supplied 30% of annual Montana timber harvest, today it's over 50%. Loggers can become Accredited Logging Professionals if they pass stewardship classes. Family forests also provide open space, clean water, wildlife habitat, and the recreational opportunities for which Montana is famous. In years of severe wildfire, these lands, when managed well, have provided an important wildfire control buffer between wildlands and surrounding communities. The Montana Forest Stewardship Steering Committee advises MSU Extension Forestry in how to best meet the needs of these landowners.

**What has been done**
Extension Forestry provides forest landowner education programs ranging from core Forest Stewardship Planning Workshops to topic specific workshops like Windbreaks/Living Snowfences, Alternative Forest Management Practices, Wildfire Hazard Reduction, and Tree Pruning and Care. Five Forest Stewardship workshops were offered in 2018. Eighty-three percent of participating ownerships completed the workshop and submitted a stewardship plan; accounting for 6,369 acres.

**Results**
Of participants in the Stewardship workshop, 66% completed the post-workshop evaluation. 92% increased their knowledge of forest function and ability to make informed management decisions with confidence. Over 44% planned to apply for cost-share funds to thin and reduce fire hazards and 64% planned to manage for specific wildlife species. The management plans included 558 acres of commercial harvests, 2,210 acres of intermediate treatments including pre-commercial

thinning, planting, and pruning. Participants plan to implement practices to conserve or improve 4,914 acres of wildlife habitat, 509 acres for water quality, 3,634 acres for forest health, and 1,986 acres for wildfire hazard reduction and resilience. In addition, 41 additional ownerships that completed plans over the past five years were monitored. They have commercially and salvage harvested 1,276 acres, tree planted 132 acres, thinned 131 acres, managed 562 acres for insect and disease control, created defensible space on 35 acres and improved riparian/wetlands on 151 acres.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships |
| 104 | Protect Soil from Harmful Effects of Natural Elements |
| 111 | Conservation and Efficient Use of Water |
| 112 | Watershed Protection and Management |
| 122 | Management and Control of Forest and Range Fires |
| 123 | Management and Sustainability of Forest Resources |
| 124 | Urban Forestry |
| 131 | Alternative Uses of Land |
| 132 | Weather and Climate |
| 136 | Conservation of Biological Diversity |
| 605 | Natural Resource and Environmental Economics |
| 903 | Communication, Education, and Information Delivery |

**Outcome #2**

**1. Outcome Measures**

Increased number of homeowners regularly testing wells and managing them for safe consumption and environmental soundness. Increased number of Montanans who utilize online Extension and other resources related to watershed protection, drinking water safety and other water quality topics.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Montana has 60,000 miles of perennial streams which provide irrigation, drinking water and recreation. Approximately 45 percent of those streams are listed as impaired. Non-point sources of pollution, which everyone plays a role in, cause the most impairment. To improve management, the general public must understand that their actions have an impact and make decisions to mitigate damage. There is no government oversight of water quality for private drinking wells so it is the homeowner's responsibility to test and understand their water drinking quality.

**What has been done**
MSU Extension Water Quality (MSUEWQ) works with county partners and agencies to engage citizens in data collection to understand surface and groundwater issues, and also provides leadership of the Water Committee of the statewide Watershed Coordination Council. MSUEWQ offered six workshops in 2018, with 60 participants who collectively volunteered 600 hours working with citizens collect samples and better understand watershed issues.

**Results**
Evaluations from the Big Sky Watershed Corps' Water Monitoring and Storymaps meeting indicated that the quality of workshop was good (79%) or very good (21%). Participants felt the alignment of the workshop with the personal professional goals was good (30%) or very good (46%). Of the group (n=24), all indicated the materials on the website were useful and many provided suggestions to enhance and improve. The biggest complaint was too little time for the detailed information provided and for practicing teaching. The facilitators are using all the feedback to improve the resources and training opportunities in the future. The goal is to have competent, trained volunteers who are able to help with monitoring Montana's water resources.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships |
| 104 | Protect Soil from Harmful Effects of Natural Elements |
| 111 | Conservation and Efficient Use of Water |
| 112 | Watershed Protection and Management |
| 132 | Weather and Climate |
| 136 | Conservation of Biological Diversity |
| 903 | Communication, Education, and Information Delivery |

## Outcome #3

### 1. Outcome Measures

Energy Efficiency and Alternatives: Increased number of consumers accessing and utilizing Extension resources and participating in training to improve efficiency, reduce environmental impacts and lower costs.

### 2. Associated Institution Types

- 1862 Extension

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 214 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Montana has a need for technical training and assistance for contractors who work with government programs such as the Weatherization Assistance Program (WAP), and for others who are trying to ensure energy-efficiency and indoor-air-quality standards are met. Certification is often required for contractor, raters, energy auditors, retrofit-installers, etc. who work within the building industry. The Montana Department of Public Health and Human Services provides regular input into Extension's Montana Weatherization Training Center (WTC).

**What has been done**
During 2018, the MT WTC conducted 26 direct engagement trainings/classes that yielded contact with over 200 individuals from agencies across Montana and several surrounding states. Through these trainings, 214 individuals were trained to Department of Energy standards and certified. When randomly checked, approximately 91% of homes worked on by these certified individuals met or exceeded DOE standards when randomly inspected by the State of Montana DPHHS personnel.

**Results**
Individuals trained by the WTC worked on more than 1,000 low-income homes throughout Montana. These homes showed significant improvements in energy efficiency (approximately 30% savings) which lowers the financial burden of energy bills for the low-income families living within them.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 132 | Weather and Climate |
| 141 | Air Resource Protection and Management |
| 402 | Engineering Systems and Equipment |
| 605 | Natural Resource and Environmental Economics |
| 903 | Communication, Education, and Information Delivery |

## Outcome #4

### 1. Outcome Measures

Natural Resource Development: Increased number of collaborations with partners in eastern Montana to explore benefits and challenges as a result of the Bakken Oil Field and related issues. Increase in the number of landowners who are educated and make sound decisions about water and mineral rights.

### 2. Associated Institution Types

- 1862 Extension

### 3a. Outcome Type:

Change in Action Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2018 | 57 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Water is the life blood of agriculture. Early in 2018, the Montana Department of Natural Resources and Conservation mailed notices to all well and water owners in Sweet Grass County about filing for and updating current water rights. Many producers were concerned about implications of the letter.

**What has been done**
Extension collaborated with the local conservation district, Crazy Mountain Stockgrowers and local land managers to develop an educational program. Fifty-seven people attended the meeting.

**Results**
Of the 57 people who attended the water rights meeting, 50 applied for water rights on their wells and were able to examine and clarify their existing water rights.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 111 | Conservation and Efficient Use of Water |
| 112 | Watershed Protection and Management |
| 903 | Communication, Education, and Information Delivery |

## Outcome #5

### 1. Outcome Measures

Bio-energy research: Continued examination of the potential for greater utilization of hazardous forest fuels as a source of alternative carbon neutral liquid fuel production.

### 2. Associated Institution Types

- 1862 Extension
- 1862 Research

### 3a. Outcome Type:

Change in Action Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2018 | 0 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Montana has more than 20 million acres of non-reserved timberland that contains live and dead trees that are comprised of an estimated 850 million dry tons of wood. More than 135 million tons of standing dead trees were inventoried in 2003 and that number has more than likely increased 10 fold as a result of insect outbreaks and wildfires since during the past 15 years. In addition, overly dense conifer regeneration across many forested areas, estimated to comprise more than half of the 9 billion trees in the state has led to drought stress and increased fuel loading as well. Fire hazard reduction work is needed to mitigate the increasing risk and cost of landscape level catastrophic wildfires, yet there is little to no market for this estimated 200 million tons of excessive woody biomass. Developing carbon neutral bioenergy products from this woody biomass offers the most reasonable solution to this problem.

**What has been done**
A multi-year analysis of forest inventories, land ownerships, forest contractors and wood products infrastructure was conducted with multiple partners across the state. In addition, MSU Extension participated in two successful Northwest NIFA grants totaling more than $50 million (Northwest Advanced Renewables Alliance with Washington State University as the PI and Bioenergy Alliance Network of the Rockies, Colorado State University PI) where the supply and conversion of woody biomass to liquid fuels was the main research topic.

**Results**
The costs associated with harvesting only biomass typically exceed any existing market price for this material and thus such materials that result from timber harvesting or forest restoration and wildfire mitigation practices is currently piled and burned, or masticated and left on site. Commercial logging currently produces an estimated 860 thousand dry tons per year which could be marketed as a substantially lower cost since it is a by-product of commercial logging and

currently a cost to treat in order to comply with the Montana Hazardous fuel Reduction Act. Some market sources have developed for this materials such as the Fuels for School Program where schools have converted their heating units to burn woody biomass, Sawmills that utilized wood waste to produce heat for wood drying kilns and the Stoltze Land and Lumber sawmill that built a 2.5 Megawatt power cogeneration facility that uses heat for their dry kilns and sells electricity to NW Energy.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 112 | Watershed Protection and Management |
| 122 | Management and Control of Forest and Range Fires |
| 123 | Management and Sustainability of Forest Resources |
| 124 | Urban Forestry |
| 131 | Alternative Uses of Land |
| 903 | Communication, Education, and Information Delivery |

**Outcome #6**

**1. Outcome Measures**

Increased knowledge and use of best management practices for successfully integrating livestock grazing with fish and wildlife resources.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Wildlife space use, demography, and population viability are linked to habitat conditions that are influenced by human activities, especially agriculture, at multiple special and temporal scales. An improved understanding of the relationships among habitat conditions, rangeland management, and population processes are necessary for effective conservation and management of wildlife in working landscapes.

**What has been done**

A study was started to investigate the effects of rangeland management practices on obligate grassland birds and their predators in northern mixed-grass prairies. Included in the study were steps to evaluate the effects of grazing systems on sharp-tailed grouse space use and demography, develop a mechanistic understanding of the ecological relationships between various grazing treatments and the abundance and diversity of grassland bird and mesopredator community. Radio-marked females were located and observed during nesting and brood-rearing and during the winter. Habitat conditions at each nest and brood flush site were evaluated and stocking information for every pasture in which the radio-marked sharp-tailed grouse were located was collected. The field data was used to estimate eight demographic parameters related to fertility.

**Results**
Preliminary analysis of the data suggested that visual obstruction at the nest bowl best predicted nest site selection and survival. The type of grazing system (summer-rotation pasture, rest-rotation pasture and season-long pasture) did not influence nest site selection or survival, however the relative probability of selection declined with increasing stocking rates. Four peer-reviewed journal articles have been published related to this study, three graduate students have completed their theses, and a dozen conference presentations have been made. All three graduate students have been permanently employed within natural resource management agencies. The information has been shared directly in seminars and workshops for more than 160 producers, landowners, agents, undergrad and graduate students.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships |
| 111 | Conservation and Efficient Use of Water |
| 112 | Watershed Protection and Management |
| 131 | Alternative Uses of Land |
| 132 | Weather and Climate |
| 135 | Aquatic and Terrestrial Wildlife |
| 136 | Conservation of Biological Diversity |
| 903 | Communication, Education, and Information Delivery |

**Outcome #7**

**1. Outcome Measures**

Increased knowledge and practice of sustainable livestock grazing practices on forests, rangeland and pastures.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Manure and fertilizer are the primary source of NH3 emissions in this region causing economic loss to farms, air quality degradation, and nitrogen (N) deposition and pollution of natural ecosystems. To help mitigate atmospheric CO2 increases, environmental scientists and policy makers have considered using terrestrial ecosystems to sequester carbon (C) in vegetation and soils. For agricultural ecosystems in semiarid climates, modifying cropping systems to increase crop frequency and reduce fallow, and minimize soil disturbance represent two management practices that have been proposed to enhance soil C storage. Prior to this study there was an information gap related to the potential of Montanan's soils to sequester C in response to modifying cropping systems.

**What has been done**
Management practices that result in mitigation of NH3 emissions, and improved crop N efficiency and agricultural sustainability were investigated on private farms across the state and micrometeorological techniques were used to quantify NH3 losses. Data from six long-term (10 year) cropping system studies in Montana were analyzed. Fertilizer recommendations have been developed on how N management can be improved to reduce NH3 losses and improve fertilizer N use efficiency for improved profitability and environmental quality. Over the past two decades, tillage reduction has occurred across Montana, and many traditional tilled fallow-wheat systems disappeared. This study provides information to growers about the impact of this tillage reduction on solid organic C levels in their farm fields.

**Results**
Grower surveys were conducted following two seminars (Montana Grain Growers Convention and Nitrogen Conference). Evaluations indicated that 80% of respondents would likely change a management practice based on what they learned and 100% said they would share what they learned with at least one other person. Respondents said the information presented was relevant to the region. They affirmed that nitrogen fertility and nitrogen inputs are typically a growers largest annual cost input and that N is the fertilizer nutrient most often limiting crop yield and quality in the Northern Great Plains cropping systems. For all these reasons, growers said that management of this input to maximize crop efficiency is important to a growers' bottom line, as well as to environmental quality. Many producers indicated they have already changed their urea management practices to minimize volatilization. These actions have increased their yield, grain protein and net revenue.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships |

| | |
|---|---|
| 104 | Protect Soil from Harmful Effects of Natural Elements |
| 111 | Conservation and Efficient Use of Water |
| 131 | Alternative Uses of Land |
| 132 | Weather and Climate |
| 903 | Communication, Education, and Information Delivery |

**Outcome #8**

**1. Outcome Measures**

Increased awareness about how communities can best address challenges and opportunities related to oil and gas development.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
MAES and Extension have been working on a series of projects over many years that seek to advance understanding of sustainability in agricultural and water resource management through an approach to soils research that takes a broad view of how soils function within Montana landscapes, watersheds, and local communities. Central to these efforts is a strategic modeling to target key sites and test mechanisms driving the interactions of hydrologic systems, nutrient dynamics across soil-water connections and socioeconomic factors.

**What has been done**
Multidisciplinary efforts have been used to catalyze agricultural resilience, create a local watershed observatory and apply landscape and watershed level understanding to work in the Judith River Watershed and elsewhere. Early in 2018 a five-member faculty advisory board was created to advise on Environmental Analytical Lab operations. Thirty faculty (LRES, Research Centers, Ecology, Earth Sciences, Engineering, Chemistry, Microbiology) were trained in the lab. Eight instruments are currently running samples and funding was secured for two new instruments. More than 6000 water samples have been collected and analyzed. The accounting and data management systems are in place via a web-based system.

**Results**

The Montana National Science Foundation?s Established Program to Stimulate Competitive Research (EPSCoR) awarded the Consortium for Research on Environmental Water Systems (CREWS), for which MSU is a partner along with four additional institutions, a $20 million, five-year award to develop collaborations that explore how natural waters systems and water quality are related to mining, agriculture and energy and how changing compositions and levels of nutrients and contaminants affect water quality - from soils and rivers to the local communities that rely on clean water. The grant will build on MAES/Extension work, particularly with a focus on agricultural systems in central Montana (Judith River Watershed) and on work with the Crow Tribe in the Powder River Basin. Three journal articles were published related to observation regarding the effects of management on water quality, specifically nitrates, and community engagement in addressing the issue in the Judith River Watershed

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships |
| 104 | Protect Soil from Harmful Effects of Natural Elements |
| 111 | Conservation and Efficient Use of Water |
| 112 | Watershed Protection and Management |
| 131 | Alternative Uses of Land |
| 132 | Weather and Climate |
| 136 | Conservation of Biological Diversity |
| 605 | Natural Resource and Environmental Economics |
| 903 | Communication, Education, and Information Delivery |

**Outcome #9**

**1. Outcome Measures**

Increase understanding of cheatgrass invasion in the Northern Great Plains

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Introduced species, woody plant expansion, and climate change on rangelands threaten the ability of these lands to provide the ecological goods and services desired by society. In the northern Great Plains, improved understanding of the specific ecological conditions associated with cheatgrass invasion is needed to assist resource managers in developing management prescriptions appropriate for sites with reduced resistance or resilience to cheatgrass.

**What has been done**

A study was conducted to: 1) determine the ecological site conditions (soils, topography, climate, vegetation) associated with locations showing evidence of cheatgrass, 2) quantify disturbance history/intensity on sites showing evidence of cheatgrass invasion, 3) evaluate relationships among ecological site characteristics, disturbance and cheatgrass abundance and 4) evaluate management opportunities for cheatgrass.

**Results**

The project provided ecologically-based information to rangeland and natural resource managers that will assist them in developing appropriate management strategies to ensure continued production of the goods and services desired from rangelands including meat protein, wildlife and wildlife habitat, clean air and water, biological diversity, and recreational opportunities. Two grad students defended their theses on research related to this project and the information was presented at the Annual Grass Management Workshop hosted by the Natural Resources Conservation Service in Roundup, MT in November 2018. Additional presentations were made for the Society for Range Management and the Natural Areas Association.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships |
| 104 | Protect Soil from Harmful Effects of Natural Elements |
| 111 | Conservation and Efficient Use of Water |
| 123 | Management and Sustainability of Forest Resources |
| 132 | Weather and Climate |
| 136 | Conservation of Biological Diversity |
| 903 | Communication, Education, and Information Delivery |

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

**External factors which affected outcomes**

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

**Brief Explanation**

The Communications Specialist for MAES resigned at the end of 2018 leaving a gap in knowledge of MAES projects for this report.

### V(I). Planned Program (Evaluation Studies)

### Evaluation Results

Extension Forestry Stewardship Workshops led to an additional 6,369 acres of forest being actively managed. Forty-one ownerships that completed plans over the last five years were contacted for follow-up. These reported: commercially and salvage harvested 1,276 acres; tree planted 132 acres; thinned 131 acres; managed 562 acres for insect and disease control, created defensible space on 35 acres and improved riparian/wetlands on 151 acres.
Extension Water Quality trained 60 new volunteers to assist with sample collection and education to teach the general public about the impact of their actions on streams.
Weatherization Training Center trained contractors who worked on more than 1,000 low-income homes across Montana to make them more energy efficient, saving families approximately 30% on their utility bill.
Of 57 people who attended the water rights meeting in Sweet Grass County, 50 applied for water rights on their wells and were able to examine and clarify their existing water rights.

### Key Items of Evaluation

-Preliminary analysis of a study to determine the effects of rangeland management practices on obligate grassland birds and their predators in northern mixed-grass prairies found that the type of grazing system did not influence nest site selection or survival, however the relative probability of selection declined with stocking rates.
-Data from six long-term cropping system studies were analyzed. Fertilizer recommendations were developed on how N management can be improved to reduce NH3 losses and improve fertilizer N use efficiency for improved profitability and environmental quality. Over the last two decades, tillage has been dramatically reduced. This study will provide information to growers about how the impact of this tillage reduction on solid organic C levels in their fields. Evaluations from the Montana Grain Growers Convention and Nitrogen Conference found that 80% of respondents would change a management practice based on what they learned. 100% said they would share what they learned with at least one other person. Many producers indicated they had already changed their urea management practices to minimize volatization. These actions have increased their yield, grain protein and net revenue.
-The Consortium for Research on Environmental Water System (CREWS), for which MSU is a partner along with four other institutions, received a $20 million, five-year award to develop collaborations that explore how natural water systems and water quality are related to mining, agriculture and energy and how changing compositions and levels of nutrients and contaminants affect water quality from soils and rivers to the local communities that rely on clean water.

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

**Program # 6**

**1. Name of the Planned Program**

Youth and Family Development

☑ Reporting on this Program

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

1. Program Knowledge Areas and Percentage

| KA Code | Knowledge Area | %1862 Extension | %1890 Extension | %1862 Research | %1890 Research |
|---|---|---|---|---|---|
| 307 | Animal Management Systems | 5% | | 0% | |
| 602 | Business Management, Finance, and Taxation | 5% | | 0% | |
| 801 | Individual and Family Resource Management | 25% | | 0% | |
| 802 | Human Development and Family Well-Being | 25% | | 0% | |
| 806 | Youth Development | 35% | | 0% | |
| 903 | Communication, Education, and Information Delivery | 5% | | 0% | |
| | **Total** | 100% | | 0% | |

## V(C). Planned Program (Inputs)

**1. Actual amount of FTE/SYs expended this Program**

| Year: 2018 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 8.0 | 0.0 | 0.0 | 0.0 |
| **Actual Paid** | 17.6 | 0.0 | 0.0 | 0.0 |
| **Actual Volunteer** | 52.0 | 0.0 | 0.0 | 0.0 |

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 552865 | 0 | 0 | 0 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 0 | 0 | 0 | 0 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 359299 | 0 | 0 | 0 |

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

• Collaborate with Native American reservations and 1994 land-grant institutions to provide culturally appropriate programming and related materials to Native American families.
• Conduct workshops and clinics that provide active learning and skill development
• Conduct meetings that focus on facilitation and leadership skills
• Develop curriculum and supporting teaching tools for volunteers to use
• Provide training for youth and adult volunteers
• Partner with youth serving groups on state and local levels
• Provide/develop web-based education and information access
• Facilitate small support groups for caregivers
• Develop printed and online resources

### 2. Brief description of the target audience

• Youth aged 5-19
• Children ages 0-5
• Parents of youth involved in 4-H
• Adult and youth volunteer leaders
• Professionals involved with youth development
• School administrators and teachers
• Military families
• Rural and urban Montana families, landowners and business owners
• Caregivers
• Healthcare providers and services
• Reservation populations

### 3. How was eXtension used?

• Connecting with resources and specialists from other areas
• Youth leadership programming
• Peer-reviewed and innovative planning, program development and evaluation tools
• Leadership training
• Techniques for working with youth and adult volunteers
• 4-H Curriculum

- Implementation of citizenship programs

### V(E). Planned Program (Outputs)

### 1. Standard output measures

| 2018 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 11073 | 83764 | 14833 | 23472 |

### 2. Number of Patent Applications Submitted (Standard Research Output)

**Patent Applications Submitted**

Year: 2018

Actual: 0

**Patents listed**

### 3. Publications (Standard General Output Measure)

**Number of Peer Reviewed Publications**

| 2018 | Extension | Research | Total |
|---|---|---|---|
| **Actual** | 37 | 0 | 0 |

### V(F). State Defined Outputs

**Output Target**

**Output #1**

**Output Measure**

- Number of youth enrolled in organized 4-H clubs

| Year | Actual |
|---|---|
| 2018 | 8870 |

**Output #2**

**Output Measure**

- Number of youth participating in 4-H overnight camping programs

| Year | Actual |
|---|---|
| 2018 | 550 |

**Output #3**

**Output Measure**

- Number of youth and adult volunteers offering support for the 4-H program

| Year | Actual |
|---|---|
| 2018 | 3277 |

**Output #4**

**Output Measure**

- Number of participants in classes and support groups for parents and caregivers.

| Year | Actual |
|---|---|
| 2018 | 65 |

**Output #5**

**Output Measure**

- Number of participants in personal finance classes

| Year | Actual |
|---|---|
| 2018 | 93 |

### V(G). State Defined Outcomes

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Youth competency development: Increased number of youth participating in 4-H projects and activities and demonstrating increased knowledge and ability in specific competency areas including but not limited to science, healthy living and citizenship. |
| 2 | Youth life skill development: Increased number of youth participating in 4-H activities and demonstrating increased knowledge and ability in specific life skill areas including but not limited to teamwork, communication skills and public speaking. |
| 3 | Leadership/Volunteer Development: Increased number of youth and adults who have received leadership training and demonstrate increased knowledge and ability as a result of the training. |
| 4 | Military Family Partnerships: Increased interaction with military families resulting in increased capacity of families to access resources and support. |
| 5 | Parenting/Caregiving: Increased number of parents and caregivers who access support and resources and increased knowledge and ability of participants as a result of those efforts. |
| 6 | Personal Finances: Increased number of participants in classes and trainings and increased knowledge and aptitude of those participants based on pre- and post- survey results. Increased number of ACA inquiries, referrals, resources developed and shared, workshops and enrollments. |
| 7 | Expand research-based mental health educational programming to youth and adults statewide. |

## Outcome #1

### 1. Outcome Measures

Youth competency development: Increased number of youth participating in 4-H projects and activities and demonstrating increased knowledge and ability in specific competency areas including but not limited to science, healthy living and citizenship.

### 2. Associated Institution Types

- 1862 Extension

### 3a. Outcome Type:

Change in Action Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2018 | 0 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
According to the Education Commission of the U.S., between 2017 and 2027, Science, Technology, Engineering and Math (STEM) jobs will grow at 13%, compared to non-STEM jobs at 9.4%. Average salary of STEM jobs is $38.85, compared to non-STEM jobs at $19.30. According to PEW Research Center, as of January 2018, the United States ranked 38 of 71 countries in math competency and 24 of 71 in science competency. Research has shown that youth in 4-H develop an increased interest in science three times higher than non-4-Hers.

**What has been done**
During 2018, Montana 4-Hers completed over 40,000 STEM projects in fields including robotics, bioscience, livestock, food and nutrition, plant sciences and engineering. Livestock projects continue to be popular and fill a need for Montana by educating the next generation of ranchers. Through classes, shows and one-on-one training, youth learn livestock quality assurance skills including following medication labels and giving injections, proper animal nutrition and housing, ethics, carcass analysis, showmanship and more. Youth in shooting sports learn gun safety and ethics. Some counties include hunting, fishing and wildlife education.

**Results**
On the Fort Peck Reservation, the Advanced Market Livestock Program was started in 2017 to educate youth about how animal quality impacts market value and eating enjoyment, and how various cuts of meat, even low dollar cuts, can be utilized. Youth raising livestock, as well as hunters showed a genuine interest in learning more. In 2018, 11 more classes were offered, and in addition to teaching the science of meat, cultural connections were made by including elders. 182 youth participated. Youth reported learning how to analyze cuts of meats, mix spices, make sausage, food safety, equipment safety and cooking at the right temperature. Students also reported increased employment opportunities in restaurants, grocery stores and meat shops.

They gained a feeling of self-respect being trusted to use a knife. Grandparents in the grandparents raising grandchildren program reported increased satisfaction in being able to connect with their grandkids. Some regional shops are beginning to offer similar classes at a fee of $200. At this rate, MSU Extension saved participants, $125,600 by gathering sponsorships, partnerships and grants to offer the program for free. The program received the Excellence in 4-H Programming national award from the National Association of County Agents.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 307 | Animal Management Systems |
| 602 | Business Management, Finance, and Taxation |
| 801 | Individual and Family Resource Management |
| 802 | Human Development and Family Well-Being |
| 806 | Youth Development |
| 903 | Communication, Education, and Information Delivery |

**Outcome #2**

**1. Outcome Measures**

Youth life skill development: Increased number of youth participating in 4-H activities and demonstrating increased knowledge and ability in specific life skill areas including but not limited to teamwork, communication skills and public speaking.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
As the world grows and changes it is necessary to prepare youth of today for the future of tomorrow. 4-H grows and develops youth to be leaders with compassion, empathy and a vision to make the world a better place. Creating a positive experience for youth is key to success. Research shows that eight elements are needed to help youth thrive. These eight elements are integrated throughout all 4-H programming: relationship with a caring adult, opportunity for mastery, opportunity to see oneself I the future, safe emotional and physical environment, engagement in learning, opportunity to value/practice service to others, inclusive environment and

opportunity for self-determination.

**What has been done**
MSU Extension agents reported providing 593 learning opportunities for 14,039 youth during 2018. These included everything from livestock marketing workshops to Ag Safety Day, to Sportsmanship and Ethics training to Concession Stand Food Safety Workshops and Public Speaking/Demonstration Days. These are in addition to regular club activities. Through these workshops, youth learn valuable skills including public speaking, time management, independence, resilience and compassion. 4-H is working on creating some statewide metrics for measuring the impact of these skills. The first of these will be ready in 2019.

**Results**
Ravalli County: My involvement in 4-H has given me a passion to care of others, and that I how I was able to decide on nursing as my career. Throughout my years in 4-H, I have developed better social and communication skills as participant, a leader of my club and work with people in my community. 4-H is where I learned valuable skills such as interviewing, running meetings, and the ability to interact with a variety of people in a variety of situations. 4-H has given me lasting relationships with people. Most importantly, 4-H has given me the confidence to become a nurse, and more particularly, a nurse with social skills that will allow me to communicate with my patients and co-workers in any situation.
Roosevelt County: 4-H has taught me to give back to the community by helping those in need, making the community a better place through beautification projects and developing my leadership skills by helping younger 4-H members with their projects.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 307 | Animal Management Systems |
| 602 | Business Management, Finance, and Taxation |
| 801 | Individual and Family Resource Management |
| 802 | Human Development and Family Well-Being |
| 806 | Youth Development |
| 903 | Communication, Education, and Information Delivery |

## Outcome #3

### 1. Outcome Measures

Leadership/Volunteer Development: Increased number of youth and adults who have received leadership training and demonstrate increased knowledge and ability as a result of the training.

### 2. Associated Institution Types

- 1862 Extension

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Leaders, both youth and adult, are vital to the strength of 4-H programs and communities. The greater the depth of leadership within a program, the greater the likelihood that the program will be successful. Trained, caring adults matched with youth create partnerships that increase the competence, connection, confidence, compassion and character for both entities and increase the ability of clubs and communities to function at the highest level. MSU Extension is committed to training volunteers and improving the leadership skills of youth and adults. In 2018, more than 3,500 leaders provided in excess of $2 million in service to Montana's youth. 75% of youth who participate in 4-H leadership are also leaders in other organizations.

**What has been done**
The 4-H motto, learn by doing, is applied to leadership through experiences that allow youth to lead. Youth receive training and guidance in preparing programs such as 4-H project days, camps and service-learning activities. Youth are called upon to completed projects or events from idea to implementation and evaluation. In addition, youth manage all aspects of club activities from conducting needs assessments, running organized meetings, budgeting and resource management. Individual counties and regions provide extensive opportunities for leadership including volunteer certification. Leaders are trained around the 4-H essential elements: belonging, independence, mastery and generosity.

**Results**
Cascade County: Due to active, engaged, and motivated volunteers, we have seen an increase in first-year member enrollments and a decrease in member drop-outs. The number of volunteers has slightly increased with volunteers citing enthusiasm and satisfaction with their experience, training and involvement.
Broadwater County: 4-H enrollment has increased 40% in three years, leading to the first new club in the county since 1986. Forty-one adults were certified as leaders, a 95% increase, primarily in new project leaders, in three years. These volunteers reported an average of eight hours/month at a value to the county of $87,325. The leadership helped 4-H raise $40,343 to assist with enrichment activities, recognition and program support.
Yellowstone County: Due to leader training, participation in county meetings increased 50% from last year with the adults commenting they appreciated receiving details prior to the meeting and felt welcome to provide input. The number of applicants for camp counselor increased and 85% of 4-H Club officers completed the Officer Training event.
Carbon County: "Everyone should do training like this. I learned so much about how I communicate, and tricks to improve. It was both informative and inspiring."

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 802 | Human Development and Family Well-Being |
| 806 | Youth Development |

**Outcome #4**

**1. Outcome Measures**

Military Family Partnerships: Increased interaction with military families resulting in increased capacity of families to access resources and support.

Not Reporting on this Outcome Measure

**Outcome #5**

**1. Outcome Measures**

Parenting/Caregiving: Increased number of parents and caregivers who access support and resources and increased knowledge and ability of participants as a result of those efforts.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
By 2025 it is expected that more than 25% of Montana?s population will be over 65 yeas of age. With extended life expectancy comes a variety of chronic illnesses. Research indicates high rates of depression and anxiety among caregivers, as well as increased vulnerability to health problems. In 2014 AARP estimated Montana had 118,000 unpaid caregivers providing 110 million hours of care to loved ones at a value of $1.4 billion (based on $12.97/hour). Montana is currently ranked 49/50 in services for caregivers. Extension seeks to provide increased support. More than 6600 grandparents in Montana are responsible for the primary care of their grandchildren.

**What has been done**
Powerful Tools for Caregivers (PTC) is an educational program that provides family caregivers with skills and confidence to better care for themselves while caring for someone with a chronic illness. The Extension PTC class trains instructors to conduct six weekly 90-minute classes in communities across Montana to empower caregivers. The Montana Grandparents Raising

Grandchildren (GRG) Project provides resources for grandparent-headed families including support group facilitator training and coordination of a network of 24 education/support groups across the state, including on the seven Indian Reservation.

**Results**
Following the PTC classes, participants reported: 97% identified ways to take better care of personal health; 97% felt more competent in her/his ability as a caregiver; 92% regained an identity beyond just being a caregiver; 94% found positive ways to deal with the stress; 97% overall felt better about their role as a caregiver.
A team of three Extension agents was convened to manage this program following the departure of the previous manager at the end of 2017. The team, along with a graduate student, managed the project. They worked with the Montana Department of Health and Human Services to apply for non-competitive federal funds to begin development of an evidence-based kinship navigator program. The funding was received, and work is underway to develop the program into a full kinship program serving not only grandparents but other kinship caregivers.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 602 | Business Management, Finance, and Taxation |
| 801 | Individual and Family Resource Management |
| 802 | Human Development and Family Well-Being |
| 806 | Youth Development |
| 903 | Communication, Education, and Information Delivery |

**Outcome #6**

**1. Outcome Measures**

Personal Finances: Increased number of participants in classes and trainings and increased knowledge and aptitude of those participants based on pre- and post- survey results. Increased number of ACA inquiries, referrals, resources developed and shared, workshops and enrollments.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Increased knowledge about personal finance topics leads to improved decision making and better financial security for individuals and families. When people have good financial security, they are less likely to need government and community safety net programs (food bank, supplemental nutrition, Section 8 housing, etc.). Montanans of all ages can benefit from learning about the need for estate planning as 70% die without writing a will. The average age of farm operators is 58. During the next decade many operations will be passed down to the next generation. Many don?t realize how their property is titled impacts who will receive it if they die without a will.

**What has been done**
Solid Finances is a web-based adult financial series with the goal of improving the financial literacy of working adults. Classes include topics such as banking, health insurance, avoiding financial scams, taking the mystery out of retirement planning, working investments, budgeting and more. During 2018, 459 people attended 18 Solid Finances Webinars and the recordings were watched an additional 926 times. In addition, 77 educational presentations covering Estate Planning were attended by 1,990 people in 23 counties. Four new MontGuides (peer-reviewed information sheets) were developed: ABLE accounts, Estate Planning Aspects of Livestock Brands, the Montana Body Donation Program and them Montana Endowment Tax Credit. 1735 Estate planning packets were sold and 1,361 Dying Without a Will CDs were requested and delivered.

**Results**
Estate Planning Classes evaluations revealed:
-90% planned to review their beneficiary designations on their assets.
-83% indicated they would complete a separate listing of tangible personal property
-94% indicated they would discuss estate planning with a spouse or family member
-91% were going to review beneficiary designation
-75% planned to get a legal power of attorney
-38% planned to make an appointment with an attorney to execute a will

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 602 | Business Management, Finance, and Taxation |
| 801 | Individual and Family Resource Management |
| 802 | Human Development and Family Well-Being |
| 903 | Communication, Education, and Information Delivery |

## Outcome #7

### 1. Outcome Measures

Expand research-based mental health educational programming to youth and adults statewide.

### 2. Associated Institution Types

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Mental illnesses are a common problem affecting 25% of the U.S. population each year, with 6% having serious mental illness. The prevalence of mental health problems is even greater in Montana where the suicide rate is nearly twice the national rate (Montana Strategic Suicide Prevention Plan, 2015). There are large populations at high risk of mental illness including Native Americans and veterans, as well as people employed as farmers and ranchers. Prevention efforts also need to focus on youth, a developmental time when mental illnesses often first manifest. In rural Montana, were healthcare services are scare, mental health literacy is critical as family members and friends may be the first to identify changes in a loved one needing professional services.

**What has been done**
To address the Mental Health needs of Montanans, MSU Extension has joined with the MSU Center for Mental Health Research and Recovery (CMHRR) to implement mental health literacy and suicide prevention programming. Many Extension faculty have been called upon by their consitituents to support mental health efforts in their counties. In 2018, Extension offered Mental Health First Aid training, participated in the Youth Aware of Mental Health (YAM) research project (11 Montana Schools), and offered programs such as Question, Persuade, Respond (QPR). Partnerships were developed with Stone Child College and Little Bighorn College to offer programming on the reservations.

**Results**
During 2017-2018, 641 youth receive YAM training through Extension. So far, results have been positive: (n-72) 36% reported a decrease in depressive symptoms and 15.6% reported stable symptoms. Only 16.8% reported minor increases. After YAM, 50.5% (n=100) reported a decrease in anxiety. Among YAM completers, 40.3% reported an increase in the likelihood they would talk to family or a teacher about mental health.
Correct responses on the Mental Health First Aide pre-class survey were 55% correct, and post-class 97%. MHFA was taught in nine communities in 2018. Of participants 47 were white, 18 Native American, one Hispanic and one African American. One participant was in law enforcement, three were first responders and 25 were in a healthcare related field.
Extension also assisted in recruiting participants for a study on the effectiveness of Thrive, an online program that has been shown to improve depressive symptoms and anxiety.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 801 | Individual and Family Resource Management |
| 802 | Human Development and Family Well-Being |
| 806 | Youth Development |
| 903 | Communication, Education, and Information Delivery |

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

### External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

### Brief Explanation

MSU Extension's work in youth and family development is extensive and often very specific to the needs of individual communities. Efforts continue to improve tracking of impacts.

## V(I). Planned Program (Evaluation Studies)

### Evaluation Results

In 2018, more than 3,500 leaders provided in excess of $2 million in service to Montana's youth. 75% of youth who participate in 4-H leadership are also leaders in other organizations.
Broadwater County: 4-H enrollment has increased 40% in three years, leading to the first new club in the county since 1986. Forty-one adults were certified as leaders, a 95% increase, primarily in new project leaders, in three years. These volunteers reported an average of eight hours/month at a value to the county of $87,325. The leadership helped 4-H raise $40,343 to assist with enrichment activities, recognition and program support.
MSU Extension agents reported providing 593 learning opportunities for 14,039 youth during 2018. These included everything from livestock marketing workshops to Ag Safety Day, to Sportsmanship and Ethics training to Concession Stand Food Safety Workshops and Public Speaking/Demonstration Days. These are in addition to regular club activities. Through these workshops, youth learn valuable skills including public speaking, time management, independence, resilience and compassion
Ravalli County: My involvement in 4-H has given me a passion to care of others, and that I how I was able to decide on nursing as my career. Throughout my years in 4-H, I have developed better social and communication skills as participant, a leader of my club and work with people in my community. 4-H is where I learned valuable skills such as interviewing, running meetings, and the ability to interact with a variety of people in a variety of situations. 4-H has given me lasting relationships with people. Most importantly, 4-H has given me the confidence to become a nurse, and more particularly, a nurse with

social skills that will allow me to communicate with my patients and co-workers in any situation.
During 2018, Montana 4-Hers completed over 40,000 STEM projects in fields including robotics, bioscience, livestock, food and nutrition, plant sciences and engineering.
On the Fort Peck Reservation, the Advanced Market Livestock Program was started in 2017 to educate youth about how animal quality impacts market value and eating enjoyment, and how various cuts of meat, even low dollar cuts, can be utilized. In 2018, 11 more classes were offered, and in addition to teaching the science of meat, cultural connections were made by including elders. 182 youth participated. Youth learned how to analyze cuts of meats, mix spices, make sausage, food safety, equipment safety and cooking at the right temperature. Students also reported increased employment opportunities in restaurants, grocery stores and meat shops. They gained a feeling of self-respect being trusted to use a knife. Grandparents in the grandparents raising grandchildren program reported increased satisfaction in being able to connect with their grandkids. Some regional shops are beginning to offer similar classes at a fee of $200. At this rate, MSU Extension saved participants, $125,600 by gathering sponsorships, partnerships and grants to offer the program for free. The program received the Excellence in 4-H Programming national award from the National Association of County Agents.

## Key Items of Evaluation

Powerful Tools for Caregivers (PTC) is an educational program that provides family caregivers with skills and confidence to better care for themselves while caring for someone with a chronic illness: Following the PTC classes, participants reported: 97% identified ways to take better care of personal health; 97% felt more competent in her/his ability as a caregiver; 92% regained an identity beyond just being a caregiver; 94% found positive ways to deal with the stress; 97% overall felt better about their role as a caregiver.
Increased knowledge about personal finance topics leads to improved decision making and better financial security for individuals and families. When people have good financial security, they are less likely to need government and community safety net programs (food bank, supplemental nutrition, Section 8 housing, etc.).
Solid Finances: During 2018, 459 people attended 18 Solid Finances Webinars and the recordings were watched an additional 926 times. In addition, 77 educational presentations covering Estate Planning were attended by 1,990 people in 23 counties.
Estate Planning Classes evaluations revealed:
-90% planned to review their beneficiary designations on their assets.
-94% indicated they would discuss estate planning with a spouse or family member
-38% planned to make an appointment with an attorney to execute a will
In 2018, Extension offered Mental Health First Aid training, participated in the Youth Aware of Mental Health (YAM) research project (11 Montana Schools), and offered programs such as Question, Persuade, Respond (QPR). Partnerships were developed with Stone Child College and Little Bighorn College to offer programming on the reservations.
During 2017-2018, 641 youth receive YAM training through Extension. So far, results have been positive: (n-72) 36% reported a decrease in depressive symptoms and 15.6% reported stable symptoms. Only 16.8% reported minor increases. After YAM, 50.5% (n=100) reported a decrease in anxiety. Among YAM completers, 40.3% reported an increase in the likelihood they would talk to family or a teacher about mental health.
Correct responses on the Mental Health First Aide pre-class survey were 55% correct, and post-class 97%.

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

**Program # 7**

**1. Name of the Planned Program**

Healthy Living, Nutrition and Food Safety

☑ Reporting on this Program

**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 | 5% | | 10% | |
| 702 | Requirements and Function of Nutrients and Other Food Components | 5% | | 0% | |
| 703 | Nutrition Education and Behavior | 20% | | 0% | |
| 704 | Nutrition and Hunger in the Population | 10% | | 40% | |
| 721 | Insects and Other Pests Affecting Humans | 5% | | 5% | |
| 722 | Zoonotic Diseases and Parasites Affecting Humans | 5% | | 45% | |
| 724 | Healthy Lifestyle | 20% | | 0% | |
| 801 | Individual and Family Resource Management | 10% | | 0% | |
| 802 | Human Development and Family Well-Being | 10% | | 0% | |
| 805 | Community Institutions, Health, and Social Services | 10% | | 0% | |
| | **Total** | 100% | | 100% | |

## V(C). Planned Program (Inputs)

**1. Actual amount of FTE/SYs expended this Program**

| Year: 2018 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 4.0 | 0.0 | 6.3 | 0.0 |
| **Actual Paid** | 7.5 | 0.0 | 2.9 | 0.0 |
| **Actual Volunteer** | 2.1 | 0.0 | 0.0 | 0.0 |

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 162086 | 0 | 36550 | 0 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 0 | 0 | 260836 | 0 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 183985 | 0 | 34779 | 0 |

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

- Conduct train the trainer workshops
- Conduct workshops, seminars, meetings
- Facilitate meetings, discussion groups, focus groups
- Develop local and state partnerships
- Develop MontGuides (fact sheets), publications, website materials, video based materials
- Conduct web based, interactive training/education opportunities

### 2. Brief description of the target audience

- Low income adults
- Low income youth
- Adults that are FSP eligible
- Youth from FSP eligible households
- Teachers in the Montana School System
- Middle to older aged women, especially those living in rural areas
- Parents and youth living in rural areas
- Working people
- Elderly and shut-in people
- Reservation youth
- Food service managers and staff

### 3. How was eXtension used?

eXtension was used for newsletters, fact sheets, general resources and evaluation tools and reports.

## V(E). Planned Program (Outputs)

### 1. Standard output measures

| 2018 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 6091 | 156580 | 9046 | 20774 |

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

**Patent Applications Submitted**

| | |
|---|---|
| Year: | 2018 |
| Actual: | 0 |

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

| 2018 | Extension | Research | Total |
|---|---|---|---|
| **Actual** | 0 | 0 | 26 |

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

**Output Target**

**Output #1**

**Output Measure**

- Number of participants in Strong Women, Arthritis Foundation and other exercise programs facilitated through MSU Extension
  Not reporting on this Output for this Annual Report

**Output #2**

**Output Measure**

- Number of food safety and nutrition related MontGuides distributed by MSU Extension Publications
  Not reporting on this Output for this Annual Report

**Output #3**

**Output Measure**

- Number of adult participants in EFNEP/SNAP-Ed

| Year | Actual |
|---|---|
| 2018 | 1058 |

## Output #4

### Output Measure

- Number of participants in all levels of ServSafe classes
  Not reporting on this Output for this Annual Report

**V(G). State Defined Outcomes**

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Healthy Lifestyles: Increased participation in healthy lifestyle programming and health monitoring that leads to healthy lifestyle choices. |
| 2 | Nutrition: Increased participation in nutrition classes, training and use of online and printed resources leading to measureable changes in nutrition habits. |
| 3 | SNAP-Ed: Increased participation by eligible SNAP recipients leading to increased knowledge and behavior change related to nutrition, food resource management, food safety and physical activity. EFNEP: Increased participation by eligible low-income families with young children, pregnant woman and teens, leading to increased knowledge and behavior change related to nutrition, food resource management, food safety and physical activity. |
| 4 | Food Safety: Increased participation in food safety classes, trainings and increased knowledge, utilization and certifications earned by participants. |
| 5 | Food Preservation: Increased participation in food preservation classes and increased knowledge and utilization of concepts learned by participants. |

## Outcome #1

### 1. Outcome Measures

Healthy Lifestyles: Increased participation in healthy lifestyle programming and health monitoring that leads to healthy lifestyle choices.

### 2. Associated Institution Types

- 1862 Extension

### 3a. Outcome Type:

Change in Action Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2018 | 0 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Chronic diseases are Montana's leading cause of death, illness and disability and account for 70 percent of healthcare costs. In Montana, heart disease is the leading cause of death, and the number one complication of diabetes. Statistics show that 29.1 million Americans, or one in every 11 people have diabetes. The percentage of Americans 65 and older with diabetes remains high, at 25.9%, or 11.8 million seniors (diagnosed and undiagnosed). 1.4 million Americans are diagnosed with diabetes every year. Additionally, Native American population groups are at higher risk of developing diabetes. Since there are seven reservations located within the boundaries of our state, the need for diabetes education in Montana was identified as paramount.

**What has been done**
The Diabetes Empowerment Education Program (DEEP) is an evidence-based diabetes self-management program developed by the University of Illinois, Chicago, that has been shown to be successful in helping participants take control of their disease and reduce the risk of life-threatening complications. MSU Extension partnered with Mountain Pacific Quality Health, Stillwater Billings Clinic, The Montana Geriatric Center of the University of Montana and the Montana Department of Health and Human Services to expand the implementation to Montana counties and reservations. To date, 54 Extension agents and health care providers in 36 counties have been trained as facilitators.

**Results**
The lead agent who was compiling data on DEEP left Montana during 2018 so cumulative data from DEEP is not available this year. However, interactive lessons remained the same. Previous data showed that the program improved HBA1c levels and systolic blood pressure and led to a significant drop in LDL - Low-Density-Lipoproteins, or the "bad" cholesterol. It is reasonable to expect that continued this year. At one location, participants (n=38) reported: 55% said they planned to make serious lifestyle changes as a result of the class; 75% said sharing their

experiences with others made them more determined to play an active role in managing their disease; 90% said they visited with their doctor about medication and alternative strategies to better cope.
In addition, MSU Extension agents offered StrongWomen, Montana Arthritis Foundation and Living Well with Chronic Illness programming. StrongWomen in Sidney, MT: (n=22) 94% reported much improved health; 91% more energy; 88% less joint pain; 74% better sleep. Sheridan County Arthritis Program: (n=35) "I have less pain because of this class." "My doctor told me I need to do these classes."

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 702 | Requirements and Function of Nutrients and Other Food Components |
| 703 | Nutrition Education and Behavior |
| 704 | Nutrition and Hunger in the Population |
| 724 | Healthy Lifestyle |
| 801 | Individual and Family Resource Management |
| 802 | Human Development and Family Well-Being |
| 805 | Community Institutions, Health, and Social Services |

**Outcome #2**

**1. Outcome Measures**

Nutrition: Increased participation in nutrition classes, training and use of online and printed resources leading to measureable changes in nutrition habits.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
The Fort Belknap Reservation lies in a food desert. Access to fresh fruit and vegetables is very limited within a 60-mile radius. This contributes to negative health status of residents. The Fort Belknap Food Sustainability Project (FBFSP) teaches and mentors residents in growing, raising and selling their own home grown and organic food which will in turn improve the health of

families and the communities. The White Clay and Nakoda tribes historically lived off the land and preserved their own food. The FBFSP enriches healthy living while utilizing cultural practices of food preparation, gathering and gardening, preservation and drying, and selling/trading.

**What has been done**
Extension partners closely with the First Nations Native Youth and Culture Fund Program Director, 45 local elders, schools and youth to provide research-based classes in planting, harvesting, preservation, human nutrition, healthy cooking, food safety and more. Everyone works together in the community gardens in Hays, Lodge Pole and Dodson, and in the fruit tree orchard in Hays. Together the community plants trees, provides improvements (fencing, clean up), and cooks and preserves food.

**Results**
Every year the community gardens produce fresh fruits and vegetables that are used by community elders and programming for families and youth. The local office facilitates trading of extra produce from one family to another. A farmers' market provides further opportunities to share and sell goods. Training in food safety and preservation provides job skills. In 2018 the project had increased numbers of people participating in activities and education, increased volunteers, increased farmers' market participants; increased number of home-grown gardens and an increased number of people preserving their bounty.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 701 | Nutrient Composition of Food |
| 702 | Requirements and Function of Nutrients and Other Food Components |
| 703 | Nutrition Education and Behavior |
| 704 | Nutrition and Hunger in the Population |
| 724 | Healthy Lifestyle |
| 801 | Individual and Family Resource Management |
| 802 | Human Development and Family Well-Being |
| 805 | Community Institutions, Health, and Social Services |

**Outcome #3**

**1. Outcome Measures**

SNAP-Ed: Increased participation by eligible SNAP recipients leading to increased knowledge and behavior change related to nutrition, food resource management, food safety and physical activity.
EFNEP: Increased participation by eligible low-income families with young children, pregnant woman and teens, leading to increased knowledge and behavior change related to nutrition, food resource management, food safety and physical activity.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Food insecurity and hunger is prevalent in Montana. One in nine Montanans face hunger/food insecurity; 29% of Montana children and 61% of adults are overweight or obese (74% of American Indian Montana adults); 20% of Montana adults eat less than one serving of vegetables a day; and 77% of Montana adults do not get enough aerobic and muscle-strengthening exercises to meet guidelines. Accessing affordable, healthy foods is a challenge and can result in obesity and health issues. Nutrition education helps Montanans learn how to stretch their food dollars while meeting USDA dietary guidelines.

**What has been done**
MSU Extension administers Montana?s Expanded Food and Nutrition Program (EFNEP) and Supplemental Nutrition Access Program Education (SNAP-Ed). EFNEP serves very low-income families who reside in Billings and Missoula and is funded through a USDA-NIFA grant. SNAP-Ed is funded through a USDA Food and Nutrition Service grant through the Montana Department of Health and Human Services. Families who qualify for government benefits are eligible to participate in the educational series. EFNEP and SNAP-Ed directly reached 8,272 youth and adults in 2018. Lessons for adults included budgeting and tips for purchasing and preparing healthy food and incorporating more physical activity; and for kids, choosing healthy foods and learning fun physical activities.

**Results**
Specific behaviors improved by adult EFNEP participants included: 44% eat vegetables more often; 47% eat dark green vegetables more often; 41% eat fruit more often; 40% drink regular soda less often; 32% cook dinner at home more times per week; 47% Exercise for at least 30 minutes more days per week; 45% thaw frozen food correctly more often; 37% have enough money for food more often; 46% plan meals before shopping more often; 37% compare food prices more often.
Specific behaviors improved by youth (EFNEP) participants included: 77% improved their ability to choose foods according to MyPlate; 26% improved knowledge of physical activity; 49% improved knowledge of basic food safety practices.
Results are similar for SNAP-Ed participants. Overall these lifestyle changes improve the health and quality of life for participants; while reducing food insecurity due to better skills to extend limited dollars while making healthy choices.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 703 | Nutrition Education and Behavior |
| 704 | Nutrition and Hunger in the Population |
| 724 | Healthy Lifestyle |
| 801 | Individual and Family Resource Management |
| 802 | Human Development and Family Well-Being |
| 805 | Community Institutions, Health, and Social Services |

**Outcome #4**

**1. Outcome Measures**

Food Safety: Increased participation in food safety classes, trainings and increased knowledge, utilization and certifications earned by participants.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Each year in America there are over 48 million documented cases of food-borne illness. The financial cost of food-borne illness is tremendous, including lost wages, healthcare and investigative costs. Basic food safety training on controlling time and temperature when handling food, and ensuring proper cleaning and sanitizing reduces the incidence of food-borne illness. Many food service groups, including school systems, Head Start and food banks, now require food safety training. In January 2015, the state of Montana Rule for Retail Food Establishments went into effect, requiring additional training for retail employees and volunteers serving food.

**What has been done**
ServSafe is the education program of the National Restaurant Association and is widely recognized throughout the United States. Extension professionals from at least 15 counties and reservations are certified trainers of the program. They provided dozens of 2-hour/Level 1, 4-hour/Level 2, and 8-hour/Level 3 sessions. Depending on the level, participants learn: controlling time and temperature; ensuring proper personal hygiene; preventing cross-contamination; proper cleaning and sanitizing; the impact of safety on an operation; the flow of food through an operation and managing a food-safe operation.

**Results**
A new Health and Nutrition Specialist started in 2018 and has created systems for recording state-wide data beginning January 2019. In the meantime, individual Extension offices have reported as follows:
-Plentywood High School Culinary Arts Class: 11 students completed the Level 2 class
-Roosevelt County: Eight people received Level 3 certification
-Hill County/Rocky Boy Reservation: Five people earned Level 3 certification and 75 people earned Level 1 certification.
-Treasure County: Forsyth High School Culinary Arts Class received a grant to fund ServSafe Manager Certification. Students received the training as part of their high school work. Certification makes them more employable and more likely to start at a higher wage.
Another popular food safety class in 2018 was how to safely use a pressure cooker. In a class of 52, 89% said they were confident to use the cooker; 75% knew all the safety precautions, including not to use it for pressure canning; and 75% said they would not put food in the electric pressure cooker more an one hour before cooking.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 702 | Requirements and Function of Nutrients and Other Food Components |
| 703 | Nutrition Education and Behavior |
| 704 | Nutrition and Hunger in the Population |
| 724 | Healthy Lifestyle |
| 801 | Individual and Family Resource Management |
| 802 | Human Development and Family Well-Being |
| 805 | Community Institutions, Health, and Social Services |

**Outcome #5**

**1. Outcome Measures**

Food Preservation: Increased participation in food preservation classes and increased knowledge and utilization of concepts learned by participants.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Montana has an abundance of nutritious, seasonal, wild and homegrown foods. Sustainable food trends, the economy, and presence of food desserts across Montana have all increased interest in home food preservation as an important and popular activity. Recent national surveys reveal that a high percentage of home food processors are using practices that put them at high risk for food borne illness and economic loss due to food spoilage. MSU Extension has long been recognized as a credible source for science-based recommendations for home food preservation.

**What has been done**
Extension utilizes many strategies for educating the public about safe food preservation. Every office responds to drop-in visitors, phone calls and emails asking individual questions. MontGuides, fact sheets and other resources are distributed during county fairs, farmers' markets, community events and trainings. Classes covering topics such as canning; water bath canning; meat preserving and canning; pickling, freezing; drying and the science of food-borne illnesses and how to prevent them are regularly offered in communities all across the state. Extension faculty share information through newspaper articles, blogs, listservs, newsletters, radio spots, and social media and pressure-gauge testing at local hardware and grocery stores. Extension is finalizing work to adopt the WSU Master Food Preserver curriculum.

**Results**
Food preservation is a strength of MSU Extension programming, however, there hasn't been a strong central unit to oversee evaluation and reporting in this area so we lack data. A new Food and Nutrition Specialist was hired in 2018. She has created evaluation tools that will be utilized in 2019.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 702 | Requirements and Function of Nutrients and Other Food Components |
| 703 | Nutrition Education and Behavior |
| 704 | Nutrition and Hunger in the Population |
| 724 | Healthy Lifestyle |
| 801 | Individual and Family Resource Management |
| 802 | Human Development and Family Well-Being |
| 805 | Community Institutions, Health, and Social Services |

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

### External factors which affected outcomes

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

### Brief Explanation

During 2018, MSU Extension hired a new Food and Nutrition Specialist and a new Health and Wellness Specialist. The two have worked on an initiative to improve assessment and evaluation of programming in the Healthy Living, Nutrition and Food Safety program area. Starting in 2019, they have hired two undergraduate student interns to process evaluations. They have created, with agent input, standard, statewide evaluation tools for programming in food preparation and nutrition, physical activity and caregiving classes.
We anticipate these measures will result in stronger data and evaluation in this area. In the meantime, agents and specialist have done impressive programming and the results here represent positive impacts on the people of Montana.
The Communications Specialist for MAES resigned at the end of 2018 leaving a gap in knowledge of MAES projects for this report.

## V(I). Planned Program (Evaluation Studies)

### Evaluation Results

MAES/COA and Extension are committed to improving the lives of Montanans through research, education and outreach. Within this report are examples of successes in outreach. Highlights include:
-Diabetes Education Empowerment Program (DEEP): Diabetes is a major issue in Montana. DEEP is proving to be a successful program in improving HBA1C levels and systolic blood pressure and lowering LDL.
-Fort Belknap Food Sustainability Project: Extension and MAES are working with tribal resources to increase access to safe, nutritious food. In 2018 the project had increased numbers of people participating in activities and education, increased volunteers, increased farmers' market participants; increased number of home-grown gardens and an increased number of people preserving their bounty.
-EFNEP and SNAP-Ed: Educators work with families to encourage lifestyle changes that improve the health and quality of life for participants; while reducing food insecurity due to better skills to extend limited dollars while making healthy choices.
Specific behaviors improved by adult EFNEP participants included: 44% eat vegetables more often; 47% eat dark green vegetables more often; 41% eat fruit more often; 40% drink regular soda less often; 32% cook dinner at home more times per week; 47% Exercise for at least 30 minutes more days per week; 45% thaw frozen food correctly more often; 37% have enough money for food more often; 46% plan meals before shopping more often; 37% compare food prices more often.

Specific behaviors improved by youth (EFNEP) participants included: 77% improved their ability to choose foods according to MyPlate; 26% improved knowledge of physical activity; 49% improved knowledge of basic food safety practices.
SNAP-Ed results are very similar.
-Food Safety: ServSafe classes reduce incidences of food-borne illnesses and increase employment opportunities. This is a primary objective of MSU Extension.
MAES projects related to food security and food safety include: multistate coordination of the Multi-State Research Fund, beginning projects in community-based research on Montana Reservations (USDA NIFA CREEES and Montana Business Research Commercialization Technologies is funding-results to come), reduction in the use of pesticides in crops to increase marketability of products, and various research to better understand the genetic, metabolic and systemic physiological processes.

**Key Items of Evaluation**

-Diabetes Education Empowerment Program (DEEP): Diabetes is a major issue in Montana. DEEP is proving to be a successful program in improving HBA1C levels and systolic blood pressure and lowering LDL.
-Fort Belknap Food Sustainability Project: Extension and MAES are working with tribal resources to increase access to safe, nutritious food. In 2018 the project had increased numbers of people participating in activities and education, increased volunteers, increased farmers' market participants; increased number of home-grown gardens and an increased number of people preserving their bounty.
-EFNEP and SNAP-Ed: Educators work with families to encourage lifestyle changes that improve the health and quality of life for participants; while reducing food insecurity due to better skills to extend limited dollars while making healthy choices.
Specific behaviors improved by adult EFNEP participants included: 44% eat vegetables more often; 47% eat dark green vegetables more often; 41% eat fruit more often; 40% drink regular soda less often; 32% cook dinner at home more times per week; 47% Exercise for at least 30 minutes more days per week; 45% thaw frozen food correctly more often; 37% have enough money for food more often; 46% plan meals before shopping more often; 37% compare food prices more often.
Specific behaviors improved by youth (EFNEP) participants included: 77% improved their ability to choose foods according to MyPlate; 26% improved knowledge of physical activity; 49% improved knowledge of basic food safety practices.
SNAP-Ed results are very similar.
-Food Safety: ServSafe classes reduce incidences of food-borne illnesses and increase employment opportunities. This is a primary objective of MSU Extension.
MAES projects related to food security and food safety include: multistate coordination of the Multi-State Research Fund, beginning projects in community-based research on Montana Reservations (USDA NIFA CREEES and Montana Business Research Commercialization Technologies is funding-results to come), reduction in the use of pesticides in crops to increase marketability of products, and various research to better understand the genetic, metabolic and systemic physiological processes.
- MSU Extension agents offered StrongWomen, Montana Arthritis Foundation and Living Well with Chronic Illness programming to address the challenges presented by chronic illnesses.
StrongWomen in Sidney, MT: (n=22) 94% reported much improved health; 91% more energy; 88% less joint pain; 74% better sleep. Sheridan County Arthritis Program: (n=35) "I have less pain because of this class." "My doctor told me I need to do these classes."
A new Health and Nutrition Specialist started in 2018 and has created systems for recording state-wide data beginning January 2019. In the meantime, individual Extension offices have

reported as follows:
-Plentywood High School Culinary Arts Class: 11 students completed the Level 2 class
-Roosevelt County: Eight people received Level 3 certification
-Hill County/Rocky Boy Reservation: Five people earned Level 3 certification and 75 people earned Level 1 certification.
-Treasure County: Forsyth High School Culinary Arts Class received a grant to fund ServSafe Manager Certification. Students received the training as part of their high school work. Certification makes them more employable and more likely to start at a higher wage.
Another popular food safety class in 2018 was how to safely use a pressure cooker. In a class of 52, 89% said they were confident to use the cooker; 75% knew all the safety precautions, including not to use it for pressure canning; and 75% said they would not put food in the electric pressure cooker more an one hour before cooking.
Food preservation is a strength of MSU Extension programming, however, there hasn't been a strong central unit to oversee evaluation and reporting in this area so we lack data. A new Food and Nutrition Specialist was hired in 2018. She has created evaluation tools that will be utilized in 2019.

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

**Program # 8**

**1. Name of the Planned Program**

Community Development

☑ Reporting on this Program

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

1. Program Knowledge Areas and Percentage

| KA Code | Knowledge Area | %1862 Extension | %1890 Extension | %1862 Research | %1890 Research |
|---|---|---|---|---|---|
| 608 | Community Resource Planning and Development | 30% | | 70% | |
| 704 | Nutrition and Hunger in the Population | 20% | | 0% | |
| 723 | Hazards to Human Health and Safety | 10% | | 20% | |
| 803 | Sociological and Technological Change Affecting Individuals, Families, and Communities | 10% | | 0% | |
| 805 | Community Institutions, Health, and Social Services | 20% | | 0% | |
| 902 | Administration of Projects and Programs | 10% | | 10% | |
| | **Total** | 100% | | 100% | |

## V(C). Planned Program (Inputs)

**1. Actual amount of FTE/SYs expended this Program**

| Year: 2018 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 3.5 | 0.0 | 0.0 | 0.0 |
| **Actual Paid** | 2.1 | 0.0 | 0.3 | 0.0 |
| **Actual Volunteer** | 2.9 | 0.0 | 0.0 | 0.0 |

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 94498 | 0 | 2849 | 0 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 0 | 0 | 45370 | 0 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 0 | 0 | 6004 | 0 |

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

• Community meetings will be held to determine community values, attitudes and vision on which to develop strategies and action plans.
• Partnering with local economic development entities, agencies, businesses/industry and organizations to implement goals and plans of action.
• Planning for potential disasters that may occur in a community, e.g., EDEN.
• Training opportunities available for people serving on boards, councils and committees in both the public and private sectors.
• Culturally-sensitive meetings with tribal leaders focused on community development.

### 2. Brief description of the target audience

• Business and Community Leaders
• Local Development Entities
• Chamber of Commerce Members
• Tourism Leadership - local/state
• County and City Government
• County DES, Law Enforcement Emergency Response Coordinators
• Current community leadership/potential community leaders
• Landowners
• Adults/Youth serving on Boards
• Elected officials
• Tribal members and councils

### 3. How was eXtension used?

eXtension was used to access Extension communities of practice, the Extension Disaster Education Network and other resources and planning and evaluation tools.

## V(E). Planned Program (Outputs)

### 1. Standard output measures

| 2018 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 7720 | 87828 | 559 | 1353 |

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

**Patent Applications Submitted**

| | |
|---|---|
| Year: | 2018 |
| Actual: | 0 |

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

| 2018 | Extension | Research | Total |
|---|---|---|---|
| **Actual** | 0 | 0 | 23 |

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

**Output Target**

**Output #1**

**Output Measure**

- Number of participants in programs to support Community Foundations, endowments and other similar collaborations focused on community sustainability
  Not reporting on this Output for this Annual Report

**Output #2**

**Output Measure**

- Governance and Citizen Leadership: Number of participants at trainings offered through Extension Community Development and the MSU Extension Local Government Center to elected and public officials and volunteers.

| Year | Actual |
|---|---|
| 2018 | 7000 |

**Output #3**

**Output Measure**

- Number of participants helping with community garden projects on Montana's reservations
  Not reporting on this Output for this Annual Report

**V(G). State Defined Outcomes**

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Community Resource Development: Increased participation of community members toward supporting established community priorities with a resulting increase in the number of Community Foundations and endowments. |
| 2 | Citizen Leadership and Good Governance: Increased number of people serving on boards, councils and/or committees who are trained and prepared for the responsibilities/authorities of the entity. |
| 3 | Emergency/Disaster Planning and Management: Increased number of communities creating and updating clear disaster mitigation plans with effective and efficient leadership by Extension personnel. |
| 4 | Community Development with Tribal Populations: Increased number of collaborations with tribes to address specific community development priorities. |
| 5 | Montana elected officials will have training to support them in serving their communities. |

## Outcome #1

### 1. Outcome Measures

Community Resource Development: Increased participation of community members toward supporting established community priorities with a resulting increase in the number of Community Foundations and endowments.

### 2. Associated Institution Types

- 1862 Extension

### 3a. Outcome Type:

Change in Action Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2018 | 0 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
According to the Center for Entrepreneurship, Montanans will be transferring $12 billion of wealth between generations by 2020. By 2030, it is estimated that 25 percent of the population will be age 65 or older. Many heirs of this generation no longer live within Montana. As a result, much of Montana's estimated wealth may leave if there isn't an effort to retain it; and one way to do that is through development of community foundations.

**What has been done**
MSU Extension has trained agents and community leaders to grow and build community foundations and resources. They have provided workshops ranging from grant writing and raising funds, to increasing leadership abilities to improving relationships and engaging community members. MSU Extension has helped local foundations create long-range, strategic plans for Montana communities to develop in a thoughtful manner.

**Results**
-Northern Rosebud County: Reached goal of securing $500,000 within 10 years; created a new permanent endowment fund for the benefit of the local swimming pool; created the Eldon Rice Memorial Spirit of Community Award to recognize outstanding community volunteers and provide financial support for community projects; coached the board to develop the first annual fundraising and celebration event with 350+ community members attending and $25,000 was raised.
-Friends of Richland County Fair and Rodeo: Extension helped create a non-profit with 501c3 status and has begun setting up infrastructure to ultimately replace livestock and other facilities at the local fairground.
- Culbertson Area Community Foundation: Board met six times, published a newsletter and awarded $1,274 in grants: Missouri River Rats - $500 for potting soil and bedding plants for the

planters at the Culbertson Nursing Home and Culbertson Public Library; $774 to expand collection of children's books.
-Mineral County Economic Development: managed 15 business inquires, 2 new loan packages and requests, 1 loan payoff and advised 18 business start-ups on planning, marketing and initial projections.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 608 | Community Resource Planning and Development |
| 803 | Sociological and Technological Change Affecting Individuals, Families, and Communities |
| 805 | Community Institutions, Health, and Social Services |
| 902 | Administration of Projects and Programs |

**Outcome #2**

**1. Outcome Measures**

Citizen Leadership and Good Governance: Increased number of people serving on boards, councils and/or committees who are trained and prepared for the responsibilities/authorities of the entity.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
The successful future of a community is reliant on the leadership of its citizens. Communities with strong citizen leaders have more access to resources and can capitalize on more opportunities than communities with lower levels of local leadership. Today's communities face significant challenges that require innovative solutions. Many people don't see themselves as leaders, though they will step up to help if asked. Empowering people and developing their leadership skills is necessary for the very survival of rural America.

**What has been done**
Several Extension offices across Montana are offering year-long leadership programs. These programs start with deep discussions with current leaders about challenges and concerns for the

community and completion of needs assessments. Recruitment for applicants then occurs with effort being made to connect with an expanded group of people from a broad range of backgrounds. Participants are selected to form a cohort that then meets monthly throughout a year to work on skill development and often to work through a community challenge together. The programs strengthen the skills of individual participants while building social capacity in the community.

**Results**
-Leadership 29 (Rosebud/Treasure County): Eight businesses and organizations offered financial sponsorship and/or to send an employee to participate to kick-start the program in 2019.
-Leadership 49 (Park County): Forty people completed the program successfully increasing their knowledge about the county and enhancing their leadership skills. Seven of the group joined public boards.
-Leadership 44/53 (Wheatland County): An innovative workshop was offered to help participants consider their core, authentic values; to break down silos that exist in the community, and begin to understand how their leadership development can help connect and advance the community. This was the kickoff to start the full program in 2019.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 608 | Community Resource Planning and Development |
| 803 | Sociological and Technological Change Affecting Individuals, Families, and Communities |
| 805 | Community Institutions, Health, and Social Services |

**Outcome #3**

**1. Outcome Measures**

Emergency/Disaster Planning and Management: Increased number of communities creating and updating clear disaster mitigation plans with effective and efficient leadership by Extension personnel.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Many rural communities across Montana face significant challenges that range from struggling economic conditions to changing demographics to quality of life issues. Solutions are complex. Often a coordinator is needed to bring together people with varied strengths and skills who, as a team, can create opportunities for growth and development.

**What has been done**
Extension agents are trusted members of the communities in which they serve. Nearly all of them serve on various community boards and committees both personally and professionally. Across the state, agents have taken a greater role in advancing the economic development of their area through programming, designed by the individual community and for the community. Activities include: coordinating meetings, acting as economic development officials, writing or assisting in the writing of grants, offering expertise for business plans and marketing ideas, planning or assisting with the planning of community events and promoting agritourism.

**Results**
-Lake County: County commissioners asked Extension to take over operating control of the local community center which had losses of over $3,000/year for four years. Extension established an advisory group. This group created a clear use/rental agreement; had an energy audit completed and started using an accounting system to track income and expenses. Use of the center increased 21% and energy expenses decreased 5%. The Center is becoming the community asset it was intended to be.
-Prairie County: Extension worked with the Prairie County Economic Development Council (PCEDC) and the Eastern Plains Economic Development Corporation (EPEDC) on two cultural tourism initiatives. Together they submitted a grant to the Montana History Foundation to provide signage and promotion for sites along the transcontinental Yellowstone Trail, as well as an application to have the sites listed on the National Park Service's interactive map guide of the Lewis and Clark National Historic Trail. The $5,000 Montana History Foundation covered the cost of four new historic point signs and two points of interest were added to the NPS map.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 608 | Community Resource Planning and Development |
| 803 | Sociological and Technological Change Affecting Individuals, Families, and Communities |
| 805 | Community Institutions, Health, and Social Services |
| 902 | Administration of Projects and Programs |

**Outcome #4**

**1. Outcome Measures**

Community Development with Tribal Populations: Increased number of collaborations with tribes to address specific community development priorities.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 0 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Native American students make up the largest minority group in Montana - about 11 percent. Native students have the lowest high school graduation rate. Two major factors in this are lacking social and emotional skills as they navigate the world of academia. Flathead Reservation Extension 4-H began a mentoring program in 2012. The National 4-H Center and the U.S. Department of Justice provide funding for 4-H National Mentoring Programs. The mission of the program is to increase the developmental assets of youth, ages 5-17 and their families.

**What has been done**
Extension offered a series of hands-on activities that support social/emotional skill building, directly resulting in academic competencies. In addition, 30 mentees were matched and participated in the year-long mentoring program.

**Results**
30 youth in grades K-7 who were recommended for the program by a school counselor received mentoring. Mentors, who are local high school students or community adult volunteers, completed a stringent application process and attended monthly training to build their skills for being able to support their mentees. Matches were made either one-to-one or in groups of one-to-four depending on the needs of youth involved. Throughout the year, the matches met weekly, both for fun and skill-building activities. Both the mentors and mentees improved their social and emotional skills.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 608 | Community Resource Planning and Development |
| 803 | Sociological and Technological Change Affecting Individuals, Families, and Communities |
| 805 | Community Institutions, Health, and Social Services |

**Outcome #5**

**1. Outcome Measures**

Montana elected officials will have training to support them in serving their communities.

**2. Associated Institution Types**

- 1862 Extension

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2018 | 5000 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Montana county and municipal officials are responsible for managing more than $1.2 billion in public funds and more than 11,000 employees. Many of these public servants have little or no training for those roles and responsibilities, human resources, public meeting laws or budgeting and financing. The MSU Local Government Center (LGC) provides the only training and technical assistance of its kind for Montana municipal and county elected officials and employees.

**What has been done**
The MSU Extension LGC offers more than 150 affordable professional development workshops each year with over 5,000 direct contacts. Over 90 percent of Montana?s clerks of district court complete a 40-hour (4-year) certification program and over 70 percent of municipal clerks, treasurers and finance officer participate in a 120 hour (4-year) certification program. In addition, the MSU Extension LGC provided more than 750 hours of technical assistance to municipal and county government officials last year.

**Results**
-Testimonials from the Montana Municipal Institute:
This program is such an affirming, reassuring, & comforting learning opportunity for clerks & treasures at all points in their careers. It is well put together & thought out and I thank LGC for all their year-round efforts.

Good information for municipal clerks to use in the challenges they face daily and in the facilitating of a stronger community.

I really appreciate the opportunity to learn all corners of my job and to network. I always learn something new. Thanks for all your time you spend making this conference all that it is!

-From another 2018 training:

This presentation will help me with governance/guidance as Chair of a small public organization. It will improve my communication skills in giving notice, encouraging, and consistency.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 608 | Community Resource Planning and Development |
| 803 | Sociological and Technological Change Affecting Individuals, Families, and Communities |
| 805 | Community Institutions, Health, and Social Services |
| 902 | Administration of Projects and Programs |

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

### External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

### Brief Explanation

The Communications Specialist for MAES resigned at the end of 2018 leaving a gap in knowledge of MAES projects for this report.

## V(I). Planned Program (Evaluation Studies)

### Evaluation Results

Community Resources Development:
-Northern Rosebud County: Reached goal of securing $500,000 within 10 years; created a new permanent endowment fund for the benefit of the local swimming pool; created the Eldon Rice Memorial Spirit of Community Award to recognize outstanding community volunteers and provide financial support for community projects; coached the board to develop the first annual fundraising and celebration event with 350+ community members attending and $25,000 was raised.
-Friends of Richland County Fair and Rodeo: Extension helped create a non-profit with 501c3 status and has begun setting up infrastructure to ultimately replace livestock and other facilities at local fairground.
- Culbertson Area Community Foundation: Board met six times, published a newsletter and awarded $1,274 in grants: Missouri River Rats - $500 for potting soil and bedding plants for the planters at the Culbertson Nursing Home and Culbertson Public Library - $774 to expand collection of children's books.
-Mineral County Economic Development: managed 15 business inquires, 2 new loan

packages and requests, 1 loan payoff and advised 18 business start-up on planning, marketing and initial projections.
Montana county and municipal officials are responsible for managing more than $1.2 billion in public funds and more than 11,000 employees.

**Key Items of Evaluation**

The MSU Extension Local Government Center offers more than 120 affordable professional development workshops each year with over 7,000 direct contacts. Over 90 percent of Montana's clerks of district court complete a 40-hour (4-year) certification program and over 70 percent of municipal clerks, treasurers and finance officer participate in a 120 hour (4-year) certification program. In addition, the MSU Extension LGC provided more than 750 hours of technical assistance to municipal and county government officials last year. The LGC has expanded trainings 170% in the last five years.
-Prairie County: Extension worked with the Prairie County Economic Development Council (PCEDC) and the Eastern Plains Economic Development Corporation (EPEDC) on two cultural tourism initiatives. Together they submitted a grant to the Montana History Foundation to provide signage and promotion for sites along the transcontinental Yellowstone Trail, as well as an application to have the sites listed on the National Park Service's interactive map guide of the Lewis and Clark National Historic Trail. The $5,000 Montana History Foundation covered the cost of four new historic point signs and two points of interest were added to the NPS map.
Native American students make up the largest minority group in Montana - about 11 percent. Native students have the lowest high school graduation rate. Two major factors in this are lacking social and emotional skills as they navigate the world of academia. Flathead Reservation Extension 4-H began a mentoring program in 2012. The National 4-H Center and the U.S. Department of Justice provide funding for 4-H National Mentoring Programs. The mission of the program is to increase the developmental assets of youth, ages 5-17 and their families.
30 youth in grades K-7 who were recommended for the program by a school counselor received mentoring. Mentors, who are local high school students or community adult volunteers, completed a stringent application process and attended monthly training to build their skills for being able to support their mentees. Matches were made either one-to-one or in groups of one-to-four depending on the needs of youth involved. Throughout the year, the matches met weekly, both for fun and skill-building activities. Both the mentors and mentees improved their social and emotional skills.
Several Extension offices across Montana are offering year-long leadership programs. Participants are selected to form a cohort that then meets monthly throughout a year to work on skill development and often to work through a community challenge together. The programs strengthen the skills of individual participants while building social capacity in the community.

# VI. National Outcomes and Indicators

## 1. NIFA Selected Outcomes and Indicators

| | |
|---|---|
| **Childhood Obesity (Outcome 1, Indicator 1.c)** | |
| 0 | Number of children and youth who reported eating more of healthy foods. |
| **Climate Change (Outcome 1, Indicator 4)** | |
| 0 | Number of new crop varieties, animal breeds, and genotypes whit climate adaptive traits. |
| **Global Food Security and Hunger (Outcome 1, Indicator 4.a)** | |
| 0 | Number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources. |
| **Global Food Security and Hunger (Outcome 2, Indicator 1)** | |
| 0 | Number of new or improved innovations developed for food enterprises. |
| **Food Safety (Outcome 1, Indicator 1)** | |
| 0 | Number of viable technologies developed or modified for the detection and |
| **Sustainable Energy (Outcome 3, Indicator 2)** | |
| 0 | Number of farmers who adopted a dedicated bioenergy crop |
| **Sustainable Energy (Outcome 3, Indicator 4)** | |
| 0 | Tons of feedstocks delivered. |