

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

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

Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
121	Management of Range Resources			5%	
301	Reproductive Performance of Animals			12%	
302	Nutrient Utilization in Animals			10%	
303	Genetic Improvement of Animals			10%	
304	Animal Genome			10%	
305	Animal Physiological Processes			10%	
306	Environmental Stress in Animals			5%	
307	Animal Management Systems			10%	
308	Improved Animal Products (Before Harvest)			12%	
311	Animal Diseases			5%	
315	Animal Welfare/Well-Being and Protection			5%	
702	Requirements and Function of Nutrients and Other Food Components			3%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources			3%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	49.0	0.0
Actual Paid	0.0	0.0	38.9	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	282646	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	1866886	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	2175249	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

In 2014, Animal health research continued to be of primary importance not only to Montana's beef producers, but for the larger global safety Montana's food and product exports. Animal health accomplishments include research priorities in animal health in direct correlation with humans, livestock, or food products. Primary research veins reflective of these areas are; vaccinations, nutrient utilization, reproductive performance, animal physiology, zoonotic diseases, external parasites, animal diseases, genetic improvement of animals and management of range resources. Producing the highest quality animals and obtaining the highest profit potential are essential for Montana. In this concentration, new and improved food processes are featured as well as market economics and marketing and distribution practices. Promoting and maintaining animal health has led to advances in genetics, reproductive science and improved animal performance. Scientists continued investigating vaccines for rotavirus, strangles, respiratory diseases, and mastitis. Researchers are used feed studies with barley, camelina meal, and supplements to evaluate varying rations for calves and cows, and to continue producing superior feeder stock to markets outside of Montana. Global economic changes, fertilizer prices, drought and fire, weeds and pests, expanding export markets, market volatility and cultural changes all contribute to a challenging path for producers to remain profitable and sustainable in the industry. MSU Research, Extension and COA partnered with producers to address issues and meet the needs of Montana's agricultural industry.

Animal health research programs at MSU COA and MAES focused on reproductive performance in animals, nutrition, genetic improvements for herds, and developing better animal management systems. NIFA defined sustainable agriculture as an integrated system of plant and animal production practices having a site-specific application that will over the long-term satisfy human food and fiber needs. That definition also includes the importance of enhancing environmental quality and the natural resource base essential to the agricultural community. Researchers at MSU feel little plant/animal integrated systems level research has been done that addresses all of the factors outlined in the USDA definition of sustainable agriculture. In addition, organic certified vegetable, row crop, and animal production enterprises and research have not fully taken advantage of the potential benefits of plant/animal integration and suffer from issues ranging from animal health and finishing (particularly internal parasite control), and alternatives to confinement (finishing) to residue and cover crop management, and soil health

issues related to extensive tillage commonly used in organic farming programs. Thus, COA/MAES scientists have designed several research projects that will emphasize a combined animal and plant approach.

Food safety (as it relates specifically to animal health research priorities) and security continued to be important concerns for the beef industry at all production levels. Domestic and international consumers are demanding more information about the source of the meat products they purchase, including the age, health, nutrition, and handling management of the animal. In 2014, COA/MAES studies helped to ensure that Montana producers raise safe beef while improving the quality of the beef and ensure consumers are aware of the quality and health of their products through advancements in educational programs on beef quality assurance (BQA) practices, voluntary beef cattle marketing options, and ranch management issues throughout the state via meetings and interactive technologies.

2. Brief description of the target audience

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

3. How was eXtension used?

COA and MAES researchers worked closely with county extension agents and outreach coordinators to disseminate timely and accurate information about animal health, production and products.

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	5000	25000	3000	1500

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

Patent Applications Submitted

Year: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
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Actual	0	200	0
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V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Provide translational research to producers through outreach and Extension programs.

Year	Actual
2014	100

Output #2

Output Measure

- Publish research in scientific journals.

Year	Actual
2014	150

Output #3

Output Measure

- Present research findings to the public and interested producers through seminars and workshops.

Year	Actual
2014	100

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of off-campus educational programs offered
2	Determine management factors that affect animal products
3	Disseminate research program results to producers regarding invasive weed management and impact on livestock
4	Find genetic correlations of factors influencing residual feed intake and feed efficiency

Outcome #1

1. Outcome Measures

Number of off-campus educational programs offered

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	25

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Animal health, production and products are of significant concern to Montana producers, as animal health is a field that directly impacts the state's economy. Livestock production on Montana farms and ranches provided \$ 1.6 billion of gross income to the United States Economy, and of that amount, \$1.2 billion of the value-added was in beef.

What has been done

Interactions between the levels of supplement consumption, supplement delivery methods, and forage intakes by beef and cows were evaluated. The intent of this research is to determine how the basic processes controlling forage intake and utilization by ruminants can be manipulated by supplementation.

Results

Current 2014 research data was presented at the 2014 Montana Nutrition Conference and the Western Section of the 2014 American Society of Animal Health. Additionally, more than 25 off-campus meetings were held with seven different NGOs, with more than 15 presentations to more than 320 constituents. Presentation presenters included state agricultural extension agents, financial advisors, local business leaders and beef cattle producers and forage producers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals

- 304 Animal Genome
- 305 Animal Physiological Processes
- 306 Environmental Stress in Animals
- 307 Animal Management Systems
- 308 Improved Animal Products (Before Harvest)

Outcome #2

1. Outcome Measures

Determine management factors that affect animal products

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Beef cattle production on Montana farms and ranches annually provides more than \$2 billion to the Montana agricultural sector. These operations rely heavily upon the latest agricultural management factors that affect animal products. These include; forages, supplement consumption, supplement delivery method, feeding strategies that improve forage intake and utilization by beef cows. This also includes management techniques surrounding the impacts of stress factors on performance, health and well-being of livestock.

What has been done

Interactions between level of supplement consumption, supplement delivery method, and forage intake and utilization by beef cows and calves as well as integration of feeding strategies to improve forage intake and utilization by beef cows have all been implemented. Metabolic rates of mature cows were subjected to a step-wise reduction and then increased in feeding levels with metabolic rates of mature cows fed ad-libitum. Additionally, the reproductive performance of domestic ruminants were examined, primarily in sheep.

Results

There are myriad faculty research projects that surround management factors that affect animal products; most of the research is concentrated in pre-harvest settings, as the health of neonatal

animals is the most significant contributor to the economic performance of livestock operations. Pre-harvest livestock operating systems drastically reduce profit through costs associated with treatment, animal losses, reduced weaning weights and long-term effects on animal performance and product quality. All research accomplishments are continually published in peer-reviewed journals, state groups and meetings alongside industry professionals, producers and regional scientists from peer institutions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
121	Management of Range Resources
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
304	Animal Genome
305	Animal Physiological Processes
306	Environmental Stress in Animals
307	Animal Management Systems
311	Animal Diseases

Outcome #3

1. Outcome Measures

Disseminate research program results to producers regarding invasive weed management and impact on livestock

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Montana beef producers need to have contemporary research results regarding invasive weed management and the subsequent impacts on livestock. Low input grazing practices, without adversely affecting production, will minimize impact on soil and water resources, and enhance

economic viability. Ultimate goals of this research include finding a economic and environmental balance between livestock production and invasive species, a very difficult task in agricultural production, but one that MSU COA/MAES continually makes scientific advancements in.

What has been done

Metabolic rates of nine cattle (each of varying weights) were measured using a portable metabolic chamber in 2013. In 2014, preliminary trails were conducted with mature cattle and will again continue into 2015. At the mid-point of four seasons, researchers will complete preliminary trials and measured against measurements of cattle grazing on invasive weeds. Additionally, another research project is centered on the integration of domestic livestock into cropping systems. Instead of using traditional tilling machinery, domestic sheep are used to terminate cover crops and various weeds.

Results

Preliminary results of the livestock integration study are showing both economic and environmental benefits to the integrated system, when the sheep are sold for processing and cover crops are terminated without the cost of producers paying for tilling machinery. Many other projects have shared applied research results in forage-based livestock production systems obtaining maximum animal performance while effectively utilizing the forage resource base, which can increase economic return. Results of myriad research projects surrounding invasive weed management (7 hatch-specific funded projects) are disseminated widely and greatly across the northern Rockies region and include; producer meetings, Extension specialist materials, popular press, IPM meetings and trainings, scientific conferences and

4. Associated Knowledge Areas

KA Code	Knowledge Area
121	Management of Range Resources
302	Nutrient Utilization in Animals
307	Animal Management Systems
308	Improved Animal Products (Before Harvest)
315	Animal Welfare/Well-Being and Protection
702	Requirements and Function of Nutrients and Other Food Components
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources

Outcome #4

1. Outcome Measures

Find genetic correlations of factors influencing residual feed intake and feed efficiency

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Montana has long had the notion to retain the highly sought after genetically superior cattle being produced, but have faced the difficulties of transportation costs associated with heavier animals without the low cost of grains. Co-products and new crop development may decrease production input costs to allow more short-term retention of the superior genetic beef cattle produced in Montana.

What has been done

Research began to investigate long term effects and interactions between crossbreeding, maternal efficiency and residual feed intake on mixed grass prairie as all heifers within the cattle herd are being developed in a GrowSafe facility recently installed at MAES' Northern Agricultural Research Station in Havre, Mont. Since the project began, approx. 276 animals have been evaluated and this data will be used for evaluating long term maternal productivity.

Results

The objective of this project is to evaluate the opportunities to increase the value of beef cattle within the state of Montana. Development of new crops within the state, with the potential to produce co-products must only be evaluated on agronomic level, but must be investigated to determine the value to Montana beef production as an alternative feed source. Increasing value of beef cattle is leading projects to graze cover crops to evaluate alternative economic streams of harvesting forage with cattle to increase gain on cattle and improve soil health.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
304	Animal Genome
308	Improved Animal Products (Before Harvest)
315	Animal Welfare/Well-Being and Protection
702	Requirements and Function of Nutrients and Other Food Components

711

Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

MSU COA and MAES experienced significant faculty movement impacting this planned program. Previous projects highlighted in the 2014 Plan of Work included extensive research into brucellosis and prion diseases. The principal investigators in these projects were recruited to larger institutions with significant salary increases, and these projects were terminated. Additionally, there is some confusion between program reporting requirements between Animal health and food safety program areas, as they share a large majority of research priorities and projects. Because these two program areas are cross-disciplinary in nature, COA/MAES has elected to define food safety in solely post-harvest product terms, as outlined new a planned program in the 2016-2020 POW, to be considered within Animal Health. Any pre-harvest animal health research will be considered and reported within Animal Health; which may include previous and current Hatch project work that was originally reported under Food Safety. Additionally, COA had a joining of academic departments this year in the newly named Department of Microbiology and Immunology, where much of the COA/MAES animal health research (within the bounds of pre-harvest, neonatal animal health in a "traditional" sense) is being conducted.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Montana has 2.5 times more cattle than people providing the foundation for the number one industry in the State - agriculture. It is in this context that researchers design, implement, and conduct research projects within the COA/MAES. Research in the Animal Health Program is critical to the industry in Montana and producers and consumers alike who count on the investigators to promote a healthy industry through their consistent research. Highlights for 2013 were:

- Advancements in knowledge of Staphylococcus Aureus in humans and livestock

- Hired new faculty members, two of which are core users of new molecular tools
- Evaluated 256 animals through the GrowSafe system and added new equipment to MSU research center doubling the capacity of researchers to evaluate residual feed intake
- Conducted webinars, workshops, and seminars to share up-to-date information on animal health and quality assurance reaching audiences in excess of 1,500

Key Items of Evaluation

The Animal Bioscience Building combined with state-of-the-art laboratory equipment assisted in the successful recruitment and hiring of three new faculty members in the Animal and Range Sciences Department for the College of Agriculture. The new faculty include a beef geneticist, a range ecologist, and a rumen microbiologist. The College also purchased an Illumina MiSeq and is using it to help members of the Crow Indian Reservation identify sources of antibacterial resistant E. Coli. MSU COA is now a fully functioning partner in the WIMU - Washington, Idaho, Montana, Utah Regional Program in Veterinary Medicine. This regional veterinary program continues to privilege a "one-health" thematic approach alongside parallel coursework with first-year medical students on the MSU campus as well.

Additional advancements included:

- Research reporting high variation of intake of self-fed protein and/or energy supplements by individual animals.
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- Measured were identified regarding animal-stress and well being, as well as characterized factors affecting the biology of stress and immune responses of farm animals.
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- Development of management strategies and/or tools to enhance farm animal well-being under conditions of climatic change and other stressful environments.
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- Two years of field work were completed in incorporating sheep into farming systems. A news article and six minute video on the project's success and early findings were disseminated to a national audience.
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- Circling disease advancement: prs2A-htrA-L monocytogenes strain is highly immunogenic and provides robust protective immunity against subsequent lethal L. monocytogenes challenge through the induction of strong Listeria-specific CD8 + CD4 + T cell responses.
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- The understanding of the bovine immune systems and how it similar and dissimilar to the immune system in rodents and humans has made great strides in 2014. The information should facilitate development of new approaches to treat infectious diseases of cattle.

- - Long-term research to determine the physiological mechanism(s) and pheromonal pathways by which the biostimulatory effect of bulls, 1.) enhances the fertility of heifers and cows and, 2.) accelerates the reproductive neuroendocrine-endocrine cascade that culminates in resumption of ovulatory cycles in postpartum, anovulatory, suckled cows.
- - Developed a new model for microbial host-virus interactions which took into account the new host CRISPER anti-viral defense system, the discovery of four new viruses to science and solving the high resolution structure of an archaeal virus ATPase packaging motor.
- - Generated 13 *S. equi* mutants that each had one of the 13 target genes inactivated and cloned one virulence gene for preparation of recombinant protein.
- - The genes encoding 7 antigenic cell wall-linked proteins of *Streptococcus equi* were separately knocked out, and each of the 7 *S. equi* mutant was compared with parent *S. equi* strain in virulence using a mouse model of intranasal infection.
- - Established a program of investigation focused on understanding the role of innate immune parameters in bovine host defense.
- - Determined if growth patterns influenced by genetics or temperament impact carcass characteristics and tenderness of beef.
- - Uncovered a system of coordination between metabolic systems, wherein TrxR1 serves as a key component to coordinate activities between the redox-bioenergetics and drug/xenobiotic-metabolism systems.
 - 26 horses were investigated, three separate times, for the presence of *S. aureus*. Studies indicated that *S. aureus* is not the common inhabitant of equine nasal passages and demonstrated that other staphylococcal species are common inhabitants. Potential antibiotic resistance was also investigated.
- - Initial invitro studies were done on the effects of AcaiPS on bovine immune cells.
- - Altered lung environments were found to respond to subsequent infection more quickly and intensely, resulting in accelerated clearance of viruses.