

Montana (Montana State University) Annual Report - FY2021

Report Status: Approved as of 07/08/2022

Contributing Organizations

Montana State University

Executive Summary

Overview

2021 was a year of transitions and challenges for the people of Montana, Montana State University (MSU), Montana Agricultural Experiment Station (MAES) and MSU Extension (MSUE). COVID-19 related work from home directives established by MSU remained in place through July 6, 2021. Faculty and administration adapted well to the challenges of distance communications, managing research team and clientele safety in labs, field research, field days, and Extension programs. The challenges did exact some costs in the form of slowed-down efforts and collaborations that could not be fully implemented due to COVID restrictions. Overall, the faculty are commended for persevering and excelling throughout the year and accomplishing many goals. During the challenges MSU faculty were able to build new partnerships and develop programming modalities that increased audience reach. Their response to the severe drought in Montana had a significant impact on the sustainability of many agricultural operations.

In 2021, Montana's drought conditions advanced to 70 percent of the state being designated as *extreme* and *exceptional*. These dry conditions were on full display by August with more than 20 percent of the *state* in *exceptional* drought through the fall months, reaching the most intense conditions in December, with 33 percent of the state in *exceptional* drought. In addition to the extreme negative agronomic impacts, such extreme drought has other consequences in Montana's semi-arid climate. Montana had wildfire events covering nearly 750,000 acres; many of these fires devastated grazing lands, agricultural production fields, and pastures. MSUE and MAES faculty rose to the challenges resulting from the drought. Integrated and multi-disciplinary collaborations resulted in helping Montanans feed livestock safely; make difficult financial decisions that protected the sustainability of operations; and protect their wellness through healthy eating, local food production and consumption, and mental health awareness programming.

MAES faculty addressed pressing environmental and sustainability concerns through their research. Improved biological control options for major pest species in the western U.S. will result in reduced pesticide usage, increased sustainability of agricultural production systems, and economic benefits to both agricultural producers and consumers. More efficient use of rangelands and improvement of grazing utilization of rangelands ensures effective use of resources and quality nutrition for livestock, creating high quality products. Research in cover crops suitable for a semi-arid environment prioritizes protecting the soil and building soil health. MAES faculty lead the development of agronomic methods to optimize the carbon footprint associated with water and nitrogen use, and by managing soil to increase carbon content. Plant-based protein is of increasing interest to food consumers, with heavy reliance on pulse crops which are heavily featured in MAES research.

Critical Issue: Agriculture

Animal Sciences encompasses research, teaching, and engagement 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. MSU Research, Extension and COA are partners with producers to address issues and meet the needs of Montana's agricultural industry

Plant Sciences: The broader impact of the Plant and Soil Sciences field is a larger and higher quality food supply for the world, as well as the improved ability of Montana farmers to compete in a global marketplace and strengthen export markets for U.S. wheat and other products. Research objectives in Plant Sciences address basic 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.

Additionally, the science of growing and maintaining plants for food, enjoyment and improvement of the human environment continues to be of primary significance to COA, MAES, and Extension efforts. MSU Extension's horticulture programs, publications and links provide expert yard, garden and urban integrated pest management resources for individuals and businesses throughout Montana.

Farm, Ranch, and Business Management: COA, MAES and Extension personnel support Montanans in managing their farms, ranches and similar enterprises as businesses. Best practices, contracts, estate planning, marketing, taxation, accounting, operational planning, budgeting, agricultural policy and commodity support programs, risk management, and decision support software for agriculture are all covered through extensive research and educational programming specifically designed to support Montana's number one industry, agriculture.

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 improve integrated pest and disease management. Research, development, and distribution of biological controls as low-impact pest control options promotes sustainable practices. Producers and researchers continue to evaluate new integrated pest management (IPM) methodologies so they can maintain a competitive position in U.S. and world markets while helping alleviate global hunger. The importance of integrated pest management remains a consistently critical field as invasive species continue to threaten Montana's wild and agricultural lands as well as the global safety of the state's food exports.

Energy & Natural Resources: Energy production and natural resources have played a vital role in Montana's history and continues to be a priority for Extension and MAES. 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. Management and stewardship is required to maximize potential outputs, as well as public safety, and a sustainable future. Water quality affects all entities and requires intentional management strategies. Rangeland ecology and management of invasive species is also fundamentally important. Extension and MAES provide unbiased, science-based research, education and outreach related to preserving and supporting the best use and management of these resources.

Critical Issue: Community Development

Community Development: Montana's large size and small population spread over a wide range of landscapes creates unique challenges and opportunities for communities. MSU Extension agents live and work in the communities they serve and provide a historical, trusted link connecting leaders and interest groups with a focus on efforts toward community vitality. MSU Extension and MAES use proven economic and community development strategies to improve the conditions impacting business, family life and the health of a community as a whole.

Critical Issue: Family and Consumer Sciences

Youth and Family Development: Positive youth development occurs through providing opportunities, choices, relationships, and the support necessary for youth to fully participate. Youth development takes place in families, peer groups, schools, neighborhoods and communities. Across the state, families are concerned with helping youth build skills and confidence to become competent, contributing and caring citizens. MSU Extension provides the support and framework for Montana's largest youth development organization, Montana 4-H. MSU Extension and MAES recognize that families are not all the same and offer resources and training to help them navigate diverse situations. Montanans desire resources that help them become better caregivers for elderly or disabled friends and family; and to support family members, often grandchildren, who encounter challenges. They are concerned about their own aging process and value resources to maintain a high quality of life, help manage their personal finances, contribute to the health of their communities and prepare for the distribution of their estates. They often look to MSU Extension for solutions and resources.

Healthy Living, Nutrition & Food Safety: In Montana, heart disease is the leading cause of death while diabetes, stroke, osteoporosis, and hypertension, significantly impact quality of life. Research shows that healthy food choices, physical activity and early detection of symptoms can prevent or delay these diseases saving millions in health care costs while improving life quality and ability to remain independent. Utilizing its network across the state and the trusted relationships with agents in local communities, MSU Extension works with the Montana Department of Health and Human Services and other agencies to provide educational programming in every county and reservation.

Critical Issue: Youth Development

Youth and Family Development: Positive youth development occurs through providing opportunities, choices, relationships, and the support necessary for youth to fully participate. Youth development takes place in families, peer groups, schools, neighborhoods and communities. Across the state, families are concerned with helping youth build skills and confidence to become competent, contributing and caring citizens. MSU Extension provides the support and framework for Montana's largest youth development organization, Montana

4-H. MSU Extension and MAES recognize that families are not all the same and offer resources and training to help them navigate diverse situations. Montanans desire resources that help them become better caregivers for elderly or disabled friends and family; and to support family members, often grandchildren, who encounter challenges. They are concerned about their own aging process and value resources to maintain a high quality of life, help manage their personal finances, contribute to the health of their communities and prepare for the distribution of their estates. They often look to MSU Extension for solutions and resources.

Merit and Scientific Peer Review Processes

Updates

None

Stakeholder Input

Actions to seek stakeholder input that encouraged their participation with a brief explanation

None

Methods to identify individuals and groups and brief explanation

None

Methods for collecting stakeholder input and brief explanation

None

A statement of how the input will be considered and brief explanation of what you learned from your stakeholders

None

Highlighted Results by Project or Program

Critical Issue

Agriculture

Small Grain Quality and Molecular Biology

Project Director

Michael Giroux

Organization

Montana State University

Accession Number

1026179



Improving wheat yield and product quality

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Agronomic yield and product quality of cereal crops such as wheat are the two most important factors affecting farmer income. Agronomic yield is controlled by many factors with the rate and duration of carbon fixation in leaves a primary factor. Product quality is impacted by genes that influence seed development and determine seed composition and suitability for various product applications.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Total agronomic yield in cereals is a function of the amount of carbon fixed in leaves and ultimately stored and harvested in seeds. Among the important yield limiting processes we propose to study here are tillering, plant height, and leaf and seed starch biosynthesis. Our first and second objectives are both focused on genes that impact wheat tillering. Both have the goal

to identify new allelic variants that can be used to optimize wheat plant biomass for different applications. The specific genes are the major wheat dwarfing gene, termed *Reduced height (Rht)* and a gene that is linked to *Rht*, termed *Teosinte Branched (TB1)*. Essentially all current spring and winter wheat varieties are semi-dwarf and contain one of two common *Rht* mutations and *Rht* is perhaps the most important single yield related gene known. The development and characterization of new *Rht* alleles will lead to a greater understanding of yield limiting processes and perhaps to greater agronomic yields. While variation in *TB1* impacts tillering, most common wheat varieties do not vary substantially in *TB1* function.

Briefly describe how your target audience benefited from your project's activities.

Target audiences of plant breeders and geneticists benefit from having access to information describing how to select for improved yield and product quality. The germplasm and genetic variation we describe can be used in breeding programs in the development of improved varieties of wheat.

Briefly describe how the broader public benefited from your project's activities.

The public will benefit by having access to food and/or feed produced containing genetic variation we characterized. Since we are focused on the development of germplasm that can be used to increase wheat yield and quality the public will benefit from improved and cheaper wheat based products.

Developing Nutritional Strategies for Cattle Development

Project Director

Megan Van Emon

Organization

Montana State University

Accession Number

1018992



2021 Beef Cattle Management

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The main issue this project addresses is beef cattle management and development in Montana. This includes issues faced by Montana livestock producers, such as strategic supplementation for meeting cattle nutrient needs, water quality impacts on cattle digestion, and supplement attributes needed for successful cattle production.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

During the year, I successfully completed strategic supplementation projects to determine how summer protein supplementation impacted beef cattle performance, calf growth, and nutrient digestion. Two water quality studies were also completed, identifying how water salt or sulfate at different concentrations impacts cattle nutrient digestion. Another project was completed determining how mineral supplement intake varies on pasture and how this will impact cattle performance and nutrient digestion. Research from previous reports has not been successfully published in scientific peer-reviewed journals and presented at scientific meetings. During the 2021 reporting period, I was a co-author of 8 peer-reviewed publications and 6 conference proceedings papers. I was a co-PI on 2 grants that were awarded during the funding period. Additionally, I was the advisor for 3 graduate students and a committee member for 4 graduate students that successfully defended their degrees.

Briefly describe how your target audience benefited from your project's activities.

The results from the completed studies will be used by beef cattle producers to aid in improving cattle production. The water quality research is especially important to Montana producers due to the low-quality water sources in some areas of the state, mainly the Eastern side. This research is instrumental in determining how low quality water impacts nutrient digestion and

how beef cattle producer's may be able to alter their management to address water quality needs. The supplement research that was conducted through industry funding will aid producers to make informed supplement decisions for both protein supplements and mineral supplements.

Briefly describe how the broader public benefited from your project's activities.

The research conducted provided much needed information for beef cattle producers, but also to aid in supporting beef cattle production efficiency and production. The broader audience may be assured through this research that producers are caring nutritionally for their livestock and providing a quality product for public consumption. This research also impacts the use of grazing rangelands by beef cattle, therefore, the results from these studies could indicate a more efficient use of rangelands and improvement of grazing utilization of rangelands that may not be used for other production.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

The main issue that was encountered late in the reporting period was the prolific drought occurring in the Western United States. This drought is currently on-going and may impact the following reporting cycle as well. Feeding decisions were made late in the 2021 reporting cycle to postpone the final projects until 2022 due to the drought and feed expenses.

Professional development opportunities occurred through presenting the research data to a scientific audience at the Western Section of the American Society of Animal Science meetings in October 2022. I placed this in 2021 because the conference papers were submitted during the 2021 reporting cycle.

Currently, one Extension publication is being developed to provide needed information to the stakeholders of Montana. Additionally, a research report is being developed to provide stakeholders about the research that has occurred.

During the 2022 reporting period, additional manuscripts will be published in peer-reviewed journals and the research will be presented at regional and national animal science meetings.

Restoration of Ecological Systems in the Context of Aboveground-Belowground Linkages

Project Director

Catherine Zabinski

Organization

Montana State University

Accession Number

1019015



Restoration of Ecological Systems in the Context of Aboveground-Belowground Linkages

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

My research is organized along two initiatives: the first is to better understand plants' effects on soil processes, based on how those plants function or on their rooting characteristics; and the second is to study the effects of soil fungi on plant community diversity. Plants form the basis of all ecosystem function, affecting the diversity of animal communities and also a rich compendium of small animals and insects that live in the soil. By better understanding how different kinds of plants influence soil systems, farmers and land managers will be able to more effectively optimize management systems that enhance soil-based processes to increase ecosystem services.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

During this past year, we published one scholarly manuscript describing the effects of cover crop treatments on soil properties in a dryland wheat system. This study was conducted on four sites over four years, and provided direct information on how different cover crop mixes affect soil health, comparing both which species were grown in the cover crop and how much plant biomass was produced. We were able to extend that question to a study that was set up 18 years ago to look at the effects of different cropping systems on soil organic matter. We completed field work and a M.S. student published a professional paper on the effects of leaving a field empty for one growing season (fallow) versus growing a legume for harvest or as a cover crop, or planting wheat. By comparing soil measures in different kind of farming systems, we gain a better understanding of how our agricultural practices influence soil health.

For the second objective, to study the effects of soil fungi on plant community diversity, we prepared a manuscript on the effects of six fungal species on seven plant species native to alpine grasslands, and measured host plant growth responses and floral traits. The fungi we study, mycorrhizal fungi, are an integral part of healthy soils, and with this research we have documented how a diversity of soil fungi contribute not only to plant community diversity, but also to traits that affect pollinator communities.

Briefly describe how your target audience benefited from your project's activities.

Our research on the influence of cover crop mixtures on soil health was presented at a meeting organized by the United Nations Food and Agriculture Organization. This research is important because we have much less data on how cover crops influence soils in semi-arid systems. In areas that receive more growing season moisture, cover crops, planted after the harvest of the cash crop, can protect soils from erosion and add organic matter that supports a rich soil community. In contrast, in semi-arid systems with dryland agriculture, cover crops can use up all of the soil moisture necessary for the cash crop to survive the following season. That does not minimize the importance of protecting the soil and building soil health. Our research addresses a much needed aspect of sustainable food production.

This work was also presented to producers and agriculture professionals at two regional conferences, the Soil Health Innovations Conference and the Western Nutrient Management Conference.

A second portion of our target audience is the undergraduate and graduate students at Montana State University. I presented three guest lectures on soil ecology, with an emphasis on restoration scenarios, native systems, and agricultural production. I also taught three courses that incorporated what we are learning from our research, a course on restoration ecology, an environmental sciences capstone course, and a graduate course on belowground ecology. Students gain a better understanding of the ecology of soil systems, and can incorporate that understanding into their future work as environmental consultants, farmers, restoration practitioners, and policy makers.

Briefly describe how the broader public benefited from your project's activities.

A large number of people across the globe live in semi-arid regions, and much of their food is produced locally. My research contributes to an understanding of how to better manage soils in semi-arid regions to account for long term sustainability of food production, and in the process of restoration of damaged ecosystems. Besides my work at the university, I also gave an invited lecture at a Grain Conference in Maine, with an audience of people who grow wheat and make bread. My goal was to help that audience make connections between healthy soils and good food. When a broader public can start to embrace the complexity of living soils instead of thinking about it as dirt, we will have made a big step toward an acceptance of building soil health.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

I did not experience any major changes or problems during the past year of this study.

This project has supported the training for four M.S. students during the past year, two who finished in the spring, one researching the effects of cropping systems on soil health and the other studying how restoration projects near urban areas are affected by the nearby human impacts. This fall I am advising two new graduate students, one who is measuring soil microbial communities associated with Camelina crops, and the second who is working on a project to measure soil health relative to cropping intensity across a range of farms. Additionally, we employed two undergraduates during this period, and trained an additional M.S. student in methods of mycorrhizal ecology.

During the next reporting period, we will be submitting at least two grant proposals for on-farm research looking at how different farming techniques affect soil health. For one proposal, I am assembling an advisory team of farmers to increase the effectiveness of linking university research to farmers' needs. In addition, we are analyzing and writing up data from the last four years of an eight-year study to measure cover crop effects on soil health.

Closing Out (end date 09/07/2023)

[Sustainable cropping systems through diversified cropping strategies in the northern Great Plains](#)

Project Director

Perry Miller

Organization

Montana State University

Accession Number

1015810



Sustainable cropping systems through diversified cropping strategies in the northern Great Plains

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

This project aims to improve farm profitability by diversifying semiarid wheat-based systems in Montana with dicot crops, especially pulse crops (dry pea, lentil, chickpea). Sustainability is targeted by implementing conservation agriculture practices of no-tillage in concert with high crop residues and crop diversity. Resiliency in cropland agriculture depends on strong soils; thus our agronomic strategies aim to increase soil carbon, and use soil nitrogen and water efficiently.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Goal 1. In 2021, more than 30 cereal, oilseed, pulse and specialty crops were grown in a demonstration trial at Bozeman, MT, to provide educational opportunities for students (*AGSC 242 Crop Identification*), colleagues, and ag clientele at the 2021 Post Farm Field Day. Recognizing a need for data on comparative crop growth rates to support agricultural models, we record the growth stage of each crop weekly using a universal numerical crop scale. We will report growth rates in response to cumulative thermal time after sufficient growing seasons have been sampled; likely after 2023. Niger (*Guizotia abyssinica*), a popular birdseed, was noted for special attraction for pollinators and seed was increased to explore this aspect. Preliminary research in 2017 on seeding rate and roll timing in lentil was parlayed into a large lentil grant (USDA – NIFA Specialty Crop Research Initiative 2018-51181-28366) where agronomic research of lentil (*Lens culinaris*) was completed at seven locations in Montana and North Dakota, 2019-21. Research examining micro- to macro-scale patterns for protein concentration in pea, as well as the linkage of pea leaf weevil (*Sitona lineatus*) management to protein concentration in pea (pea leaf weevil larva feed exclusively on legume nodules) continues. Preliminary hemp (*Cannabis sativa*) research continued on a small scale for the 4th consecutive year, exploring fiber yield response to seeding rate and nitrogen fertilizer. Grower interest in canola (spring and winter) (*Brassica napus*) is surging in Montana with over 167,000 acres harvested in 2021, including more than 20,000 acres of winter canola. In collaboration with Kansas State University we are exploring canola genetics with superior winter hardiness (planted in 2021). There is surging interest in sainfoin (*Onobrychis viciifolia*) for perennial legume forage but very little research specific to sainfoin. In 2021, 2nd-year forage was harvested from a 2019 sainfoin establishment study with three seeding dates and four seed placement depths. In 2021, early maturing accessions of sorghum (*Sorghum bicolor*) were increased, and will be observed on Montana farms in 2022, as demanded for cover crops and wildlife habitat.

Goal 2. In 2021, results were being analyzed and reported from an 8-yr study of cover crops focusing on four functional plant group types in semiarid Montana. Various effects on soil properties were minimal and loss of grain yield in subsequent wheat (*Triticum aestivum*) was sometimes consequential due to soil water use by cover crops. Legume species often had the greatest biomass, increased soil N, had variable effects on subsequent wheat yield, and consistently increased grain protein of subsequent wheat.

Goal 3. Greenhouse Gas Rotation Study (GGRS): 2021 was the 19th year of this diversified cropping system study with an emphasis on crop economics and soil response. From 2003 to 2020, nine cropping systems were employed with varying inclusion rates and management for grain legumes (mostly dry pea) in wheat-based systems, all split-managed with full and half recommended rates of nitrogen supply. Economic analysis showed strong superiority for the wheat – pea harvested grain

rotation. Soil carbon samples were taken in October 2020 to determine carbon change amongst these systems and N management strategies. Soil pH decline was found to be strongly correlated with cumulative N fertilizer application; a 4-yr perennial forage phase was begun in 2021 to measure the remediation ability of perennial forage in this environment.

Organic Cropping Systems: The 2nd year of a 4-yr crop rotation study that measures the effects of cropping and tillage intensity on creeping thistle demographics was completed in 2021. Creeping thistle response is reported by colleague Tim Seipel.

Carbon Accrual Rotation Block: 2021 was the 5th year of this study that includes eight crop rotations emblematic of different regions of Montana, managed with low and medium disturbance direct-seeding systems, and with and without cover crops. The growing season was the driest ever recorded at the Bozeman research farm, due to a combination of high summer heat and low summer rainfall. Canola yields were the lowest ever recorded at this site (330 – 450 lb/ac), while pea yields were about half of normal (970 - 1470 lb/ac). Overall average crop yields were 10% greater in tall compared with short wheat stubble. Soil carbon will be measured at the 6-yr mark following harvest of winter wheat in September 2022.

Goal 4. Research results were shared with students at Montana State University, in three Extension articles focused on long-term effects of cover crops, a Field Day at the MSU research farm near Bozeman, and two farm conferences in Great Falls, MT. Owing to Covid19 concerns, travel to scientific conferences outside of Montana was not recommended in 2021.

Briefly describe how your target audience benefited from your project's activities.

The target audiences for this research are agricultural producers in the semiarid northern Great Plains, and associated public and commercial knowledge brokers and peer knowledge generators. These audiences are engaged directly via various agricultural commodity, Extension, and scientific meetings/conferences within and outside the NGP region, and by personal responses via email and telephone. A secondary, but no less important target audience is represented by undergraduate and graduate students at Montana State University, who will provide future direction to U.S. agriculture.

Briefly describe how the broader public benefited from your project's activities.

This research project contributes directly to the public interest by developing methods of growing diverse food and feed crops as sustainably as possible in Montana's semiarid environment. Our agronomic methods aim to optimize the carbon footprint associated with water and nitrogen use, and by managing soil to increase carbon content. Plant-based protein is of increasing interest to food consumers, with heavy reliance on pulse crops which are heavily featured in this research program.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Training/Professional Development

In 2021, Sydney Atencio completed her M.Sc. study examining the link for fusarium root disease with fertility and seed-coat fungicides in lentil, Charlie Watt continued his Ph.D. program linking cropping systems with soil organic matter, Samuel Koeshall continued his Ph.D. program studying pea protein influences and took on the role of Research Associate for this project, and Tristan Hoyer completed his second year of field and laboratory assistance, prior to his graduation in May 2022.

Research dissemination to communities of interest?

Perry Miller, Extension colleagues (eg. Clain Jones, Mary Burrows), and graduate students contributed presentations at field days and farm conferences in Montana, indicating sustained interest in cropping systems information. Three Extension articles focused on different dimensions of cover crop use in Montana were published in Montana, summarizing 8 years of field research on plant and soil response. Intermittent discussion is held with Montana NRCS personnel with respect to sustainable crop management practices, quietly influencing policy, and facilitated greatly by a former M.Sc. student (Susan Tallman) becoming the State Agronomist for NRCS. Additionally Perry Miller appears twice annually on a live PBS television program called 'Montana Ag Live' that serves as a phone-in question show targeted at 400,000 households. Last spring's program was focused on pulse crops and the fall program was a special feature on hemp.

Next reporting period to accomplish goals

Both in lead and collaborating roles, we are adding a stronger forage thrust to this cropping systems project, reflecting the growing and diverse forage needs for Montana ranchers, and a desire to explore soil enhancement via short (3-4 yr) phases of perennial cover. Pea protein and winter canola research will be expanded importantly to understand more fully the environmental drivers of pea protein and winter canola survival and yield potential. Soil acidification of farm soils in Montana is occurring at an alarming rate and so with collaborators Manbir Rakkar and Clain Jones we will be exploring various chemical and plant-based remediation strategies. Interest in Climate Smart Farming is surging and pending proposal success, our long-term soil carbon research efforts may be featured more prominently.

Animal Sciences

Project Director

Steven Siegelin

Organization

Montana State University

Accession Number

7000079



Animal Sciences - FY2021

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

In 2021, Montana's drought conditions advanced to 70 percent of the state being designated as *extreme* and *exceptional*. These dry conditions were on full display by August with more than 20 percent of the *state* in *exceptional* drought through the fall months, and reaching the most intense conditions in December with 33 percent of the state in *exceptional* drought. In addition to the extreme negative agronomic impacts, such extreme drought has other consequences in Montana's semi-arid climate. The high percentage of Montana's private- and public-owned range, forest, grass and wild lands are highly susceptible to wildfire. Montana had more than 2,500 wildfire events covering nearly 750,000 acres; many of these fires devastated grazing lands, agriculture production fields, and pastures. Additionally, during drought, grasshopper and blister beetle populations exploded and were feeding on all crops and, consequently, injuring cattle.

One senior agent shared that "producers have been looking for information to manage through these drought conditions and the story I can provide is not very positive, making it difficult to keep a positive mental attitude as I deal with people this year. High feed prices, grasshoppers, drought impacted pastures and declining cattle prices, common pregnancy testing rates of over 30% open paint the picture of the challenge." These are complex issues for livestock producers to navigate.

Livestock production in Montana is extensive in practice. Animals graze much of the year on private or public land range allotments during the spring to fall seasons and return to pastures during the winter months. In drought years, ranchers may reduce the number of days on rangeland to protect the quality and sustainability of the rangeland plant population. This results in early introduction to winter pastures, which increases demands on the pasture and for increased supplemental feed to maintain animal health through winter and calving or lambing.

Range stewardship, forage quality, nitrate toxicity, procuring supplemental winter feedstocks, high hay prices driven by drought-limited supplies at the regional level, and low-quality drinking water all create a complex web of issues that are not simply resolved. In 2021 these issues resulted in many difficult decisions. The most devastating consequence occurred when ranchers decided to partially liquidate their cow herds because they either didn't have the feedstocks needed to support the herd or could not afford to purchase feed due to tight supplies. One county reported that 50% of the cows in the county were sold or moved out state with the hope they could return when the impacts of the drought subside.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

MSU Extension developed multi-faceted approaches to supporting agriculture as the intensity of the drought became evident. [A Drought Taskforce](#) was formed to coordinate responses and provide science-based resources. These resources were utilized to create timely and targeted educational events at the regional and local levels, and provided farm stress management resources to support agriculture producers during devastating environmental events.

Five regional drought mitigation workshops were held across the drought-affected areas of Montana. These rapid response meetings brought science-based information to hundreds of producers quickly when they needed hope that solutions existed. These meetings were followed with dozens of county- or reservation-level educational workshops that were more accessible to producers, specifically targeting the local condition. Agents and specialists consulted with hundreds of producers individually, helping them find solutions to specific situations. MSU Extension agents' roles as trusted, local experts is crucial to minimizing the impacts of the drought and protecting the long-term success of the farm or ranch as a business and the land as a sustainable source of food or fiber resources for the world.

Briefly describe how your target audience benefited from your project's activities.

The 2021 drought was an emergent issue. Much excellent work was done to support producers. This support continues as 70 percent of Montana remains in *extreme* or *exceptional* drought conditions as of March 1, 2022. Preliminary outcomes and impacts are shared here. Drought impacts crops, livestock, and natural resources

Livestock producers benefited most with education from unbiased resources and the follow-up consultations with trusted Extension agents and specialists. Drought conditions in Montana reduce standing feedstocks that cannot be easily replaced. High nitrate levels in hay crops complicate issues as feedstocks are further limited. MSU Extension agents and specialists help producers evaluate their herd, feedstock reserves, feed quality and safety, water quantity and quality, and the forecasted feed supplies and costs. Myriad solutions are possible in these highly complex situations.

The problems agents and specialists dealt with included livestock deaths from water sulfate, poisonous plants, nitrate accumulations in weedy species, and assessing drought-stressed crops for grazing and haying potential. Representative impacts for agent support of producers include providing information through forage testing and drought marketing research; and providing the information needed to make informed decisions about the purchase or sale of feed or livestock. One representative example allowed a producer to make the decision to sell 40 short-term cows instead of feeding them high-cost feed that was nutritionally deficient. Making an informed, evidence-based decision saved him \$24,000 in feed cost and timely marketing added \$300 per head versus delaying the decision to market - total value of this one consultation was a \$36,000 positive impact for the operation. Another agent found that of the forage tested for nitrates, 68% were safe to feed, 26% tested at a level high enough that dilution of the feed would be necessary, and 6% tested as extremely high with a potential for lethal effects. This information provided producers with tools to make decisions about timing of harvesting a crop, when grazing a crop was safe, and how to safely feed the forages tested. Test results were not always bad news. One county agent commented that knowing their nitrate levels were manageable allowed producers to have the peace of mind that their cattle were safe to consume forages. Due to the drought this past year, producers' awareness in the severity of nitrate toxicity has increased through MSU.

In 2021, Extension agents and specialists have been called on to help producers determine how to manage loss rather than increase profit. One of the unmeasurable benefits of these interactions is the mental health value of sharing problems with those who listen with concern and help identify solutions. As trusted resources, Extension agents play an important role of giving hope in difficult times, and helping producers find tangible ways to make threatening conditions more manageable. Farm and ranch stress levels were high entering 2021 and the drought-impacted producers saw that stress increase greatly. One agent shared a concern felt across Extension. He made sure to answer his phone anytime it rang this summer because producers were struggling, depressed, discouraged, and even panicked. By answering his phone, he supported the person calling; letting the caller know that he cares about and wants to help them succeed in difficult times. He was giving people hope and solutions for a future success.

Briefly describe how the broader public benefited from your project's activities.

The 2021 drought affected broad areas and many landowners in Montana. Farms, ranches, and rural landowners contribute to community infrastructure through the products they produce with the resources on their lands; equipment and services bought from and maintained by community businesses; and the ecosystem services their lands provide such as clean water and air, viewsheds, recreational opportunities, wildlife habitat, and property taxes. Maintaining a healthy, sustainable, and functional landscape helps grow healthy and functional rural and frontier communities by supporting the agricultural industry, recreational tourism, and wildlife habitat. Disasters that affect part of the community can also act as an agent that enhances community teamwork, cohesion, cooperation, and unity as they help each other survive the physical, mental, and operational challenges each person faces during extreme drought.



In 2-3 sentences, briefly describe the issue or problem that your project addresses.

In 2021, Montana's relatively wet spring and lush vegetation growth was followed by a hot, dry summer with intermittent thunder/lightning storms; providing an environment ripe for wildfires. Rural landowners and communities who depend on forests, rangelands and croplands for their livelihoods are adversely impacted by wildfires that can destroy timber, grazing, and crops, as well as disrupt their annual work schedules with the additional burdens of personal and livestock evacuation, fire suppression actions, and land rehabilitation after fires.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Wildfire impacts on land ownership and management involves two phases. The first is preventative vegetation management that reduces risks from presence of excess fuel and enhances the ability of first responders to effectively suppress and control an ignition. This is achieved through strategic tree harvesting, forest thinning, and woody debris treatment as well as strategic grazing to reduce fine fuels. Such actions, conducted independently, can be prohibitively expensive for a landowner. Integrating wildfire hazard reduction practices into the routine of forest and range landowner and manager practices requires identifying where risks exist, and then finding viable solutions where commercial timber harvesting and grazing practices can be modified, to provide both a sustainable income source and fire hazard reduction. MSU Extension's Forest Stewardship program provided landowners with science and experiential learning opportunities that help individual landowners learn what is needed on their own land and develop and tailor plans that meet their specific land management and conservation goals. Where commercial ventures are not possible, MSU Extension helps landowners develop management plans that can utilize cost-share assistance through Federal, state, and nonprofit programs offered through the NRCS, Farm Bureau, Montana Department of Natural Resources and Conservation, independent foundations, and other grant opportunities.

After the fire, MSU Extension helps landowners develop unique post-fire assessment, rehabilitation plans, and implementation that fits each landowner's unique goals. Wildfires tend to burn across forested and range lands in mosaics with different intensities and severities. Depending on the vegetation type, sites may best recover on their own, or they may require immediate and significant management actions to stabilize soils and revegetate with preferred species. Common issues are forested areas where severe fire has killed existing trees, seed sources, and the understory vegetation. These sites are extremely prone to erosion, dangerous hazard trees, invasion of exotic plants, noxious weeds, and increased off-site water flow, increasing downstream flooding, and turbidity. Seeding preferred cover species to stabilize soils and provide livestock and wildlife forage is an immediate action that provides site benefits but also requires identifying the appropriate sites for such action, the best cover crop species, and appropriate seeding strategies. Likewise, fire-killed timber can have value both as a commodity product sold to sawmills, and as a soil stabilization barrier to erosion. How to salvage-log after the fire requires site-specific protocols to protect ecology, allowing access for salvage logging that accomplishes and funds protection of the site, and implementing the appropriate strategies that ensure a sustainable future for the land.

MSU Extension's strategic program development resulted in targeted programming that provides landowners with the skills and knowledge needed to assess fire-prone and fire-impacted lands. MSU Extension has also shown the flexibility to assist landowners within days to weeks after fire events. These workshops are followed with on-site visits by Extension professionals to help them identify high risk areas and develop site-specific action plans to address consequential risks and hazards, as well as restore land productivity as expediently as possible. The network of Extension professionals across the state and their close connections with businesses, contractors, and financial assistance providers results in immediate, timely help for landowners who may be overwhelmed by the magnitude of their losses.

Briefly describe how your target audience benefited from your project's activities.

In 2021, approximately 400,000 acres of private lands have participated in wildfire-recovery workshops after this intense fire season. MSU Extension forestry experts and local agents have helped fire-affected landowners quickly conduct restoration assessments and develop restoration plans. The wildfire preparedness and recovery workshops provided by MSU Extension

over the past 25 years have helped over 3,500 private landowners that own between 15 and 30,000 acres of forest and rangelands, totaling over 1.5 million acres. As a result of MSU programming, approximately 750,000 acres have had pre-fire active fuels reduction strategies applied through forest management actions, noxious weed control, and strategic grazing practices.

Impacted landowners are affected by wildfires in two ways. First, they lose significant assets that are part of their livelihood and income. Second, most are psychologically devastated and feel hopeless as they do not have any experience with this sort of phenomenon and do not know what to do or where to start. The post-wildfire workshops give them the knowledge of how to assess damage to their property and a list of recommendations and practices they can choose from to restore the productivity of their lands. The research-based workshop utilizes case studies to show them time-series photos and data of recovery and what to expect for ecosystem recovery. These educational workshops also show them how different actions will lead to different outcomes. They can choose what actions they want to take to best meet their needs. Most ranchers and farmers are “action” people, thus not knowing what to do puts them into a mental state of paralysis. Once they learn what can be done, they recover their sense of self-reliance and put a concerted effort into restoring their lands. For individual wildfire events, landowners form collaborative groups so they can share resources and be more effective in garnering state and federal aid. MSU Extension agents and specialists are not mental health experts; however, our engagement with clientele during high stress periods of life as empathetic listeners and providers of solutions during difficult times helps people focus on constructive actions that resolve stressful issues or mitigate many of the negative ramifications.

Briefly describe how the broader public benefited from your project's activities.

Wildfires affect specific areas and landowners; fire preparedness and land recovery actions impact the communities that surround the impacted landscapes. Farms, ranches, and rural landowners contribute to community infrastructure through the products they produce with the resources on their lands, equipment and services bought from and maintained by community businesses, and the ecosystem services their lands provide such as clean water and air, viewsheds, recreational opportunities, wildlife habitat, and property taxes. Maintaining a healthy and functional landscape helps maintain healthy and functional rural and frontier communities. Disasters that affect part of the community can also act as an agent that enhances community teamwork, cohesion, and cooperation.

Farm, Ranch, and Business Management

Project Director

Steven Siegelin

Organization

Montana State University

Accession Number

7000084



Farm, Ranch, and Business Management - FY2021

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Most Montanans die without written a will. A decedent’s assets are then distributed through a combination of contracts (beneficiary forms, account titles, etc.) and Montana laws of intestate succession. Lack of knowledge about the various tools that are available to direct assets upon the owner’s death can lead to lengthy estate settlement processes and assets not being directed according to the owner’s wishes.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

MSU Extension utilized a wide range of programs to reach Montanans with Estate planning education remotely during 2021. MSU Extension offered several webinar series targeting different groups’ estate planning needs. These included:

- **MontGuide Mondays** reached a general audience and increased estate planning capacity by engaging six county agents as instructors (258 people)

- **Tuesday Tips** reached a general audience with one county agent co-teaching (594 people)
- **Wednesday Wisdom** was a programming and funding partnership with AARP (2,416 people)
- **Thoughtful Thursdays** was a partnership with MSU Alumni Foundation (256 people)
- **Fabulous Fridays** was a partnership with the Montana 4-H Foundation and 4-H Center for Youth Development (404 people)

In addition to these educational series, another 18 topical sessions were offered in a variety of conferences or other settings. These additional meetings reached over 600 people. The online webinars were created during COVID-19 restrictions. Collectively, 4,500 people participated in estate planning educational events. The teaching capacity was increased by training county agents in estate planning.

In addition to online opportunities, a five-lesson **Learn at Home** series was developed to meet the needs of people who do not have computers or internet. Lessons were provided as bi-weekly correspondence learning opportunities. Over 100 people learned using this modality. Two hours per week were set aside for phone consultations with correspondence learners.

Remote work allowed time to focus on developing new resources and delivery methods. The 4,500 people reached was far greater than were previously reached via one specialist traveling the state.

Briefly describe how your target audience benefited from your project's activities.

Montanans across the state benefit from the Estate Planning Education efforts in several important ways. First, Montanans were able to access unbiased, factual information about the various tools, laws and policies in Montana that direct how an individual can direct their assets upon their death. Second, Montanans who take actions to direct their assets via contracts, wills or other tools can decrease the length and complexity of settling their estate. Third, effective estate plans can reduce burden on probate courts by simplifying asset transfers. Finally, Montanans can reduce family conflict caused by uncertain or incomplete estate planning.

As a result of participating in these programs:

- 50% discussed estate planning with adult children
- 61% discussed estate planning with a spouse
- 66% review ownership title on financial accounts
- 46% reviewed beneficiary designations on life insurance policies
- 38% made an appointment with an attorney to execute a will
- 49% reviewed beneficiary designations on their stocks, bonds, and mutual funds
- 37% added payable on death designations
- 31% added transfer on death registration on their stocks, bonds, and mutual funds

Briefly describe how the broader public benefited from your project's activities.

Implementing appropriate estate planning at its simplest level maximizes the amount of assets transferred from the decedent to their beneficiaries. It also ensures that the decedent's possessions are distributed following their wishes. In more complicated estates and larger estates like farming or ranching operations, failure to plan can be devastating, including the dissolution of agriculture operations, family conflict, and even estrangement. Proper estate planning keeps financial resources in the economy, reduces family stress, and supports successful inter-generational transfer in agriculture or other business operations.

Integrated Pest Management

Project Director

Steven Siegelin

Organization

Montana State University

Accession Number

7000085



Integrated Pest Management - FY2021

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Montana State University and MSU Extension provide plant pest identification through the Schutter Diagnostic Laboratory (the Lab). The mission of the Lab is to safeguard Montana agriculture, landscapes, and public spaces from plant pests by offering identification services, management advice, and education. The Lab's recommendations are based on integrated pest management (IPM) principles, where IPM is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic and environmental risks. The mission of the Lab also includes the early detection of new and invasive pests that may pose a risk to Montana and to the U.S. to prevent significant limitations to agricultural production and international trade.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The Schutter Diagnostic Laboratory (the Lab) at Montana State University (MSU) is a service to the citizens of Montana for plant pest identification and integrated pest management education. In 2021, the Lab conducted a total of 2,643 plant disease, insect/other arthropod, plant, mushroom, herbicide injury, and other abiotic disorders diagnoses through physical, email, and APP (Plant Sample Submission App) samples. Several types of diagnoses or identifications were completed in the following categories: plant disease (1026), arthropods (792), plant ID (385), mushroom ID (49), herbicide injury (81), and abiotic disorders (310).

Samples were received from 53 of 56 counties and reservation offices in Montana and eight additional states-Arizona, Colorado, Idaho, Minnesota, New Jersey, North Dakota, Oregon, and Wyoming. In addition to diagnostic services, the Lab diagnosticians provided outreach, research, and educational materials about pests of concern to clients in Montana. The Lab maintains a Facebook page that has over 800 followers. In 2021, the Lab published a total of 58 Facebook posts reaching over 38,000 people, engaging 65 followers per post on average. The posts usually focus on timely information about plant diseases, insects, or plant identification for our wide range of clientele. The Lab also sent out Urban Alerts (<https://mturbanalert.org>) and AgAlerts (<https://mtagalert.org>) that inform our clientele on trends and pertinent diagnostic issues statewide. The MSU Urban Alert system (528 subscribers) is intended for Extension agents, landscape professionals, arborists, city foresters/managers, and any other client concerned with ornamental plants and vegetables. In 2021, 14 urban alerts were posted. The MSU AgAlert system (1154 subscribers) provides current and research-based information on emerging issues for Montana agricultural clients. There were 23 AgAlerts posted in 2021.

Briefly describe how your target audience benefited from your project's activities.

- o \$1.8 million USD were saved based on the Lab diagnoses and associated management recommendations, affecting approximately 810,000 acres.
- o 84% of clients utilized recommendations and/or resources that were provided by the diagnosticians in the diagnostic reports.

- 96% of the survey respondents found it easy to submit samples.

- 94% of the survey respondents thought the timeliness of a response/diagnosis was good or excellent.

Plant and Weed Issues

During the drought conditions of 2021, producers encountered different plants than usual in pastures and rangeland, leading to issues with toxicity to livestock. Accurate plant identification was an important step in addressing these types of issues. For example, this year the Lab processed several samples of pasture and rangeland plants after livestock losses had occurred. Poisonous plants such as western waterhemlock and nitrate-accumulating plants like those in the goosefoot genus (kochia and lambsquarters) were identified and recommendations for next steps were given. In many cases, the Lab confirmed submitted plants were not known to be toxic or problematic to livestock.

The Lab is an important resource for early detection of new pests. For example, the agricultural industry is concerned about the potential for waterhemp and Palmer amaranth to spread into Montana and negatively impact agriculture. In 2021, the Lab worked with the Agricultural Genotyping Center in Fargo, ND, to confirm a new population of waterhemp in a sugarbeet field in Montana, and to confirm a suspected Palmer amaranth population was instead the more benign Powell amaranth.

Most herbicide injury cases were observed on ornamental or vegetable garden settings. The Lab assessed 60 samples for herbicide injury symptoms. Of these, eleven woody ornamental samples showed symptoms consistent with synthetic auxin herbicide injury. These symptoms may have arisen due to herbicide drift or root uptake resulting from lawn applications. Twelve vegetable samples from home gardens also showed symptoms consistent with synthetic auxin herbicide injury. Based on site histories it is likely most of these occurred because of herbicide carryover in garden amendments or newly purchased topsoil. Other issues encountered in residential landscapes included woody plants showing glyphosate injury symptoms (seven cases), drift of contact herbicides from nearby crop fields (four cases). In eleven potential herbicide injury cases, plant symptoms were suspected to be due to other environmental factors.

Insect and Arthropod Issues

Several drought-related insect issues were identified and support to MSU Extension agents, landowners, and partner organizations was provided. Grasshoppers, particularly the two-striped grasshopper were a serious issue throughout the state in both croplands and yards and gardens. In late-June to mid-July, blister beetle populations began to rise as the drought developed in the northern and eastern regions of Montana. The beneficial 'banded argiope' spider was very common throughout the state (known to feed heavily on grasshoppers).

Briefly describe how the broader public benefited from your project's activities.

The Schutter Diagnostic Lab provides important services throughout Montana and in partnership with valuable networks that identify and protect people in the U.S. from the spread or introduction of plants, diseases, or pests that threaten our ecological, food, or fiber systems. Proper identification of a situation is the first step in making sound decisions that maximize the benefits to people and the environment.

Clients recognize the immediate and long-term benefits provided by the Lab.

- The Schutter Lab's diagnosis allowed us to help the community and to personally have safe, non-toxic options for my own garden needs.
- The diagnostic lab gave us reassurance that our no-treatment decision was scientifically justifiable and probably a best management practice for that situation.
- The diagnosis helped to stop the occurrence of animal deaths due to toxic plants.
- It's just a great resource to contact and it's free! The ladies at the Lab are very friendly, a joy to interact with, and very focused on solving problems. We are lucky to have such a great service available to us free of charge.
- We will make changes to what we plant in the future or add seed treatment to the crop before planting.

- o The diagnostic report gave me peace of mind in knowing that the insects I found are not a major concern for my health and the integrity of my furniture and books. I learned that a chemical treatment is not necessary and that I can likely bring these insects under control with some simple steps like sealing cracks and not storing things directly on the ground.

Biological Control in Pest Management Systems of Plants

Project Director

Jeffrey Littlefield

Organization

Montana State University

Accession Number

1014148



Biological Control in Pest Management Systems of Plants

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Invasive plant species are recognized to be a serious problem on Montana's range and forested lands. Noxious weeds have a substantial economic impact on the productivity of these lands and in addition, the presence of these invaders may compromise the ecological integrity of all Montana's land and those of surrounding states or Canadian provinces. This project will continue to investigate the use of biological control using exotic insects or mites for the management of noxious weeds. These projects will contribute to the selection of potentially new biological control agents for the control of noxious weeds, as well as a general understanding of biological control and its implementation in weed management systems.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

My contributions to this regional projects are to determine environmental safety of exotic biocontrol agents prior to their release into the environment; aid in the release, establishment and redistribution of natural enemies; and to evaluate natural enemy efficacy (i.e. potential impact) and to study ecological/physiological basis for insect –plant interactions which may affect these pest management systems.

The rush skeletonweed crown moth (*Oporopsamma wertheimsteinii*) was received from the BBKA and the Russian Academy of Sciences in October 2021. Seventy three adults emerged from feeding tubes on plants collected in Armenia. Adults were placed in oviposition tubes and a thousand plus eggs were harvested. Larvae are currently being used for impact studies on non-target plants that had some insect feeding in past quarantine tests at MSU. These tests will evaluate the potential risk to native plants by the moth.

I also made releases of imported insects for biological control of three weeds. In two cases these represent new agents being released. For invasive hawkweeds, female *Cheliosia urbana* (a root boring fly) were collected by G. Cortat (CABI Switzerland) between 27 April and 9 May 2021. Approximately 200 eggs and 9 females were sent to the MSU containment facility on 18 May. Due to a delay during the transport females died without laying new eggs. The few larvae that hatched during shipment died before arrival and no larvae hatched from the remaining eggs. At MSU, we are currently rearing two populations of the hoarycress gall mite, *Aceria drabae*. Our original rearing colony has been maintained since 2016. These mites were collected in Bulgaria by the BBKA at a higher elevation site and was supplement in 2018. In 2021 a collection as made by the (BBKA) from north-central Greece. Galls were received at the MSU containment facility in late May, 2021. Approximately 3,176 mites were individually transferred to plants to initiate a new colony. We will be maintain these colonies for release and for transfer to regional cooperators. Four releases of the mite have been made in Montana. Two initial releases were made in 2019 in Gallatin (Bozeman) and Broadwater (Toston) counties. Due to the size of the infestation at Toston, we made additional releases at this site in 2020. In 2021, two more release sites were added: Lake (Charlo) and Lewis & Clark (Helena) counties. I have also been providing a stem gall wasp for Russian knapweed control. This agent has been released and established at a

number of Montanan sites. Approximately 3,750 adult *Aulacidea acroptilonica* were reared from galls collected from Broadwater County, MT April 2021. However, we had poor emergence of wasps from galls. Gall wasps were consigned to cooperators located in Carbon, Petroleum, and Teton counties, as well as the Rocky Boy's Reservation.

The rush skeletonweed root moth (*Bradyrrhoa gilveolella*) has been found to be established at one location in southern Idaho. I have been monitoring of moth populations and possible impact on plant density and plant size. Plant density has substantially declined from 29.1 plants/ 0.25 m² in 2011 to 0.5 plants in 2021.

Briefly describe how your target audience benefited from your project's activities.

My projects impact various federal, state, county and private stakeholders and are part of larger regional consortia or efforts on biological control of weeds. Consortia groups have been developed for numerous weeds, and various stakeholders are associated with these groups. Stakeholders may include federal, state, county agencies as well a private organizations, companies or individuals. Benefits of my research activities have consisted of: 1) new or improved natural enemy species or biotypes for biological control of weed pests in the western U.S.; 2) improved methodologies for incorporating biological control into IPM programs for key agricultural resources in the western U.S.; 3) data addressing the ecological basis of success and failure of biological control; and 4) data addressing the environmental and economic impacts of biological control. These projects will contribute to the selection of potentially new biological control agents for the control of noxious weeds. New agents are being investigated for the biological control of Russian knapweed, hoary cress, common tansy, oxeye daisy, invasive hawkweeds, and rush skeletonweed. The target weeds have either no biological control agents currently available or the agents already established are not effective over the range of the target weed. In addition, a better understanding of biological control and its implementation will be achieved by monitoring the impacts associated with these biological control agents. Publications and presentations will continue to provide the state or federal agencies, and private producer groups with both technical and practical information on the availability and use of weed biocontrol agents.

Briefly describe how the broader public benefited from your project's activities.

The availability of new or improved biological control options for major pest species in the western U.S. will result in reduced pesticide usage, increased sustainability of agricultural production systems, and economic benefits to both agricultural producers (in the form of reduced pest management costs) and consumers (in the form of reduced food costs). The attendant benefits of reducing pesticide usage include reduced food, soil and water contamination, reduced impacts on non-target species including wildlife, and reduced human exposure to potentially harmful chemicals. Enhanced knowledge of the ecological mechanisms underlying weed management and biological control will increase success rates. Enhanced knowledge of the environmental and economic impacts of biological control will improve the environmental safety of biological control and foster its adoption in current and new pest management programs.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

COVID-19 travel restrictions impacted the travel overseas cooperators for the collection of biocontrol agents. In addition in-person presentations were limited in 2021. I was able to present several on-line presentations updating cooperators and clientele as to the status of these biocontrol projects. For example I was on Montana AG Live - PBS (TV) (A regular call-in information program dealing with agricultural and gardening issues in Montana) on May 9, 2021 and on October 31, 2021 discussing invasive species; "Status of released biocontrol agents for field bindweed" presented at Field Bindweed Consortia Meeting, USDA-ARS, On-line. (January 14, 2021); "Rearing, release and monitoring of *Aceria drabae*", Montana State University, Online Workshop. (October 4, 2021) and "Hoary cress mite update" at the Montana Weed Control Association Annual meeting Jan. 27, 2021 and Wyoming Weed & Pest Biocontrol Meeting, , Wyoming Weed & Pest, on-line. (November 2, 2021). Several research papers were published in scientific journals. These include:

Marini, F. Weyl, P.; Vidovic, B.; Petanovic, R.; Littlefield, J.; Simoni, S.; de Lillo, E.; Cristofaro, M.; Smith, L. 2021. Eriophyid Mites in Classical Biological Control of Weeds: Progress and Challenges. *Insect* 12: 513. 25 pp.
<https://doi.org/10.3390/insects12060513>

Stutz, S., McClay, A., De Clerck-Floate, R. and Littlefield, J. 2021. Petition for field release of *Dichrorampha aeratana* (Pierce and Metcalfe, 1915) (Lepidoptera, Tortricidae) as a biological control agent for oxeye daisy, *Leucanthemum vulgare* Lam., in the USA and Canada. TAG petition submitted to USDA-APHIS-PPQ.

Critical Issue

Community Development

Rapid Response to Mitigate Impacts of SARS-CoV-2 Across Food and Agricultural Systems

Project Director

Mark Jutila

Organization

Montana State University

Accession Number

1024688



Rapid Response to Mitigate Impacts of SARS-CoV-2 Across Food and Agricultural Systems

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Our primary goal is to pursue research and outreach efforts to minimize the negative impacts of COVID-19 on the public, including efforts in agricultural systems. We are focused on studies of host immune responses against SARS-CoV-2, diagnostics, viral evolution, emergence of viral variants, among other efforts to meet the goals of this project.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

In our first year of this project, we pursued efforts on COVID-19 related to the following in our non-technical summary: (1) mechanisms of SARS-CoV-2 transmission within and between humans and animal species; (2) the nature of protective, as well as permissive, immune responses in humans and animal species; (3) persistence and transmissibility of SARS-CoV-2 in animal and human wastes and further utilization of the waste. We established a SARS-CoV-2 resource and research lab in our BSL-3 facility, and supported multiple research efforts on campus, including outreach efforts working with the Country Health Surveillance Programs and local COVID-19 diagnostic efforts. Studies on anti-SARS-CoV-2 antibody responses in vaccinated and naturally infected people, analysis of variants within local diagnostic samples, analysis of the potential for infectious virus in human surgical gut tissue samples, analysis of pathophysiological responses against SARS-CoV-2 within the lung of an animal model of COVID-19, and comparison of inactivation methods for SARS-CoV-2 were completed in the past year.

Briefly describe how your target audience benefited from your project's activities.

Efforts in this project contributed to multiple scientific publications and multiple scientific meeting presentations, which served as the main conduits for dissemination of information to those who study SARS-CoV-2, the main target audience of the basic research component of this project. This information will benefit the overall national research efforts on COVID-19, including efforts in diagnostics and waste management.

Briefly describe how the broader public benefited from your project's activities.

Our collaborative efforts on the study of variants within local diagnostic samples were of benefit to local health departments in evaluating specific outbreaks in the county. Efforts by MSU scientists in screening waste water/sewage samples for SARS-CoV-2 were of similar public benefit. Through public outreach efforts, information on vaccine and natural infection induced immunity was disseminated. All of these efforts provided important public benefit through the dissemination of new knowledge on COVID-19 so the public could make more informed decisions concerning mitigation strategies to minimize the impact of COVID-19.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to

communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

There are no changes to this project nor did any unforeseen problems require changes to our approaches and methods. Training and professional development opportunities were provided to faculty, professional staff and students through the extensive training requirements to work on BSL-3 level pathogens in our Select Agent facility. Each new research personnel had to go through extensive training programs and a CDC certification process. Most results have been disseminated through scientific publication and presentations at local, regional and national research meetings. Dissimination to the public was through public seminars and workshops and articles in the local press. During the ucoming year, we plan on continuing efforts similar to year 1, with a major emphasis of studying host immune and pathophysiological responses to SARS-CoV-2 infection and SARS-CoV-2 evolution in different animal cells, including cells from livestock species.

Community Development

Project Director

Steven Siegelin

Organization

Montana State University

Accession Number

7000089



Community Development - FY2021

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Rural and frontier counties consistently identify the need for new leaders in their communities. These counties need 1 in 8, to 1 in 20, citizens to take on leadership roles in government, non-profits, or private community-minded entities. A decade ago, the MSU Extension agents in Park County built trust with key community leaders, collaborated with Wyoming Extension Community Development agents, and led the development of an eight-month leadership program, Leadership 49. Now in its eighth year, the long-term impact of the program is being measured.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

- Leadership 49 was created with an advisory committee of community leaders from across Park County.

- Seven Leadership 49 classes have graduated 120 participants.

- Participants have engaged in over 50 Community Based Experiences where they learn about communities and issues throughout this geographically-large and diverse county; spanning from the Northern and Northeastern Gates of Yellowstone National Park to traditional ranches and farms in the northern part of the county.

- Leadership 49 educational strategies and materials are continually adapted and updated to fit the immediate needs identified by a planning team made up of program alumni.

- Extension, community development, and other experts in leadership have led participants in developing leadership skills.

Briefly describe how your target audience benefited from your project's activities.

Over the first six cohorts, participants have reported the following:

- 100% of participants better understand themselves.
- 100% are or will contribute to the enhancement and sustainability of their community.
- 100% increased their network or connection with people or leaders.
- 100% will promote positive impacts for the people of Park County.
- 98% have a greater understanding of county-wide opportunities and challenges.
- 97% Have a greater appreciation for the differences in others.
- 95% feel prepared to facilitate, mediate, and effectively engage in community-based conversations.
- 95% are able to foster and facilitate positive cultural change.
- 94% feel better prepared to persevere and exhibit resilience in the face of adversity.
- 85% of participants say they have become a better leader.
- 56% have helped improve the effectiveness of meetings and actions of boards or committees.

What participants say about how they benefitted from Leadership 49:

- “The skills that taught me how to collect ideas, recognize and organize a team with a goal in mind and the process to bring that team to a final goal. Including things such as the sticky notes of ideas on a board, the dots, how to keep a group on task, as well as the dynamics of a group.”
- “I think for me it was being able to listen to different perspectives from fellow participants. ”
- “Connecting me with the challenges and opportunities in the county that I had no idea about has helped me brainstorm how I can use my skills and passions to be a leader in the community.”
- “In combination with some other experiences this year, I see that there is a place for me in a leadership role or that I am capable of this. It has made considering applying to formal leadership roles in the county more accessible, in part because it took away some of the mystery of the process and introduced me to the real people in those roles. If we all have something to contribute to this county as a leader, then that means I have something to contribute. I can do this.”
- “Exploring the entire county, understanding each communities' strengths and weaknesses and how to get involved.”

- o “It was a year full of self-discovery and discovering more about not only the community I lived in but the experiences and lifestyles of rural America.”
- o “I believe that I benefited the most from being pushed outside of my comfort zone in certain situations and was challenged to address problems or potential issues head on. To utilize what we learned rather than resort back to the default behaviors that I may have had prior to the program.”
- o “Thank you so much for the opportunity to be part of this experience. I look at this as the start of a continuing process that will grow and change over time. I built lasting relationships and learned so much about myself. You guys do an amazing job!”
- o “I found that discussion and lessons around how to have and navigate through difficult conversations has been most beneficial to me. A lot of the conversations I have for work are high emotion because the topics can include compensation, leave from work, benefits, and potential termination of employment. I find myself looking back through notes and my binder from our sessions frequently.”
- o “Leadership 49 was a way for me to explore growth and development in a safe setting with fellow humans navigating this crazy life.”
- o “The conversations about politics and personal stories over lunch were very powerful to me. It was a completely different mindset than I had ever been in around other adults. It was very humanizing.”
- o “Such powerful community-building/connecting! As a new resident to Park County, this program was invaluable -- I feel deeply invested and committed to being a better community member. L49 is a major reason why Park County really feels like home.”
- o “L49 was a transformative and pivotal experience in my Park County journey, and I'm so grateful to have participated early in my time here so I can thoughtfully contribute and invest in this community. Such an incredible head/kickstart!”
- o “Sometimes leading means knowing when to step back. Leaders do not need to be loud.”

Briefly describe how the broader public benefited from your project's activities.

Leadership 49 began to address local needs, benefitting from the previous work by Wyoming Extension’s EVOLVE program. In recent years, a team of MSU Extension Community Development and other agents began expanding the relationship with Wyoming Extension and learned from the experiences in Leadership 49 and developed a robust leadership framework that will be implemented in counties across Montana.

Four additional counties now have similar leadership programs and agents in other disciplines are being trained to lead community-based leadership programs. Early results in these counties have individuals being inspired to share what they learned about leadership with others, taking on community leadership roles, and pursuing partnerships that strengthen their communities.



In 2-3 sentences, briefly describe the issue or problem that your project addresses.

For this project, I published a paper that measures a negative association between seasonal labor-intensive agricultural activity and crime rates within U.S. county-year observations. This research importantly shows that seasonal farm labors have no discernable impact on increasing local crime rates in the short-run, and if anything, reduce crime rates within U.S. counties. I also measured the association between historical seasonal farm employment and changes in COVID-19 incidence within U.S. counties, I investigated how local housing market shocks affect farm wages and H-2A employment within U.S. commuting zones, and I began investigating the effects of county-level exposure to domestic and foreign tariffs on employment and wages in rural U.S. counties from 1995-2016.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

My research investigates rural labor markets, including employment, wages, demand for foreign guest workers, and social impacts of seasonal agricultural activities. All of these topics are imperative to improving economic development in rural economies. For example, many high-value crops in the United States require large crews of seasonal workers, and community residents have often expressed fears that crime rates would increase if seasonal worker housing was constructed near their homes. Research I recently published, using resources from this grant, shows that on the contrary, if anything, seasonal labor-intensive agricultural activity decreases crime rates in the short-run. Some of my other research investigates potential associations between activities that employ seasonal farm workers and the spread of COVID-19 within U.S. counties in 2020. I found a positive association, which raises concerns for sustaining agricultural production during a pandemic and protecting worker safety. I also measured positive effects of housing demand shocks on H-2A employment within U.S. commuting zones from 2001-2019. Housing demand shocks also cause employment in local nontradable non-farm industries that traditionally employ immigrants with low levels of education to increase and farm wages to rise, consistent with housing demand pulling local workers out of the farm sector. Our findings provide suggestive evidence that farm employers seek additional workers through the H-2A program in response to inward labor supply shocks, though other mechanisms might also be at play. Finally, I began preliminary work to measure the effects of domestic and foreign crop, livestock, and non-farm tariffs on employment and wages within U.S. counties. Preliminary results suggest that increased county exposure to foreign tariffs on U.S. crops negatively affects rural employment and wages, while exposure to increased domestic tariffs on non-farm imports increases non-farm employment but decreases agricultural employment. This is consistent with negative impacts of foreign tariffs on producers that traditionally export their goods and protectionist non-farm policies helping non-farm industries to compete with other global producers while simultaneously increasing input costs to production for agricultural industries that potentially use non-farm imports in production. Further investigation is still needed.

Briefly describe how your target audience benefited from your project's activities.

I disseminated the findings from my research at multiple venues. I presented research on labor-intensive agricultural activity and crime rates at a research seminar at Kansas State University, research on the H-2A program at the International Conference of Agricultural Economics and research on COVID-19 and farm labor at the Allied Social Sciences Association Annual Meeting. I also made presentations at various extension meetings and webinars, including the Montana State University Spring Fall Economics conferences, webinars for the University of California Davis, and a webinar for the Virginia Sustainable Farms and Agribusiness Education Webar Series, hosted by Virginia Tech. I participated in media interviews for the podcast *Off-Farm Income: Ideas for the Ultimate Livestyle Business Agriculture* and CBS News Sunday Morning. Presentations and academic venues help further the field of research. Presentations provided helpful feedback for myself and my coauthors while also teaching other researchers about our most recent findings. Extension presentations allowed me to share relevant findings to stakeholders and a larger public audience in venues where audience participants could also ask questions directly about my research and findings.

In 2021, I published a paper titled "Seasonal Farm Labor and Criminal Activity in the United States" in the *American Journal of Agricultural Economics*, a paper titled "Seasonal Farm Labor and Risk of COVID-19 Spread" in the *Applied Economic Perspectives and Policy*, and a chapter titled "The Changing Nature of Agricultural Labor Markets" in a book titled *Handbook of Agricultural Economics*, volume 5. The *Handbook of Agricultural Economics* is widely referenced in the agricultural economics field as a first source of information on topics of information when beginning a literature review or seeking an overview of specific topics.

Briefly describe how the broader public benefited from your project's activities.

My research helps illuminate social and economic questions of interest for development in rural America. My research in 2021 specifically addressed questions relating seasonal labor-intensive agricultural activities and crime. Our findings can help alleviate concerns that migration of seasonal farm workers might increase crime rates--we find no evidence that this is the case and even find that crime rates decrease during most labor-intensive months of agricultural activity. My findings that show a positive effect of housing demand shocks, which also increase employment in non-farm sectors and increase farm wages, on H-2A employment provide suggestive evidence that farm employers hire H-2A workers when local economic activities pull workers within the community out of agriculture. These findings are directly relevant for policymakers who for many years have considered and discussed potential reforms to the H-2A program. These findings are also relevant for farm employers and community leaders in the rural United States where H-2A workers are employed. Finally, ongoing research measuring the effects of county exposure to domestic and foreign tariffs on agricultural and non-agricultural goods will help bring to policy and trade discussions the potential effects of global trade policies on rural communities.

[Healthy Living, Nutrition, & Food Safety](#)

Project Director

Steven Siegelin

Organization

Montana State University

Accession Number

7000088



Healthy Living, Nutrition, & Food Safety - FY2021

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

In Montana, 1 in 10 individuals experience food insecurity and 92% of Montana adults do not meet the vegetable intake recommendations. Growing Together Montana is a collaboration between the MSU Extension Nutrition Education Program and the Montana Master Gardener Program that addresses food insecurity in Montana. This work is due, in part, to Montana State University Extension's participation in a multi-state Growing Together collaboration which provides support for states who implement similar projects.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

To address food insecurity, Growing Together Montana provided mini-grants of up to \$2,000 per application to Master Gardeners and communities to start, convert, or maintain gardens for the purpose of donating fruits and vegetables to food pantries or other organizations that provide food to individuals who are experiencing food insecurity. In coordination with garden projects, Extension provided nutrition education on how to prepare garden produce to individuals who have access to the donated produce.

Fort Peck Indian Reservation received one of the grants to purchase seed, supplies, amendments and to test soil and water. The local goal for the program was to learn about growing food under Master Gardener Program principles, and partner with the Supplemental Nutrition Assistance Program Education (SNAP-Ed) to show how to eat healthier.

Briefly describe how your target audience benefited from your project's activities.

As a result of the Growing Together Montana collaboration in 2021, 6 projects were awarded to communities with food deserts. Over half of the projects were located within or bordering an indigenous community. In total, 8,200 individuals gained access to fresh garden produce through the 28 partner agencies that distributed produce donations.

The Fort Peck Indian Reservation program developed over 1,600 hours of volunteer labor (\$41,300). They also developed \$55,000 in in-kind and donated equipment support. The result was 4,700 pounds of fresh food supporting hundreds of households; supporting the establishment of two other community gardens; and several food tasting events where popular recipes were shared.

Briefly describe how the broader public benefited from your project's activities.

Most of the garden projects from 2021 plan to continue into the 2022 growing season with more community members involved, resulting in increased capacity for growing more produce. Other outcomes during the 2021 growing season include 28 organizations engaged and involved in the project, \$57,385 in additional funds or in-kind contributions were leveraged through partnerships and donations, 1,600 Non-Extension Master Gardener volunteer hours (\$40,368) dedicated to assisting the projects, and over 1,000 Extension Master Gardener volunteer hours (\$25,230) dedicated to leading the projects.

Another underlying representative benefit demonstrated at the Fort Peck Indian Reservation's experience are the number of partnerships that are built through this program. The Fort Peck FRTEP office built partnerships with Fort Peck Tribes Community Services Program, Natural Resources Department, Health Promotion Disease Prevention program; USDA-NRCS and SNAP-Ed; Master Gardener and other volunteers. Partnerships like these where success is enjoyed by all often serve as a foundation where future impactful programs develop to improve communities.

Type

Projects / Programs

Projects / Programs without a Critical Issue

0

Not Provided