External Review Team Report
Animal and Range Sciences Department
Montana State University
October 9-10, 2013

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The review team spent two days in an external review of the Department of Animal and Range Sciences at Montana State University. We were asked 9 questions by the Provost to consider as we did our review. Our report is organized to give our impressions of those questions. We were provided a department self-assessment approximately a month before the visit. Our visitation agenda included visits with Interim Department Head Pat Hatfield, Associate Provost Ron Larsen, Interim Dean Glen Duff, Assistant Dean Nora Smith, presentations on the department by various faculty, comments from departmental stakeholders, lunch with undergraduate and graduate students, a tour of facilities, meeting with range faculty, meeting with animal science faculty, and exit comments with the faculty, staff, and students, the Dean, and the Vice-Provost.

The review team wishes to thank all involved for providing us this opportunity. As with most review teams, the benefit to us is to see how another department operates. Faculty, staff, students, and administrators were all helpful in providing us the information we sought in the time we had and answering our many questions. It is always difficult to get a complete picture of the department as an external review team and this was no different. Our comments below reflect our collective view of the department based on material provided and talking with many people while we were on campus. Our intention is to give the department our view of their operations as outsiders and make some suggestions on where we believe improvements could be made. It is not our intention to think we have all the answers or know everything. Hence, our comments are just our observations without all of the intricacies and background that occurs within a department over the years. We hope the department will take these comments in that light and that they prove useful in helping chart a successful future.

Our charge was to address 9 questions provided by the university. While our report does not follow the suggested organization, we address all of the points. Our written report will seek to address each question as posed with the final question concluding with some overall thoughts and suggestions.

1. The strengths of the department. Please list any specific commendations.

The department has a great strength in undergraduate teaching. This was evident in several of the meetings we had. We did not have the opportunity to evaluate the quality of teaching, but students were uniformly pleased with the teaching in the degree programs. In addition to the classroom teaching, the students were very appreciative of the access they had to faculty.

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Student clubs and departmental support for clubs seem appropriate and important for this department.

The rangeland degree program is particularly strong given a limited faculty. Student numbers have been increasing with the addition of the wildlife habitat option. Whether this increase will continue remains to be seen, but it certainly has potential. In a similar vein, the addition of the equine option to the Animal Science degree has resulted in similar enrollment increases. The question of department enrollment goals, (how big should they get, how big is too big) was a topic brought up by several and will be discussed in more detail later in this report. However, a managed strategy that is well designed to deliver quality programming should remain a key priority.

The department appears to have a lot of positive momentum. Their new building, modern laboratories, and lab equipment all appear to be first class. The recent hiring of 3 faculty members and the upcoming hiring of 4 more positions should position them well for growth and enhanced productivity. These demonstrated investments in the department by the University and department stakeholders, can be effective recruiting tools for continuing to grow and strengthen the impact and contributions this department can make in all missions of Teaching, Research and Extension. Developing and implementing a sound strategic plan to continue the momentum is recommended.

The department has great opportunities to collaborate with the scientists at the USDA - Agricultural Research Service Fort Keogh Livestock and Range Research Laboratory. Their facilities and personnel expand research opportunities and have proven valuable to all. We encourage the department to look for ways to enhance existing collaborations and seek new opportunities for collaborative work.

The department appears to be well thought of throughout the state by its stakeholders. The support shown by participating stakeholders in taking the time to show up, visit with us and dedicate much of the day to the review process was impressive. Some of them were on the department's advisory board and appeared very appreciative that the department seems to listen to them and act upon their advice. The connection that the faculty has with their stakeholders is a major asset and strength. The stakeholders were especially appreciative of the department head and faculty being visible in the state and engaging with them locally.

2. Overall observations and determinations regarding the quality and the rigor of the academic programs.

As mentioned, we did not have the opportunity to review individual courses or instructors and cannot comment on the rigor of the programs. Hence, we rely on indicators to provide our thoughts.

First and foremost, both undergraduate and graduate students seem happy with the curriculum and the instructors. There were a few issues that the department should consider. The Animal Science undergraduate students seem to want more rigor and direction related to their required

internship. This could be through more help finding an appropriate internship or helping them understand the role of the internship in their education. We believe the faculty should decide what role the internship requirement plays in the curriculum – is it just a summer job in the field or is it an integral part of the learning process within the curriculum where the instructor and employer share the teaching responsibility?

Undergraduate students seem to appreciate having faculty advisors. While faculty generally seemed to like the opportunity to interact with students during advising, the sheer numbers of advisees also takes away from their other duties. This is another issue that the department needs to consider as enrollment grows and must realistically evaluate the impact on research and overall departmental productivity when increasing faculty time is spent advising and mentoring students formally and informally.

The faculty expressed concern with the preparedness of incoming students; however, this mirrors similar concerns throughout institutions across the U.S. Increasingly students are seen as not being ready for university-level studies due to lack of preparation in science, math, written and oral communications, and reading. As universities, especially land-grant universities, lower their standards to allow access, pressure on programs increases and non-retention becomes an issue. On the other hand, those that thrive after arriving at the university seem to be well prepared for employment following graduation. We received conflicting data on this. We recommend that the college and/or department make a concerted effort to collect this rather elusive data and share it openly.

There are two concerns we see. First, it does not appear that pre-requisites are enforced uniformly at MSU and certainly not within the department. The fact that pre-requisites are only suggestions at the whim of the instructor is concerning and an indicator of the lack of rigor. The department needs to take a hard look at pre-requisites and decide if they are really that. If they are not necessary for a student to pass a course, one of two things is happening. It was not necessary to have that background in the first place or if it was necessary the instructor is now spending time teaching what should have been learned before the student got to that class. In the former case, we believe either the pre-requisite should be dropped or the course content changed to take advantage of that pre-requisite. If the latter is true, this is diminishing both the rigor and the content in a particular class. If this is happening, we believe that the pre-requisites should be enforced and the course content adjusted to reflect that.

The second concern is with the recently created PhD program. We are concerned over the quality of the program given the lack of departmental graduate courses and resources. While students may have the opportunity to fill their program of study with courses outside the department, this is less than ideal. The department is also hiring new faculty and this may allow for additional courses aimed at PhD students if they are directed to do so. The main point here is that the department offers very few courses aimed at PhD students, or even MS students, and while most students will take some courses from other departments, in this case those would appear to be the bulk of a program. While coursework is only one part of a graduate education, it is an important part. Future employers will assume that the student has a good academic base in the field. There are opportunities to create partnerships with other programs across the country as well as other potential solutions. We believe that students who have received BS and/or MS degrees in the

department should NOT be accepted into the department's PhD program. Besides just the philosophy that students should be exposed to other universities, the lack of coursework available to these students is particularly concerning.

3. The effectiveness of the department's Assessment Plan and assessment activities, including program learning outcomes (in the Assessment Plan) and course learning outcomes (in course syllabi).

The review team was not provided with a department Assessment Plan or course syllabi. In discussions with faculty, they are only doing assessment to the extent that they are told to do so. Our view is that the department as a whole is making a poor effort for a variety of reasons.

First and foremost, the department does not appear to have bought into the idea that assessment can enhance their curriculum and the product they are providing to their clients. For a department that contains rangeland ecology where monitoring and assessment is a critical component of the profession, this is concerning. Some members of the faculty expressed willingness to perform an assessment of the department's curriculum; however, they stressed the necessary guidance and direction was not provided from the college/university as to what the plan was to contain and/or address.

Our recommendation is that if the university is serious about assessment that resources be made available to assist faculty in doing this. Merely providing documents and checklists is not enough. Training and guidance is critical in this. Matching up the department with another department that is successfully doing assessment may be an option as is assigning a university or college level assessment coordinator. This person should ensure that the departmental assessment plan is consistent with the university's expectations and that departmental faculty see the benefits of assessment rather than being overwhelmed.

4. Status of each program curriculum in terms of breadth and currency with the discipline. That is, is each curriculum still relevant and has the curriculum kept pace with changes in the discipline?

Overall the curricula seem to be appropriate in terms of breadth and currency. There are some troubling aspects.

The department should conduct a curriculum mapping exercise that focuses on the defined student learning outcomes. Obviously this should be done as they are being introduced to assessment planning.

We have detected that there is quite a bit of territorialism in individual courses. While the general concept of curricular review is seen as good, we came away with the perception that some faculty feel it is only good if it does not affect what "I" teach in "my course". This is not a question of academic freedom, but rather providing a coherent and compelling curriculum to students.

As indicated earlier, there is concern with the lack of breadth and depth in the graduate curriculum. Stringing together classes from other departments and only a few within the department makes us wonder why the student would not just get a degree from the other department. In addition, with very few graduate courses offered in the department, the only way to differentiate a graduate program of study is by these external courses. Nevertheless, the department and university need to decide if they can afford to maintain quality graduate education and if so, to commit to the investment of sufficient the resources to do so. The investments made and planned in research focused faculty are an important step in the right direction. Alternate year courses and partnering with other institutions in their fields may be one way to stretch limited resources. On the other hand, the faculty should consider if there is a core set of classes within each discipline that every graduate student should have in their first year (a curricular order of things). Integrating and discovering how coursework taken outside the department fits within the disciplines will be very important to the overall understanding of the student. Considering what kinds of positions the PhD graduates are likely to pursue may help define technical disciplinary expertise they need to acquire in their program of study. We recognize that coursework is just one part of a graduate education, but it is still an important component.

5. Overall level of faculty productivity as it relates to the stated missions of the department and university.

The department appears to be doing an excellent job in undergraduate education. The faculty members appear committed to undergraduate education and the students recognize this commitment. Teaching and advising loads need to be monitored and department, college and university expectations for teaching productivity need to be clearly understood by all faculty. If in fact senior faculty are to pick up more of the teaching load that needs to understood and recognized by all faculty and the metrics need to support that outcome. At present, current appointment FTE's are not consistent with this message.

Research productivity was difficult to assess as conflicting data were provided and presented in different ways. In addition to the self-study and department presentations, data on research productivity metrics were provided by the Provost's office. Detail on grant activity was insufficient to understand how the department was preparing to transition from well supported programs receiving special grant funding to more reliance on competitive grant funding in the future. Active grant awards and contract presented in our materials (Table 7) did not include amounts or identify all of the research team members. Supplemental materials provided by the department stated that $8M had been awarded since 2008 but it was unclear if that was the department or Animal Science faculty share or total award amounts. The department's "share" of grants is important in assessing such areas as project leadership, co-investigator roles, and collaborator roles, especially with large multidisciplinary, multi-institution grants. Research Scientists, non-tenure track and 3 new faculty are credited with $2.2M and 2.0M, respectively of the $8M total. Therefore it was difficult to evaluate and identify the research programs that are competitive and have positioned themselves for future success. The precipitous decline in

research expenditures since 2006 (Figure page 38) should be of concern and identifying a plan to recover should be a high priority. Depending on which data are used, and how it is defined, productivity may be acceptable, but should be carefully monitored. For example, metrics such as self-reported peer-reviewed journal articles per research FTE seem to be appropriate, but differs from the self-study and data from the Provost's office. The department appears to be low on grant awards and research expenditures per research FTE. There is considerable variation among faculty. Some of this was explained to us as administrative directives to refocus research efforts towards teaching. It is concerning when an external review committee is told that senior faculty have been directed to teach and leave research and grant writing to junior faculty. Whether that was the message intended, it is the message that appears to have been received. Clearly, if the university wants to be known for research productivity, however defined, resources should be appropriately directed and expectations known and made clear to all faculty. Senior faculty should be mentoring junior faculty and leading grant writing and research activities. This scenario was essentially absent from discussions with both senior and junior faculty and we found it further concerning that there was little excitement and enthusiasm for individual faculty research programs with the exception of the new faculty. Certainly there is great benefit in having senior faculty in the classroom, but not at the expense of the other department and university objectives. Several senior faculty have excellent research histories and we would encourage them to reinvigorate them and use their expertise in the mentoring of the next generation.

Adequacy of departmental Extension faculty FTE seems to be marginal in its ability to address stakeholder needs across the state, primarily due to the size and scope of the state. We were not given enough material to critically evaluate Extension productivity. We believe the Extension faculty and the department and college need to consider how to better document productivity and impact. Stakeholders and legislators, at a minimum, need to be provided with this information in a timely manner. The connection between researchers and extension needs to be enhanced. This is no different than any other university, but if extension is to provide programs on the current state-of-science and update stakeholders on the departmental research programs, they need a good connection to the research faculty as well as research conducted elsewhere. The review team received little and for some species no information on programming that indicated departmental research activities/accomplishments were being disseminated to the field. There also seems to be opportunities for specialists to connect better with county extension faculty.

The addition of a beef cattle extension specialist stationed in Miles City will be of great benefit to both that program and to the producers and other stakeholders on that side of the state. A similar position in rangeland management extension should also be seriously considered in the future.

The stakeholders recognized, and appreciated, all of the extension and outreach conducted by the department. They do not know what faculty appointments are, nor do they likely care. They only see the faculty out in the state helping them with their issues. Whomever the department has as its Head, that person must continue to make a concerted effort to interact with stakeholders, agencies, and organizations throughout the state. While that creates a significant load on the Head, it creates much goodwill.

Departmental seminars either are or are not poorly attended. We received different reports. In any case, attendance and participation by all faculty and graduate students should become part of the culture of the department. The time and day of the seminar should be given careful consideration to conflict with as few of the classes as possible. While excuses as to why people don't attend are numerous, the department as a whole needs to buy into this. Leadership by senior faculty in creating this culture should be expected by department administration.

6. Alignment of each of the department's academic programs with the Core Themes and strategic priorities of the institution.

While we did not receive material specifically addressing MSU Core Themes, a quick perusal of that online document indicates that the department is addressing objectives within each of the 5 Core Themes. All of their programs fit within the university strategic priorities as far as we can tell.

7. Diversity of the department's faculty and student body.

We did not receive specific information related to diversity. It is our observation that the department is doing well in attracting international graduate students and appears to have good gender diversity as well. The faculty in animal science appear to be fairly gender-diverse while the range faculty less so. There is no evidence of any kind of ethnic or racial diversity among the faculty. Those should be considerations as they seek new hires.

We have no basis for looking at the student body of the department other than those that showed up to an informal luncheon. Similar comments on gender would hold for undergraduates based on casual observation with a small sample.

8. Overall assessment of the quality of graduates produced by the programs in the department.

The undergraduate students entering the workforce appear employable. Stakeholders appear pleased with the quality of students though there were some recommendations made. Comments in other parts of this document may also be relevant here, especially related to the quality of students coming into the program.

Anecdotally, the members of the visitation team do not observe large numbers of students applying to graduate school at our institutions. This is obviously a very biased observation, but it may be an indicator. Perhaps most undergraduates find employment, are not encouraged to attend graduate school, or programs do not match with student interests as reasons we do not see them in our graduate school application pools.

Again, we received mixed messages on the percentage of graduates that find employment after graduation. This may be one of the best indicators, whether employers in the fields are hiring

your graduates. If as implied by some, the department's graduates are employed at a 90% success rate at two years out, that can and should be used as an important recruiting and marketing tool. Current students should also be provided employment data of alums as they are requesting more information on what they can do with their degrees upon graduation.

9. Any weaknesses or unrealized opportunities, with specific recommendations for action.

The department must create a climate and enthusiasm for research among its entire faculty. This includes the complete research cycle – getting grants, funding graduate students, and publishing the results in appropriate peer-reviewed and refereed outlets. Opportunities for undergraduate research should be pursued. If the message that senior faculty should not be involved in research has been given, this should be addressed as appropriate for MSU and the department. Whether that was the intent of the former Provost, it was the message received and relayed to us. Your senior faculty should be leading the way and showing junior faculty how it is done but that cannot be successful if the senior faculty are not legitimately engaged in robust and successful research programs of their own.

Junior faculty must be mentored appropriately and provided with a clear vision of what success looks like on the path to promotion and tenure at MSU. It was not clear that these discussions had taken place with the current new faculty. Setting expectations for the mentoring program is just as important as setting up the process. This is a time consuming task for senior faculty, but the department head and professors must take it seriously and all should be presenting a united and consistent set of expectations. Mentoring from senior faculty outside the department may be desirable in some cases especially in cases with high research appointments in areas that are expanding the existing research portfolio of the department. Mentoring should include, but not limited to, how to navigate the promotion and tenure landscape within MSU, how to be effective in teaching, research, and extension, how to advise undergraduate and graduate students, how to be collegial within a university setting and how to prioritize time, tasks and expectations.

This department has appeared to operate their research enterprise on directed funding from state and federal sources through around 2006. It appears as those sources dried up, the faculty grants have slowly declined to their 2000 level (see earlier comment in question 5). This is somewhat troubling and may indicate some issues with obtaining new grants. The list of active grants appears to indicate that some faculty are engaged in this activity, but it is unclear whether these are mostly research or extension grants and contracts. Faculty need to be sent a clear message as to what is expected of them in terms of funding of their research programs. If external funding is an expectation, what are the consequences for not seeking it and does that expectation apply to all programs. Clarity of external funding expectations for Extension programming is needed as well. If sufficient internal funds are available to support some research and extension programming without competitive grant acquisitions, those areas should be identified and known to all.

There is a weakness in administration due to the high rates of turnover from department head on up the MSU administrative ladder. Mixed messages, changes in priorities, and different funding

models can be confusing to all involved. There is no real solution to this other than finding stable and consistent and strong leadership at MSU and in the department.

Along those lines, however, we did receive mixed messages related to priorities within the department in terms of research productivity, infrastructure, and facilities. The administrative and fiscal responsibility of animal research facilities was moved from the department to the Agricultural Experiment Station and has generally been viewed as a positive, care should be exercised to ensure that the core research from this department is enhanced. The perception is that more resources are now available for the maintenance and upkeep of these facilities thereby enhancing research opportunities and outputs. However, in our discussions with both students and faculty there was serious concern expressed as to the worker safety of working facilities and equipment at the BART farm. We were not able to effectively tour the facilities at BART; therefore, we cannot address those concerns directly but this is a potentially troubling issue and must be addressed by departmental and college administration. Safety concerns should be addressed immediately. Even if BART is managed by MAES, this department is likely the largest user and should be concerned about safety. Some of the outlying operations appear to have untapped research potential and the receptivity for research at these units was unclear. Impediments to support for valuable research and Extension programming efforts at these units need to be addressed if in fact they exist.

To address some of the items above, it is our recommendation that this department schedule a formal retreat with an outside facilitator and defined objectives. A good facilitator will be able to help set up a productive agenda and lead the department to desired outcomes and direction. We detected an attitude of "not enough time" for things people just did not want to do rather than a "can do" attitude for things of benefit to the department as a whole. A retreat to build on the positives and formulate a plan to get to where the department wants to be in 5 and 10 years seems like a timely and valuable endeavor. Use this to get all faculty on the same page, to get an interim head in an informed position of leadership for his department, to take advantage of a supportive interim dean and use it to advance an aggressive plan deserving of continuing and additional investment of resources from university administration.

The department has a great opportunity to improve internal communications. Letting all staff know what is going on will help them communicate with faculty, students, and the public. They are the front line of communications and as with faculty, the public does not know or care what their assigned job duties are. They just know that when they call or drop in, they expect answers to their questions.

While the department has increased its undergraduate numbers, this can be both an asset and a detriment depending upon how the department and university respond. Many of the departmental classes require labs and field trips. As classes get larger, lab sections and motor vehicles become increasingly limited. Without more faculty and teaching assistants to cover these, the quality of teaching may decline. Stories of lab sections being cancelled because sufficient transportation cannot be obtained or having students drive their own vehicles does not lead to a quality teaching environment. In the latter case, there would seem to be some liability issues involved. The university needs to address this issue taking into account the unique requirements of degree programs such as found in this department. If the department plans to continue to grow the size

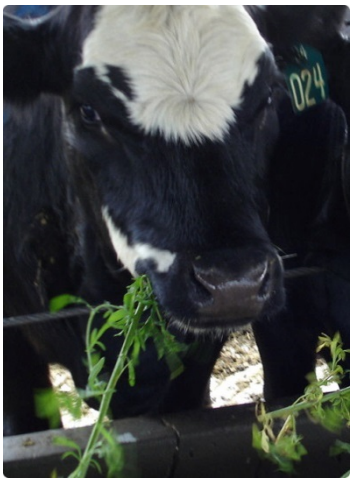
of the undergraduate program, it should do so only after sufficient resources are secured to maintain program quality at a defined level. An outstanding teaching program is benefited by a productive research component in the department as well and care should be taken that research and extension resources are not subsidizing the teaching efforts at their expense.

The department appears to be significantly understaffed in terms of laboratory assistants/research technicians. This is not unique across the country given declining budgets and increasing demands, but it does make the research and teaching enterprises more difficult. It does not make sense for faculty to be spending their time "cleaning toilets" when they are hired to be enhancing the academic enterprise. This will require the university, college, and department to find creative solutions with resources to support lower level operations that are essential for program delivery.

Graduate students seem confused about graduate education policies and finances both in the department and at the university. Students were generally confused over what they were being paid, how tuition works, and general expectations. Development of a departmental graduate student handbook is suggested and would seem to be an easy solution that clearly explains the policies and procedures that must be followed and expectations of graduate study in the department.

The Department and especially the faculty involved in the Natural Resources and Rangeland Ecology undergraduate degree should consider having their Rangeland Ecology and Management option accredited by the Society for Range Management. This process ensures that the curriculum meets current standards of the profession. This process will also force the faculty to undertake the assessment and monitoring piece described earlier. The department is also encouraged to maintain or even improve their participation on the Range Science Education Council where profession-wide discussions and training takes place.

Lastly, and perhaps most importantly, the department needs to take advantage of its uniqueness in terms of being a combined animal and range sciences department. There is an opportunity to make it a national powerhouse in that area. That will only happen if all of the faculty and staff are on board, if they have the support from the college and university to do so, and can find the budgetary support to make it happen. While it is commendable that the department was able to garner such private support to build their building, garnering commensurate support to enhance programs, encompassing the teaching, research and Extension missions, and scholarships will be even more important as they move into the future.



Montana State University

Department of Animal and Range Sciences

Self Study

Summer 2013

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INTRODUCTION

The Animal and Range Science Department (A&RS) is housed within the College of Agriculture (COA) at Montana State University (MSU). The Department provides science-based research and creative activity, instruction (on-campus and off-campus), and service to a broad range of clientele. The mission of the Department of Animal and Range Sciences is to create, evaluate and communicate science–based knowledge to enhance the management of Montana's livestock and rangeland resources in ways that are economically, socially and ecologically sustainable. To accomplish this mission, the Department brings together animal science disciplines of reproduction, nutrition, genetics, microbiology, meat science and entomology; range science disciplines of plant, rangeland, riparian and wildlife ecology. Both animal and range science disciplines focus on sustainable livestock production on rangelands. The livestock species foci include cattle, sheep and horses. The Department fosters collaborations with other programs at MSU and in the COA, allied industries, institutions, governmental agencies, and private ranches and foundations. All of these interactions allow the information that is generated to be synthesized into comprehensive scientific-based knowledge that is disseminated through formal courses on-campus, off-campus teaching activities (Extension), and scientific publications. In particular, the Department's teaching, research and Extension activities have practical application to the state's livestock producers and land managers.

The A&RS Department's on-campus instruction offers undergraduate programs of study that prepare students for a complex and rapidly changing world by providing both a scholastic foundation in basic sciences, as well as real-world opportunities to apply knowledge to complex interactions of science and management. Undergraduate instruction integrates traditional and innovative academic experiences with applied 'hands-on' applications. Graduate programs provide exceptional and unique opportunities for advanced academic training and focused independent study through departmental research programs. Off-campus A&RS instructional programs (Extension) provide research-based information to agriculture producers, land resource managers, Extension Agents, government agencies, and other clientele.

The purpose of the A&RS research programs is to generate new knowledge centered around management of the grazing animal and the natural resources of the region. We provide research results that are useful in their applications to problems and choices facing the agriculture community, natural resource managers and scientific community. We disseminate information via scientific scholarly activities, individual consultation, Extension programs and media presentations. Salary (faculty and staff) and benefits, operations and graduate research assistant (GRA) support and broad program directions are provided by the Montana Agriculture Experiment Station (MAES) which is funded by through state and federal sources. In addition, grants and contracts are solicited to support research activities. Research activities are conducted in laboratories (on-campus and off-campus research centers) and on private, state and federal lands. Faculty, undergraduate and graduate students cooperate with MAES agriculture research centers located across that state.

All A&RS faculty participate in outreach and service activities to the general public, agriculture and natural resource clientele, federal, state and local agencies, and professional organizations. Professional service activities include participation in departmental, college, university and professional society committees.

Overview of Montana

According to the U.S. Census bureau, the estimated population in Montana is 1,005,141. The population density, measured in people per square mile, is estimated at 6.8, making Montana one of the least urban states in the United States. Of the 93 million acres of land in Montana, approximately 65 million acres are public and private rangelands.

Population, 2012 estimate	**1,005,141**
Population, % change April 2010 to July 2012	1.6
Population, 2010	989,415
Persons under 5 years, % 2011	6.2
Persons under 18 years, % 2011	22.3
Persons 65 years and over, % 2011	15.2
Female persons, % 2011	49.8
White persons, % 2011	89.9
Black persons, % 2011	0.5
American Indian and Alaska Native persons, % 2011	6.4
Asian persons, % 2011	0.7
Native Hawaiian and Other Pacific Islander persons, % 2011	0.1
Persons reporting two or more races, % 2011	2.4
Persons of Hispanic or Latino Origin, % 2011	3.1
White persons, not Hispanic, % 2011	87.5
High school graduate or higher % of persons 25+ 2007-2011	91.4
Bachelor's degree or higher, % of persons 25+ 2007-2011	28.2
Per capita money income in the past 12 months (2011 $) 2007-2011	$24,640
Median household income 2007-2011	$45,324
Persons below poverty level, % 2007-2011	14.6

Source: http://quickfacts.census.gov/qfd/states/30000.html

Geography Quick Facts	
Land area in square miles, 2010	145,545
Persons per square mile	6.8

Land in Farms & Ranches: Utilization as a Percentage of Total	
Number of farms and ranches[1]	29,300
Average size of farm or ranch, acres	2,065
Real estate value/farm or ranch[3]	$1,400,580
Average value per acre[4]	$710
Total farm and ranch assets[2,3]	$48,200,000,000
Average values per farm or ranch[3]	$1,646,724
Farm and ranch debt per operation[3]	$169,106

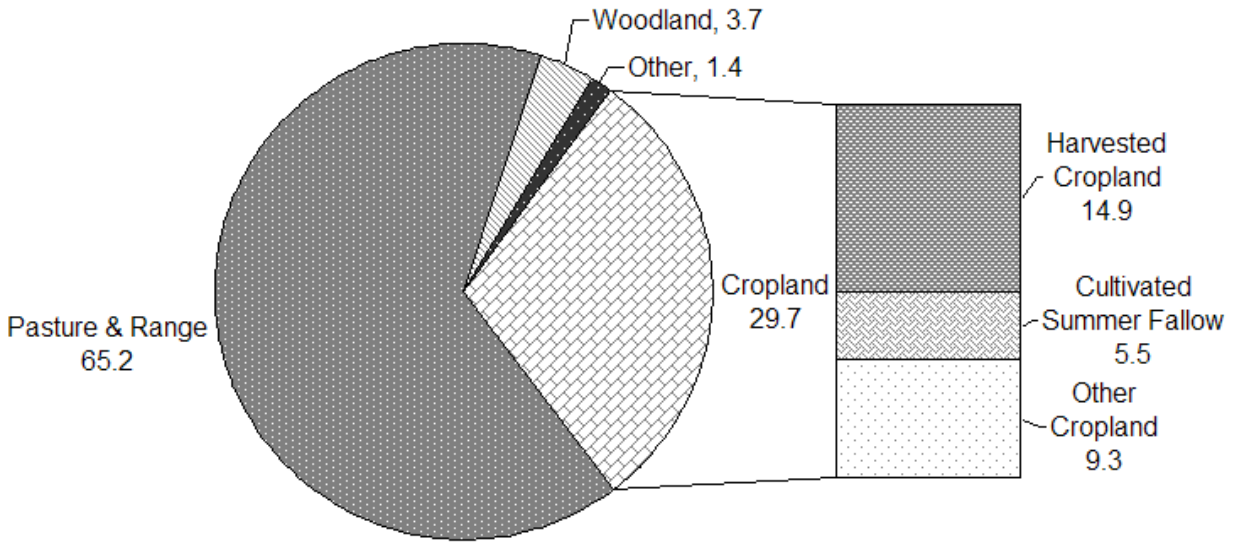
Source: 2007 Census of Agriculture; Montana 2012 Agriculture Statistics available at: http://www.nass.usda.gov/Statistics_by_State/Montana/Publications/Annual_Statistical_Bulletin/2012/2012_Bulletin.pdf.

[1]Places with annual sales of agriculture products of $1,000 or more.

[2]Excludes farm operators' household assets and debt.

[3]Source: Economic indicators of the Farm Sector, State Income and Balance Sheet Statistics, USDA-Economic Research Service are for 2011.

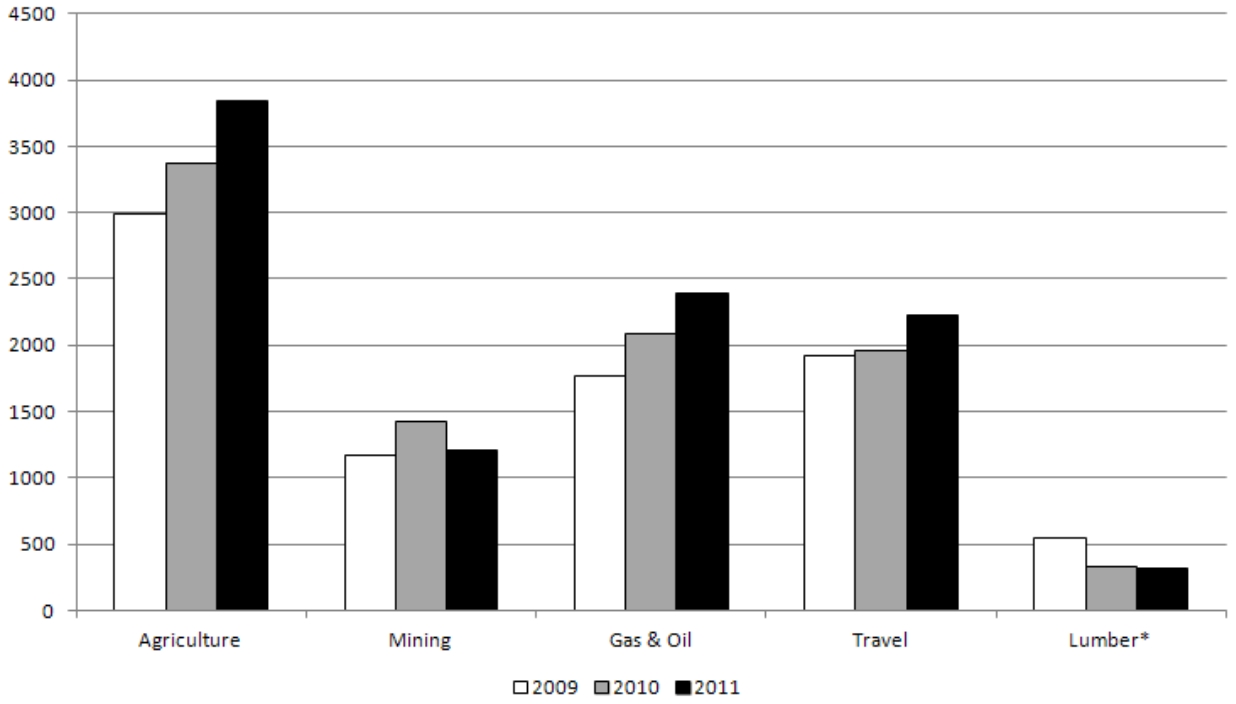
[4]Per acre, land and buildings, January 1, 2012.



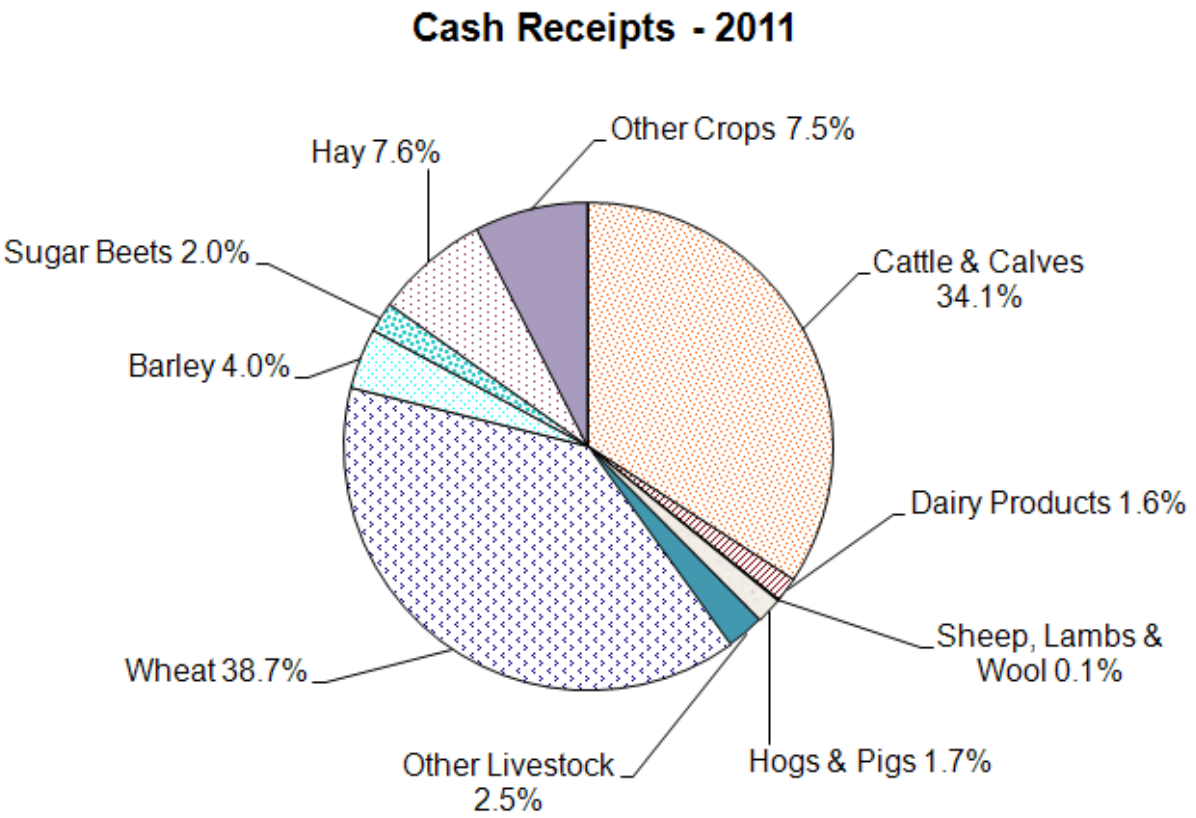
Agriculture Remains Montana's Number One Industry in 2011

Agriculture continues to outpace all other industry sectors, although most sectors saw increased activity. The 2011 value of crop production increased to $2.1 billion, an increase of $342.8 million or 19 percent above 2010. The value of livestock increased in 2011 to $1.4 billion, up $156.5 million from 2010. Net government payments decreased 9 percent in 2011 to $299 million, down $28.5 million from 2010.

When comparing major industrial sectors in Montana, receipts were mostly higher than a year ago. Agriculture showed a 14 percent increase, up $470.8 million from 2010. Mining showed a 15 percent decrease, down $219.3 million from the previous year. Gas & Oil showed an increase of 15 percent, up $304.9 million from 2010. Non-residential Travel showed an increase of 14 percent in 2011, up $274.6 million from 2010. Wood and Paper Products decreased 3 percent or $11 million below 2010.



(http://www.nass.usda.gov/Statistics_by_State/Ag_Overview/AgOverview_MT.pdf).



Montana's economy is highly dependent on livestock and associated industries. As of January 1, 2012, Montana's cattle and calf inventory was approximately 2,500,000 head with an estimated market value approximately $1.4 billion. In addition, Montana has approximately 225,000 head of sheep and lambs valued at approximately $21 million and equine sales at approximately $13 million (http://www.nass.usda.gov/Statistics_by_State/Ag_Overview/AgOverview_MT.pdf).

Animal and Range Sciences Department

The Animal and Range Sciences Department was established to serve those industries that matter most to the Montana. Range-livestock agriculture is arguably the most important factor shaping the history, economy, and culture of Montana. The Departmental history has origins almost as old as the University. Since its establishment in 1960 (with the merger of the departments of Dairy Science, Poultry Science, Animal Industry and Range Management), the Animal and Range Sciences Department has provided resources needed by livestock producers and land managers to be successful. The Department of Animal and Range Sciences continues to pride itself on providing resources to clientele in Montana through education, research, and outreach.

External evaluations were conducted in 1978, 1985, 1995 and 2000. Reports for the 1985, 1995 and 2000 are included in APPENDIX A. The 1978 report is included in a CD.

Highlights of the 1985 review include:

Some of the strengths of the department include excellent young scientist, land and animal resources, strong collaborative efforts in some areas, administrative support for research at all levels, research center out in the state, relatively stable budgets, acceptable M.S. program. Some weaknesses include poor self-image, some non-productive scientists, poor physical plant and laboratories, outdated laboratory equipment, wide variation in publication rate among scientists, and very few grants or contracts.

PROGRESS: The A&RS department again has some excellent young animal scientist. The department also has access to land and animals and strong administrative support, and relatively stable budgets. Highlights of this report suggested against establishment of a Ph.D. program. Our faculty continue to need to publish in refereed journals and obtain more grants and contracts.

Highlights of the 1995 review include:

General recommendations included to more fully integrate the three major program areas of Animal Science, Range Science and Reclamation Science (this option no longer exists within the department); develop a comprehensive strategic plan for the department that will be used to guide the department in future activities, development, and new hires; more aggressively seek external grant support; re-evaluate the seminar program for the department; give a high priority to seeking development foundation funds to support scholarships and other activities in the department; invite appropriate USDA-ARS faculty at Fort Keogh in Miles City, MT and the USDA-ARS sheep research station in Dubois, ID to officially become affiliate faculty members of the department.

Teaching:

- Streamline program offerings by reducing the number of options; consider treating Watershed Management and Abused Land Rehabilitation as options Range Science rather than two separate majors
- Continue evaluating courses for overlapping material and eliminate unnecessary duplication through revising, combining and/or eliminating courses
- Evaluate each major by considering what courses students need as opposed to what courses you currently teach
- Incorporate more Animal Science courses in the Range Science curriculum and more Range Science courses in the Animal Science curriculum
- Reduce the number of required courses
- Identify courses in which labs are necessary. Consider ways to improved labs in these courses and eliminate labs in courses where they are not essential
- Open the departmental computer facility during evening and weekend hours
- The departmental faculty should develop criteria and procedures for evaluating teaching performance within the department
- Consider offering a one to two week Meats field trip course for students in the Animal Science area

PROGRESS: Animal and Range Sciences offers two degrees, a Bachelor of Science in Animal Science with a Livestock Management and Industry Option, an Equine Science Option, a Science option, and a Bachelor of Science in Natural Resources and Rangeland Ecology with a Rangeland Ecology and Management Option and a Wildlife Habitat Ecology and Management Option. The department offers the Sustainable Livestock Production Option of the interdisciplinary degree Sustainable Food & Bioenergy Systems. With the new faculty hires, there has been some discussion on revaluating all courses for overlap.

Labs are an integral part of the 'hands-on" curriculum in Animal and Range Sciences. Over the years, the laboratory portion of the Introductory Animal Science course has been eliminated with a series of practicum courses specifically designed for our majors established at the sophomore level. With the new Animal Bioscience Building, computer facilities are open during evening and weekend hours for students that rrequire CatCard access to the facility. Teaching performance is evaluated with standard university evaluation forms. No other formal teaching performance indicator has been developed. No Meats field trip course has been created or offered; albeit a meats processing course has been created and offered.

- For Graduate Education the review team recommends **against** the establishment of a Ph.D. program within the Department of Animal and Range Sciences
- Every effort needs to be made to increase graduate student stipends
- Some flexibility should be provide in the Animal Science major by allowing students to make substitutions among the list of required courses or by reducing the number of required courses
- Establish some formal method to monitor the potential impact of teaching graduate courses on an every other year basis and the ability of students to complete their degrees in a timely fashion
- Guard against the potential problem of inbreeding among your graduate students by accepting too many students with undergraduate training from this department
- Efforts should be made to increase the total number of graduate students in the department
- Publish a departmental graduate student handbook.

PROGRESS: A Ph.D. program was developed during the early 2000's. Although low, graduate student stipends allow for living expenses and when tuition waivers are allocated, are somewhat competitive. There is flexibility in the graduate curriculum and it is at the discretion of the graduate student's committee. Graduate courses are taught on alternate year basis and there has been no problem with students finishing in a timely manner. The number of graduate students is increasing and there continues to be a large number that have received training from this department. The department still needs to publish a departmental graduate student handbook.

- Specific recommendations for the Range Research Program include establish a well-equipped laboratory facility to support Range Science research
- The range science faculty as a group should develop a comprehensive range research plan
- Develop stronger research relationships with Animal Science faculty
- Aggressively pursue extramural funding, especially from competitive grant programs
- Increase the number of peer reviewed manuscripts in high quality, nationally recognized journals.

PROGRESS: Range Science faculty have access to the laboratory facilities in the Animal Bioscience Building along with a Herbarium on the second floor. Faculty would benefit from a comprehensive research plan (along with Animal Science faculty) which should lead to increased competitive grant funding. There is a need to increase the publication of results in high quality refereed journals.

Specific research areas for Range Faculty include:

Marlow's Research:

Water quantity and quality were listed as declining ecological services from riparian areas in the 2005 United Nations Millennium Ecosystem Report. Follow-up information from later geospatial assessments of global riverine ecosystems indicates that freshwater systems already threatened by human activities stand to be further affected by anthropogenic climate change. The most likely loss of riparian ecological services in the mid-northern latitudes will be reduced late season stream flows. With more precipitation falling as rain rather than snow and limited reservoir infrastructure to hold earlier than normal run-off conflict between irrigators and municipalities over access to late season flows will escalate. Over the past 10 years I have been developing a data base about the interaction between stream flows and upland processes that can be used to develop land management strategies to mitigate the forecast effects of climate change. My earlier work has established that over-stocked Douglas fir and Ponderosa pine stands depress groundwater recharge to streams; ultimately reducing surface flow. However, before we move forward with an extensive education effort to thin unhealthy, overstocked forest stands we need to learn if associated woody plant communities dominated by species like Rocky Mountain Juniper and big sagebrush intercept and use groundwater released during treatment of Douglas fir and Ponderosa pine stands. Over the next 5 years I will be investigating the effect of big sagebrush on groundwater recharge patterns. Coupling this information with the tree research results will provide a positive action for mitigating the effects of global warming on riparian ecological services and ultimately water availability for Montana irrigators and cities.

Bret Olson

My past research has included: 1) comparing the invasive leafy spurge and spotted knapweed with native species, using physiological ecology and population biology approaches, 2) animal behavior and nutrition while grazing rangelands dominated by invasive species, and 3) ecological and social implications of grazing winter range with cattle as an alternative to feeding hay.

Following up on number 2 above, my current research is determining if: 1) individual high- and low spotted knapweed-consuming young cattle retain their grazing patterns from year to year, 2) peers influence diet selectivity while grazing spotted knapweed, 3) if yearling cattle trained to consume spotted knapweed and Canada thistle in 2004 retained their training and consumed more of the target weed than non-trained cattle in 2011, 4) calves and yearlings of the 2004 trained cattle consume more spotted knapweed and Canada thistle than those from untrained cows, and 5) yearlings trained to eat Canada thistle in mid-July consume more of the weed than untrained yearlings when grazed in late July and August.

Following up on number 3 above, my future research will quantify seasonal changes in heart rate, metabolic rate and cattle behavior, and determine to what extent cattle grazing native rangeland during winter alter their heart rate, metabolic rate and/or behavior compared with those fed hay.

Bok Sowell

For the past eight years I have been working on wildlife habitat issues in the state of Montana. We have examined sage-grouse nesting habitat, sagebrush-conifer habitats, and aspen regeneration in the Yellowstone area. My future research will investigate the relationship between sage-grouse and cattle grazing in the Centennial Valley of Montana (WSARE grant). I will also be working with Dr. Dan Tyers, US Forest Service, to study bear habitat use near Cooke City, MT and Island Park, ID.

Jeff Mosley

Jeff Mosley's research focuses on grazing management of livestock and wild ungulates and rangeland habitat management. His work emphasizes invasive plant management and livestock grazing interactions with fish and wildlife. Current research topics include targeted cattle grazing to enhance habitat of elk, mule deer, and pronghorns; targeted

livestock grazing to suppress spotted knapweed and sulfur cinquefoil; tree shearing, prescribed fire, and targeted goat browsing to suppress conifer encroachment into foothill rangeland; livestock protection dogs for predator control; and cattle grazing strategies in riparian ecosystems. New projects will investigate targeted cattle grazing to enhance sage grouse habitat, and physiological mechanisms that enable grazing ruminants to safely consume toxic/chemically defended plants.

- For Animal Science research the review panel recommended faculty members should increase their productivity by publishing their research results in appropriate journals
- Faculty should increase efforts in seeking extramural funding to support their research programs
- More collaboration between faculty among different disciplines and different species should be encouraged
- There should be increased collaboration between Animal Science faculty at MSU and research scientist at USDA Fort Keogh Livestock and Range Research Laboratory
- The College and Department are encouraged to develop a plan to reduce the department's dependence on sales income.

PROGRESS: Faculty should continue to try to increase publications in peer-reviewed refereed journals. With synergetic faculty relationships, extramural funding opportunities should increase. There has been collaboration among different disciplines and species. In addition, there has been collaboration with scientist at Fort Keogh and the Northern Agriculture Research Center in Havre. All farm receipts are directed through MAES. Operations of the Bozeman Agriculture Research and Teaching (BART) farm were removed from the A&RS and centralized in the Dean and Director's office.

- To enhance and strengthen the Extension Program, the review team recommended to proceed to hire the best available person to fill the range management Extension position
- Use every opportunity to increase visibility of the department's Extension programs
- Increase the use of radio and television as a means of efficiently reaching large numbers of people with timely information
- Expand cooperative programs with livestock organizations and allied industries
- Additional faculty are needed to balance Extension programming in the beef cattle area to this industry's importance to agriculture in the state and publish an annual research report.

PROGRESS: The Extension Program hired a Range Management Specialist after the 1995 review. All Extension faculty have worked at increasing visibility of the department's Extension programs. Extension faculty routinely participate in the Montana Ag Live PBS program and with new technology are available through social media. In addition, Extension faculty have increased presence with livestock organizations (along with federal agencies) and allied industries. No annual research report has been generated although a quarterly newsletter has been made available.

Highlights and/or recommendations from the 2000 review include:

- Maintain animal and range science together as a single department

- Engage strategic planning

- Solidify leadership – all levels including that of faculty
- Replace retiring faculty and hire new faculty
- New building – sharing with Veterinary Molecular Biology makes 'strategic sense'
- Basic research – more details provided later in the report (particularly related to plan and animal community structure and competition among species (including invasive species). Water quality potentials in natural systems; and wildlife habitat with emphasis on species of plants and animals that are listed as endangered or threatened; no mention of basis animal science research was noted)
- Enhance publications – scholarly publications includes teaching, extension and research
- Seek extramural funding
- Establish a Ph.D. program
- Establish clear areas of focus
  Examples include:
  - Nutrition, range emphasis
    - Cow-calf
    - Back grounding
    - Meats as related to product produced
  - Beef cow reproduction
    - Range of basic to applied
    - Must be in synchrony with producer needs
  - Genetics
    - Application of new technologies into breeding program
    - Statistical, reproductive and molecular
- Create opportunities for competitive funding
- Form synergistic research teams
- Maintain applied research programs
- Enhance graduate student stipends
- Improve computing support – especially for graduate students
- Increase faculty involvement with students
- Enhance TA experiences – some are purely labor and not stimulating

- Encourage courses from other departments
- Consider naming a coordinator of graduate programs
- Maintain 'gate-to-plate' mentality not just cow-calf in programs
- Internships should be required
- Make a better use of 4H and FFA emphasis in the state
- Allow more time for hands on experiences – 2 vs. 4 h labs
- Establish judging teams

  Maintain academic quadrathlon
  Livestock judging team
  Plant identification team
  URME team

- Enhance industry involvement with development, judging teams and faculty support.

PROGRESS: Much progress has been made to implement the changes suggested in this review. There has been no talk of separating animal and range sciences. Animal and Range Science faculty have updated, reviewed and adopted a strategic plan during fall 2012. There is a permanent Department Head (hired August 2010). Three new faculty were hired in 2012 and there is a current search for a Forage Specialist. The faculty moved into the Animal Bioscience Building during July 2010. With the new faculty hires, there will be an emphasis on basic research while maintaining an applied aspect. All faculty need to increase publication in peer-reviewed refereed publications and seek extramural funding for their programs. A Ph.D. program was established in the early 2000's. Faculty have their unique research programs focusing on cattle, sheep and equine; albeit more synergistic relationships would benefit the department. Graduate student stipends allow for living expenses and with tuition waivers are competitive. Most graduate students now own their own computer equipment but if not, computers are supplied. Faculty now have access to the student population with the common areas in the new building. Graduate teaching assistants have the opportunities to provide more than pure labor if they take advantage of the opportunity. Courses from other departments are available and graduate students have been taking advantage of courses. The chair of the graduate committee serves as graduate coordinator. With new faculty, there is a 'gate-to-plate' mentality of the research, teaching, and Extension programs. Internships are required for some of the options and most of the laboratory experiences are 4 hour laboratories. There is a renewed interest of the undergraduates for involvement in extracurricular activities including the livestock judging team, academic quadrathlon, plant ID and URME teams. There is also a focus of industry involvement for program development the MSU Alumni/Foundation.

Although we have made progress over the years, we are asking the review team to critically evaluate all aspects of our program and provide feedback to improve our program.

Questions for the Review Team

Given A&RS's background, the external review team is being asked to address the following questions provided by the "Guidelines for External Program Review," Office of the Provost (available at: http://www.montana.edu/wwwprov/Guidelines_for_Program_Review_2011.pdf), as well as more in-depth questions specific to the Department:

1. The strengths of the department. Please list any specific commendations.

2. Overall observations and determinations regarding the quality and the rigor of the academic programs.

3. The effectiveness of the department's Assessment Plan and assessment activities.

4. Status of the each program curriculum in terms of breadth and currency with the discipline. That is, is each curriculum still relevant and has the curriculum kept pace with changes in the discipline?

5. Overall level of faculty productivity as it relates to the stated missions of the department and university.

6. Alignment of each of the department's academic programs with the Core Themes and strategic priorities of the institution.

7. Overall assessment of the quality of graduates produced by the programs in the department.

8. Any weaknesses or unrealized opportunities, with specific recommendations for action.

In addition, the Department asks the review team to address the following questions specific to the Department:

The A&RS Department's number of undergraduate majors has grown to over 300. Do we maintain or grow student recruitment and retention in response to changing student demographics? Does the Department need to increase or decrease its number of students? How do we garner additional resources to accommodate increasing student numbers while still delivering quality education and research? Should the Department restructure its majors? Are our students curricular needs being met? Should the A&RS Department readdress curricular programs?

Our graduate program is growing. What curriculum changes are needed to better serve our graduate education mission? How do we increase our competitiveness with sustainable sources of Graduate Research Assistant and Graduate Teaching Assistant funds? How can we improve our recruitment to increase the proportion of highly-qualified students?

3. The A & RS Department has seen strong commitment from our College and University through recent hires and robust start-up packages. This is indeed an exciting time of growth and change for the Department. However, without a concomitant increase in technical support during a time when Facilities and Administration (F&A) returns have been in steep decline, it has been increasingly difficult to manage workloads. How do we grow our resources to augment staffing in technical areas? How do we continue our trajectory of excellence with fewer resources?

4. How do we better manage our interactions with stakeholders to be more proactive, avoid redundancy, and more effectively serve our clientele? How do we maintain and reward the state-focused portion of our mission, when University recognition is increasingly following federal programs that generate larger indirect costs?

5. How can faculty secure more research funding, particularly for applied research programs?

I. PROGRAM DESCRIPTION, GOALS, AND STRATEGIC PLAN

Montana State University

MSU Vision

Montana State University will be the University of Choice for those seeking a student-centered learning environment distinguished by innovation and discovery in a Rocky Mountain setting.

MSU Mission
(approved by the Board of Regents 11/2011)

Montana State University, the State's land-grant institution, educates students, creates knowledge and art, and serves communities, by integrating learning, discovery, and engagement.

MSU Strategic Plan

Adopted 2012

Montana State University's Strategic plan sets overarching goals for the university and relies on every member of the MSU community – students, faculty, staff, alumni, and our community partners – to contribute to its success.

The plan is intended to guide and inform those making strategic decisions, without constraining the tactics that will help MSU achieve its goals. Each University unit is empowered to envision its future, develop its own paths to these goals, and contribute to the University's success in diverse and creative ways.

This plan caps 18 months of work by hundreds of constituents across the University and state. The Strategic Planning Committee and the Planning Council, as well as faculty, staff, students, and community members, carefully considered the Montana University System's strategic plan as well as the accreditation process to ensure that our goals and metrics move MSU forward.

The MSU Strategic Plan can be found at:
http://www.montana.edu/strategicplan/documents/montanastate-strategic-plan.pdf

College of Agriculture (COA)

As the foundation of the land-grant mission at Montana State University, the COA and the Montana Agricultural Experiment Station (MAES) provide instruction in traditional and innovative degree programs and conduct research on old and new challenges for Montana's agricultural community. This integration creates opportunities for students and faculty to excel through hands-on learning, to serve through campus and community engagement, to explore unique solutions to distinct and interesting questions, and to connect Montanans

with the global community through research discoveries and outreach. COA website: http://ag.montana.edu.

COA Vision

To create environments where people excel through innovative learning, discovery, and outreach programs in agriculture and natural resources.

COA Mission

As a land-grant institution, Montana State University provides education, research, and Extension and outreach programs focused to meet the changing needs of Montana. The COA and the MAES generate and disseminate superior knowledge and technological solutions to increase the competitiveness of communities capturing value from Montana's agricultural and natural resources, preserve environmental quality, and improve the quality of life for all our citizens.

The MAES is a foundational component of the original land grant college, which conducts research focused on state, regional, and national issues. Research program goals and objectives are integrated with federal and state priorities through an active, dynamic, and on-going process with students, staff, faculty, administrators, and a broad spectrum of stakeholders. MAES activities are comprehensively integrated with the COA and MSU teaching, research, and service functions. Faculty on MAES appointments are required to go through a project review every three to five years. For MAES website: http://ag.montana.edu/maes.htm.

MSU Extension

The Cooperative Extension System is a nationwide, non-credit educational network. Each US state and territory has a state office at its land-grant university and a network of local or regional offices. These offices are staffed by one or more experts who provide useful, practical, and research-based information to agricultural producers, crop advisers, Extension agents, small business owners, youth, consumers, and others in rural areas and communities of all sizes. MSU Extension website: http://www. msuextension.org/.

MSU Extension Mission

MSU Extension is a statewide educational outreach network that applies unbiased, research-based university resources to practical needs identified by the people of Montana in their home communities.

Department of Animal and Range Sciences

A&RS Mission

The mission of the Animal and Range Sciences Department is to create, evaluate and communicate science–based knowledge to enhance the management of Montana's livestock and rangeland resources in ways that are economically, socially and ecologically sustainable.

Outreach

One of the many ways we accomplish our mission is through the expansive efforts of MSU Extension Specialists and Associates in the Animal and Range Sciences Department. The Department of Animal and Range Sciences has a greater number of Extension Specialist than other departments within the COA.

Dedication

The department has faculty and staff dedicated to all aspects of the animal production industry, including water, range and pasture, and wildlife management, nutrition, genetics, reproduction and meat products. This dedication is transferred to our students. The current enrollment in Animal and Range Sciences is approximately 330 undergraduate and graduate students. We strive to keep our class sizes small to encourage greater teacher/student interaction. In addition, Extension Specialist are integral to the undergraduate teaching program.

Vision of the MSU Animal & Range Sciences Department
(Adopted by faculty consensus, February 2008 updated July 2012)

The Animal & Range Sciences (A&RS) Department has a rich heritage of providing applicable training and solutions for Montana students, producers and allied industries. Montana agriculture continues to be the largest sector in the state's agricultural economy contributing $3.7 billion dollars with livestock products accounting for 43.4% of the cash receipts. Among livestock products, cattle and calves account for approximately 86% of the cash receipts with 2.5 million head of cattle. In addition, there is 93,134,579 acres total land area in Montana with 61,388,467 acres in farms and ranches. Of the land in farms and ranches, 65.2% is in pasture and rangeland. A&RS is engaged in all areas of the rangeland-livestock interface including livestock management, nutrition, physiology, meat science, pest control and genetics; rangeland and natural resource management; and forage production. A&RS is a department with 16 tenure-track faculty members, with almost an equal balance among FTE's devoted to instruction (~ 7 FTE) and research (~ 6 FTE) with 3.0 FTE for Extension. The major strength of A&RS is our commitment to the philosophy of the land grant mission: excellent teaching programs, applied research to answer problems for Montana producers, and relevant Extension programs. We are a major conduit for alumni, producers and clients to connect with the College of Agriculture (COA) and Montana State University (MSU).

Many changes are rapidly occurring in agriculture in general, and in A&RS in specific. The major challenges are related to faculty positions and program direction at the BART Farm, Red Bluff and Fort Ellis. Additional investments are required at the BART Farm and Fort Ellis to accommodate livestock and equine nutrition, physiology, reproduction and genetics projects in order to maintain research and teaching functionality. Facility operations were centralized to the Montana Agriculture Experiment Station in 2008 and are no longer administered by the Department of Animal and Range Sciences.

It remains a crucial time to set strategic goals and a vision for the future.

Creating the vision for A&RS

The department's Mission Statement is to *"to create, evaluate and communicate science-based knowledge to enhance the management of Montana's livestock and rangeland resources in ways that are economically, socially and ecologically sustainable*." The A&RS faculty need to continually develop and adjust strategic plans to guide the department's activities. To develop a shared vision for the future A&RS department, the faculty have initiated faculty-led discussions and the formation of an A&RS Department Advisory Committee. Membership in the Advisory Committee includes producers and government agency representatives from all aspects of the livestock industry in Montana; particularly related to beef, equine, sheep, and meat production. This advisory committee meets annually during the fall and serves as a conduit for accurate input to and among A&RS, stakeholders, administrators and legislators. In addition to the departmental advisory committee, the department has separate Equine and Sheep Advisory Committees. In 2008, the A&RS department developed a shared vision that was accepted through faculty consensus, which included *"who are we?"* (strengths, challenges, core values), *"what do we wish to be?"* and *"what will we be known for?"*

Strengths

1. Unique department that combines Animal Sciences and Range Sciences – one of only three in the nation.
2. Relevancy in all areas of teaching, research and Extension to meet the needs of students and Montana livestock production systems and rangeland resource management.
3. Balanced and connected faculty – historically about 1/3 of faculty FTE each in teaching, research and Extension.
4. Strong teaching program – 1/3 of COA majors graduate with a B.S. degree in Animal and Range Sciences or Natural Resources and Rangeland Ecology. Graduates are well-prepared in both practical and theoretical competence to compete in the job market or graduate studies.
5. Faculty give high priority to student education – in the classroom, advising, mentoring and extracurricular activities. (Includes efforts by non-COA faculty). Tenure-track faculty continue to advise undergraduate students and teach a majority of lower division courses.
6. Research programs are applicable to "real world" issues in livestock agriculture, rangelands and natural resources. Our graduate students are well prepared to fill positions in both industry and academia with a focus on applied sciences, an area rapidly becoming under supported by most universities.

7. Access to land and animal base for research and teaching efforts.
8. High profile Extension and outreach programs to transfer science-based knowledge. (Includes many off-campus programs by non-Extension faculty).
9. Responsive to critical needs requested by students, clients, industry and advisory committees.
10. One of few academic departments with advisory groups.
11. Faculty with vast experience willing to work together on interdisciplinary teams within the department but also across departments, colleges, and with expertise from around the nation.
12. New faculty hires are adding new energy and creativity into teaching and research programs.
13. Modern laboratory facilities will encourage growth of fundamental research programs. Additional facilities include the Meats Laboratory and Nutrition Center. New faculty have purchased the latest molecular biology equipment for sequencing.
14. Growth in enrollment, courses and degree offerings.
15. High commitment to students and clients.
16. Our teaching philosophy is to combine theory with "hands on" instruction to illustrate concepts.
17. Laboratory and field studies are essential to student retention and mastery of the basic principles forming Animal, Range and Natural Resource Sciences.
18. Our research strength lies in cooperative and interdisciplinary research.
19. New building has boosted departmental morale.
20. Up to date technology in all of the classrooms allows use of modern instruction methods.
21. Strong Outreach programs by Animal & Range Science tenure track and non-tenure track faculty.
22. Potential collaborative capabilities for new tenure track faculty with other departments and non-MSU entities.

Challenges

TEACHING:

- Balance increased enrollment goals of administration with limits on classroom facilities.
- Meeting our students requirements with changes in courses offered by other departments particularly prerequisites for other department's courses.
- Maintaining "hand-on" teaching with less state funding and support.
- Balancing faculty time with increased demands for teaching, advising and research.
- Concern over non-tenure track faculty teaching required courses.

RESEARCH:

- Erosion of AES funds, state-funded Research Associate positions, and multiple-year grant programs for applied research have limited efficient use of station land and livestock resources.
- Increasing number of competitive grants when teaching and advising demands have increased.
- Lack of depth in subject areas with most areas faculty are only "one deep".

EXTENSION:

- Lack of direction for the departmental Extension program. Animal & Range Extension Specialists need to work with the Director of Extension in identifying direction of entire Extension program.
- Loss of Extension Specialists which increases workload on other faculty members.

OUTREACH:

- Defining outreach responsibilities for Animal & Range Sciences faculty and staff.

A&RS core knowledge areas

The A&RS Department fulfills a unique niche in the university, Montana and the region. All teaching, research and extension programs are focused primarily on rangeland livestock grazing, effects of grazing on wildlife and fish habitats, integrated crop livestock production systems and management issues applied to these areas. To meet the anticipated future needs of students, producers and other stakeholders, A&RS must maintain core knowledge in the following disciplines:

Livestock: nutrition, physiology, genetics, reproduction, animal health, meat science, general production and management, and integrated livestock crop production systems.

Equine: nutrition, physiology, reproduction, health, and behavior.

Natural Resources and Rangeland Ecology: plant communities, livestock-wildlife interactions, wildlife habitat, plant taxonomy, riparian habitat processes, and grazing management and forage production.

A&RS philosophy for future teaching, research and Extension programs

Teaching

Animal Science Teaching Philosophy

Our goal is to grow from a program of individually developed and delivered semester based courses to a flow of learning experiences that engage and enhance student's learning in academics, practical and applied skills, knowledge of current topics, interdisciplinary "big picture" learning, and critical thinking. To accomplish this, faculty will work more closely to develop goals and understanding of what knowledge, skills, and experiences students need at each level of their academic career and how we as a faculty work to accomplish these learning objectives. An example template: As a faculty we develop a list of competencies: skills, knowledge, and abilities that our students should have at the end of their sophomore year. Based on this and the expectation of senior level learning objectives, we develop a skills, knowledge, and abilities "check list" for the junior year. With this type of approach we have "planned redundancy" which clearly identify to students the learning objectives at each level of their academic career. Ultimately we will develop and instill the skills, knowledge, and abilities that define a competent graduate. Our faculty is committed to the principles of the land grant university system. We will strive for consistent excellence in teaching and pursuit of best practices for student engagement and learning. We will continue to mentor and advise all animal science students on an individual basis, to clearly identify goals and paths to success. We will work as a faculty to achieve these goals and to produce a graduate that meets the standards for a professional animal scientist and ranks among the best of the nation while maximizing the efficient use of faculty time and university resources.

Natural Resource and Rangeland Ecology Teaching:
The goal of our teaching program in this area is to provide students with the scientific knowledge needed to manage our natural resources. This approach requires a combination of classroom theory and practical experience. We will be attempting to increase our "hands on" outdoor experience so our students are competitive in the job market. Our goal will be to educate our students in critical thinking, establish a base of biological knowledge, and the ability to communicate their management solutions to others. Our faculty will attempt to achieve these goals by integrating our individual classroom information deliveries into an organized set of teaching modules which produce a science based land manager.

Research

Animal Science:
Because of our location, collaboration with industry, producers, and public entities, our department is well positioned to move forward in our continuing efforts to develop extramural funded, interdisciplinary research that has a direct benefit to the students and agricultural community of Montana and the region. Building on our history of funding pertinent research with a mix of private, public, and corporate funding, our department will position itself as an effective research program that is competitive in an ever shrinking environment of public funding. We will seek new discipline and regional partnerships to seek funding and address issues important to our clients. Our ultimate goal is to do research that directly impacts the Montana Ag industry, further developing a partnership that is mutual beneficial to both the land grant mission and Agriculture producers within the state.

Natural Resources:
We continue to cooperate with agricultural producers and land managers to seek information which will improve the management of our natural resources and insure their continued use. We will seek funding from a variety of sources to discover how to manage the natural resources in a sustainable manner. Our areas of interest will focus on rangeland habitat, invasive species and watershed management. The land ownership of Montana is shared by private citizens, the federal government, the State of Montana and several tribal governments. We will continue to work with these interests to provide a scientific basis for our land management practices.

Extension

A&RS will develop and conduct comprehensive educational programs that assist livestock producers, land managers, allied industry groups, agencies, youth and the general public on relevant agricultural and natural resource issues. Extension programs will be complementary and integrated with A&RS teaching and research functions. We will disseminate high quality research-based information and technology. Close working relationships will be maintained with stakeholders to foster feedback to and from the department on educational and research programs.

A&RS Five-Year Vision and Goals Statement (2013-2018)

There is consensus among the A&RS faculty that our goals and strategic plan must address several key issues in the short-term.

Student Body

- Market our programs to recruit undergraduate students.
- Foster and manage growth in the Equine Science option
- Revised Natural Resources and Rangeland Ecology degree.

PROGRESS: The A&RS Department recently received funding through the Dean's office from the Provost for NTT instruction to enhance the equine science curriculum for the Equine Science option. In particular, new courses are being created in equine behavior, equine health management, and equine exercise physiology.

With a new faculty member in range plant ecology (Dr. Craig Carr), there is an opportunity to revisit the Natural Resources and Rangeland Ecology courses. In addition, A&RS Department is working with the Dean and Director of the COA and MAES to recruit a Wildlife Habitat Ecologist.

Utilize an Assessment Plan and other tools to retain majors.

Faculty are continually working towards growth and quality in the undergraduate and graduate programs.

Stakeholders

- Continually identify and correspond with producers, commodity and industry groups and other clients.
- Be the regional leader in range livestock and natural resource programs in education, applied research and Extension.

- Be the gateway to MSU for Montanans in the livestock and natural resource industries.

- Be an outstanding partner with clients in the livestock and natural resource industries.

PROGRESS: Extension Specialists do an outstanding job at corresponding with these clientele. A&RS faculty tours (Bringing MSU to You) are an attempt to put a face with the department.

Faculty and Staff

- Fill vacant faculty positions in animal physiology, genetics and Range Science to maintain core knowledge areas.

- Begin the process of re-filling voids in core knowledge areas with upcoming faculty retirements.

- Add a new faculty position in Range Science (possibly Extension at Fort Keogh).

- Pursue funding for an Endowed Chair in Animal Science or Range Science.

- Continue to add Research and Extension Associate positions via grants and contracts.

- Pursue opportunities to increase faculty size via Research Professors.

- Continue to work with MSU administration to clarify A&RS priorities for undergraduate and graduate instruction, research, outreach and Extension. There have been some positive results with Equine Science program as an example.

PROGRESS: Animal and Range Sciences have recently hired tenure-track faculty in rumen microbiology (Dr. Carl Yeoman), genetics (Dr. Jennifer Thomson) and range ecology (Dr. Craig Carr). A&RS has worked on recruiting a Forage Specialist to fill a recent retirement. A vacancy announcement has been created to fill the Beef Specialist position in Miles City, MT. The department also received approval to recruit a NTT position to teach introductory and 'hands-on' courses, and coach the livestock judging team. As mentioned previously, a Wildlife Habitat Ecologist will be recruited.

Curriculum

- Be a regional leader in applied natural resource and livestock education, emphasizing management that integrates research and industry experiences. May be an opportunity to increase student internship experiences.

- Revise the Animal Science degree options to ensure that instruction such as beef cattle and sheep management is continuous and relevant from the freshman through the senior level courses.

- Integrate Extension specialists, producers, and agency or industry personnel as guest lecturers to enrich the undergraduate experience. Several classes include Extension specialist as guest lectures and the Beef Specialist currently co-teaches the Beef Management course. New Extension Specialists may be involved in formal courses.

- Evaluate and improve delivery of service courses such as equitation and activities such as the judging teams. Service courses and judging teams are an integral component of the department and will remain so in the future.

- Implement collaborative graduate courses with other universities in the region. Although not accomplished but with new technology, opportunities exist.

Research and Creative Activity

- Be a regional leader in applied livestock, integrated crop/livestock systems, and natural resource research that solves problems for producers, agencies and industries. Applied livestock and natural resource research continues to be a priority.

- Anticipate and develop research on future problems through regular feedback from peers, advisory committees, producer organizations and natural resources personnel. A & RS advisory committee meets on at least an annual basis and will continue to be a priority.

- Emphasize sustained research programs to meet our core knowledge areas.

- Improve growth in competitive grants and contracts.

- Improve research output in terms of refereed journal articles, reviewed articles, publications and products targeted to producers and clients in the natural resource and livestock industries.

- Encourage collaboration with new research programs including coloration with Research Centers and the USDA-ARS.

Physical and Financial Infrastructure

- Manage functional teaching laboratories and classrooms in the Animal Bioscience Facility.

- Continue working with the Dean's office on planning and improvements at facilities at Bozeman, Fort Ellis and Red Bluff to sustain long-term research, teaching and outreach efforts.

II. STRUCTURE AND PERSONNEL

The A&RS Department is housed within the MSU COA. The departmental annual base budget for personnel comes from three funding pools with funding from these sources coming to the Dean which is then distributed across the COA (FY14 the budget) 1) $ 716,004 MAES, 2) $743,469 COA, and 3) $348,182 is from the Cooperative Extension Service (ES) to support our Extension faculty. Operations are supported by the COA Dean and MAES Director in the amount of $85,280 for research administration, with an additional $41,150 for teaching administration. Faculty with active MAES Hatch projects receive approximately $2,200/year. In addition multi-state projects received $3,000 for individual projects and $1,500 for travel to regional meetings in FY13. Extension accounts are provided $6,000 for 1.0 FTE, prorated for percent Extension effort by faculty. Additional MAES money is provided for operation of Endocrinology Laboratory ($2,000), Nutrition Laboratory ($2,000) and the Wool Laboratory ($1,250) The MAES provided GRA $60,286 in FY13 and the COA provided $39,000 for GTA support for FY13. An additional $25,000 in support for graduate assistants was provided by Bayard Taylor Foundation account. The department also is awarded grants and contracts from a diverse set of sources, averaging $1 million annually (Table 6 in Research Section).

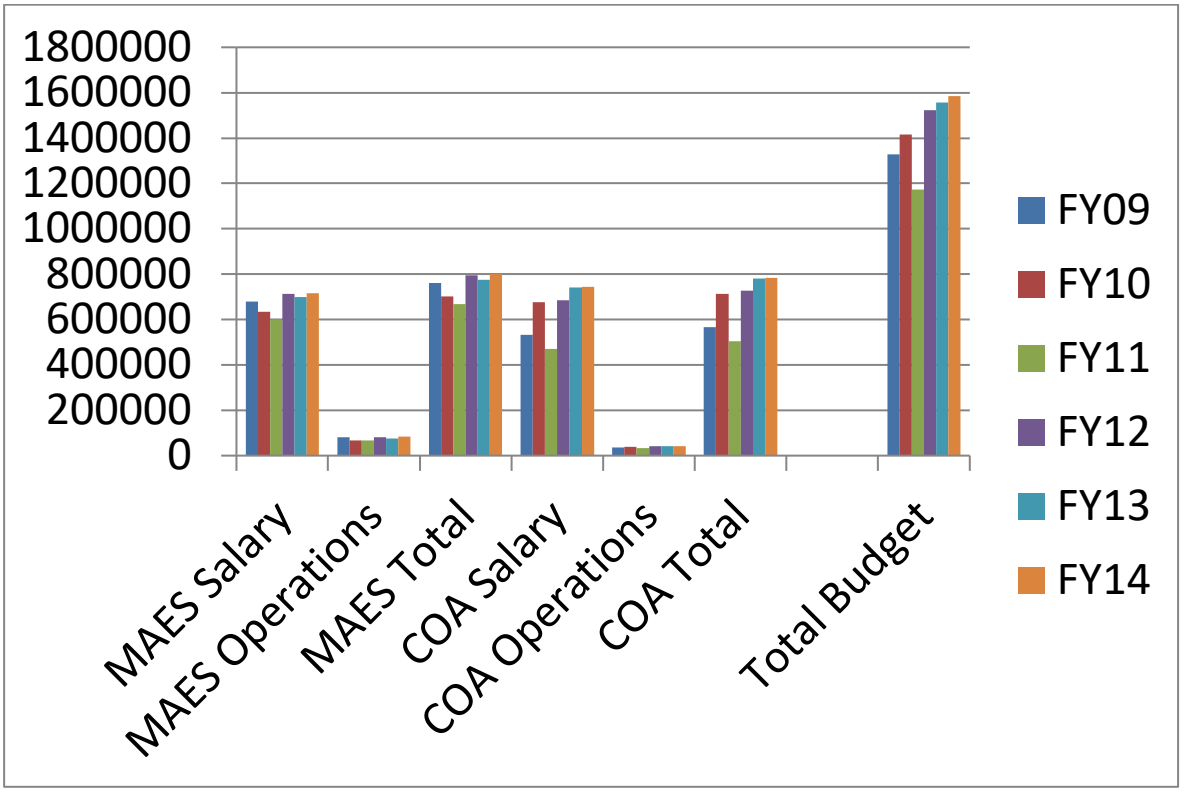


Figure 1. COA and MAES budgets since 2009. (Prior to 2009, operations from farms were included in A&RS budgets. Since these facilities have been centralized to MAES, budgeted amounts prior to 2009 were not included.)

We have 16 full-time equivalent (FTE) tenure-track positions with appointments that vary with respect to teaching, research, and Extension responsibilities: 7 COA FTEs; 6 MAES FTEs; and 3 ES FTEs (Table 1). In addition, the A&RS Department is currently recruiting for a Forage Specialist (100% ES) and will be recruiting for a Beef Specialist for the Miles City, Ft Keogh position (75% ES, 25% MAES) and a Wildlife Habitat Ecologist (75% MAES, 25% COA).

Table 1. A&RS Department Tenure-Track and Non-Tenure-Track Faculty

			FTE[a]			Appointment Split			
Individual	Hired	Rank	COA[b]	MAES[c]	ES[d]	Teaching	Research	Service	Contract[e]
James Berardinelli	1981	Professor	0.42	0.58	-	0.42	0.48	0.10	FY
Jane Boles	1999	Associate Professor	0.70	0.30	-	0.60	0.30	0.10	FY
Janice Bowman	1992	Professor	0.50	0.50	-	0.50	0.40	0.10	FY
Craig Carr	2012	Assistant Professor	0.40	0.60	-	0.36	0.54	0.10	AY
Glenn Duff	2010	Department Head	0.55	0.45	-	0.10	0.10	0.10	AY
Glenn Duff			0.11	0.11		0.11	0.11		SU
Rachel Endecott	2006	Associate Professor	0.15	-	0.85	0.70	0.20	0.10	FY
Patrick Hatfield	1996	Professor	0.30	0.70	-	0.30	0.60	0.10	FY
Gregory Johnson	1986	Professor	0.06	0.40	0.54	0.06	0.84	0.10	FY
Bryce Kawasaki	2013	Instructor	*			1.00			AY
Rodney Kott	1980	Professor	-	0.20	0.80	0.70	0.20	0.10	FY
Clayton Marlow	1980	Professor	0.70	0.30	-	0.70	0.20	0.10	FY
Shannon Moreaux	2008	Assistant Professor	1.00	-	-	0.75	0.15	0.10	AY
Shannon Moreaux					0.22			0.22	SU
Jeffrey Mosley	1995	Professor	-	0.20	0.80	0.70	0.20	0.10	FY
Bret Olson	1988	Professor	0.45	0.55	-	0.45	0.45	0.10	FY
Andrea Shockley	2003	Instructor	1.00			1.00			AY
Bok Sowell	1993	Professor	1.00	-	-	0.80	0.10	0.10	AY
Bok Sowell			0.22						SU
Jennifer Thomson	2012	Assistant Professor	0.40	0.60	-	0.36	0.54	0.10	AY
Carl Yeoman	2012	Assistant Professor	0.40	0.60	-	0.36	0.54	0.10	AY
Total FTE			9.03	5.98	2.99				

Data Source: A&RS Department

[a]Full-Time Equivalent (FTE); [b]College of Agriculture (COA); [c]Montana Agriculture Experiment Station (MAES); [d]Cooperative Extension Service (ES);

[e]Contract Type: Academic Year (AY), Fiscal Year (FY)., Summer (SU)

*Funded through A&RS Farrier School.

Table 2. Clerical and Administrative Support

Name	Position	Years in A&RS	Funding Source (FTE[a])		
			COA[b]	MAES[c]	ES[d]
Susan Cooper	Administrative Associate III	6	0.40	0.51	0.09
Julie Hager	Administrative Associate II	15	0.75	-	0.25
Peggy Kelley	Administrative Associate II	15	-	-	1.00
Denise Thompson	Administrative Associate II	13	1.00	-	-
Lisa White	Accounting Associate IV	7	0.20	0.71	0.09
Total FTE			2.35	1.22	1.43

Data Source: A&RS Department

[a]Full-Time Equivalent (FTE); [b]College of Agricultere (COA); [c]Montana Agriculture Experiment Station (MAES); [d]Cooperative Extension Service (ES);

Table 3. Professional and Technical Support

		Funding Source (%)			
Name	Position	COA[a]	MAES[b]	ES[c]	Grant
Thomas Bass	Extension Associate	-	10	65	25
Kathleen Davis	Research Associate	-	100	-	-
Merrita Fraker-Marble (.35 FTE[d])	Research Associate	-	-	-	100
Rachel Frost	Research Scientist	-	-	-	100
Hayes Goosey	Research Scientist	-	-	-	100
Bruna Irene Grimberg De Menalled (.25 FTE[d])	Research Associate	-	-	-	100
Devon Ragen	Research Associate	-	-	-	100
Jeanne Rankin	Grant Administrator/ Animal Program Leader	-	-	-	100
Brent Roeder	Range Research & Extension Specialist	-	-	-	100
Marni Rolston (.55 FTE[d])	Research Associate	-	-	-	100
Andi Shockley	Equine Manager	17	-	-	-
Leigh Spokas (.25 FTE[d])	Research Associate	-	-	-	100
Lisa Surber (.512 FTE[d])	Program Lead	-	100	-	-
Lisa Surber (.488 FTE[d])	Research Scientist	-	-	-	100
Cecil Tharp	Pesticide Education Specialist	-	-	75	25

Data Source: A&RS Department

[a]College of Agricultere (COA); [b]Montana Agriculture Experiment Station (MAES);

[c]Cooperative Extension Service (ES)

[d]Full-Time Equivalent (FTE).

Table 4 presents all classified and professional staff employed by A&RS from 2000 to present. Most Professional staff have been and continue to be grant supported.

Table 4. All Classified and Professional Staff from 2000 to Present and Dates of Employment in Animal and Range Sciences

NAME	TITLE	DATES HERE	GRANT FUNDED (Yes/No)	CLASSIFIED/ PROFESSIONAL
Baril, Rebecca	Research Assistant III	10/17/2001-2/15/2008	Yes	Classified
Barney, Linda	Accounting Associate III	7/26/2004-11/19-2004	No	Classified
Blake, Melissa	Admin Aide	3/20/200-8/18/200	No	Classified
Bossert, Michelle	Accounting Associate III	7/8/2002-9/8/2006	No	Classified
Brewster, Angie	Accounting Associate I	9/15/2003-9/30/2004	No	Classified
Campbell, Kimberly	Accounting Clerk	8/2/2001-4/10/2003	No	Classified
Clawson, Kris	Lab Specialist	6/4/2007-2/29/2008	No	Classified
Cooper, Susan	Administrative Associate III	10/23/2007-Present	No	Classified
Crawford, Jane	Associate Accounting II	3/26/2007-9/6/2007	No	Classified
Graham, Corrina	Admin Aide	5/2000-7/2000	No	Classified
Gray, Anita	Administrative Associate II	8/21/1991-7/9/2012	No	Classified
Hager, Julie	Administrative Associate II	6/8/1998-Present	No	Classified
Higgs, Bryant	Accountant	5/15/2000-6/30/2003	No	Classified
Jackson, Anya	Research Assistant	1/1/2009-9/22/2009	Yes	Classified
Kelley, Margaret	Administrative Associate II	10/1/1998-Present	No	Classified
Kirpach, Kathleen	Research Specialist	9/1/1999-5/5/2005	Yes	Classified
Meyn, Elizabeth	Research Assistant	7/1/2002-6/30/2009	No	Classified
Miller, Sheila	Administrative Aide	8/30/2000-5/9/2003	No	Classified
Miranda, Victoria	Research Assistant III	4/13/2006-4/5/2007	Yes	Classified
Pfingsten, Renee	Accounting Associate II	2/13/2006-12/29/2006	No	Classified
Philllips, Sydni	Accounting Associate I	8/14/2003-1/13/2006	No	Classified
Stoff, Cory	Research Specialist	1/16/2002=8/31/2003	No	Classified
Thompson, Denise	Administrative Associate II	10/2/2000-Present	No	Classified
Thompson, Mike	Feed Production Specialist	12/1/99-11/1/2007	No	Classified
Voegeli, Sandra	Administrative Assistant II	11/1/2008-4/16/2010	No	Classified
Wiley, Deborah	Administrative Associate II	10/16/2003-9/1/2006	No	Classified
Adair, Ronald	Research Associate	2000-2002	No	Professional
Anderson, Kim	Farm Manager	6/1/1999-8/15/2003	No	Professional
Anderson, Leif	Research Associate	1/1/1992-6/4/2003	Yes	Professional
ArmosRios, Raul	Shepard	9/12/1995-1/26/2001	No	Professional
Bass, Thomas	Extension Associate	9/1/1998-Present	Yes	Professional
Bilbao, Josh	Project Coordinator	5/16/2005-9/30/2008	Yes	Professional
Black, Wade	Project Coordinator	11/1/2006-5/31/2009	Yes	Professional
Borg, Randy	Research Associate	9/1/2005-10/31/2006	Yes	Professional
Brewer, Tracy	Research Specialist	3/1/1999-5/17/2004	Yes	Professional
Brewer, Tracy	Assistant Research Professor	5/17/2004-5/31/2008	Yes	Professional
Campos-Canorio, Rodrigo	Shepard	12/17/2003-3/15/2004	No	Professional

Choat, William	Research Assistant	12/13-2001-12/31/2003	Yes	Professional
Clark, Ryan	Research Associate	9/1/1998-5/31/2009	No	Professional
Davis, Kathleen	Research Associate	1/1/1990-Present	No	Professional
Defoe, Julia	Research Associate	8/28/2006-12/31/2006	Yes	Professional
Daniels, Todd	Research Associate	7/1/2004-11/30/2004	Yes	Professional
Duffey, Lisa	Project Coordinator	8/26/2002-6/30/2006	Yes	Professional
Fenster, Randy	Wildlife Adjunct Instructor	01/13/2004-6/23/2009	No	Professional
Fisher, Taralyn	Research & Extension Associate	7/1/2004-9/29/2006	No	Professional
Fraker-Marbe, Merrita	Research Associate	4/16/2001-Present	Yes	Professional
Frost, Rachel	Research Scientist	12/27/2005-6/30/2013	Yes	Professional
Fultz, Jessica	Research Professional	10/12/2005-5/31/2008	Yes	Professional
Goosey, Hayes	Research Scientist	10/26/1992-Present	Yes	Professional
Grove, Allison	Research Associate	10/1/2002-8/31/2008	Yes	Professional
Habernicht, Debra	Research Associate	1/1/2003-6/30/2007	Yes	Professional
Harbac, Mary	Project Coordinator	05/02/2005-3/31/2012	Yes	Professional
Hendrickson, Robert	Research Associate	11/1/99-6/30/2005	Yes	Professional
Hewitt, Gary	Regional Sheep Institute Coordinator	7/1/2006-8/31/2008	Yes	Professional
Hould, Byron	Farm Manager	12/1/2003-8/8/2007	No	Professional
Iversen, Nicole	Program Assistant	7/1/2005-10/7/2007	Yes	Professional
Kaiser, Donna	Research Associate	2/1/2001-2/13/2005	Yes	Professional
Kellom, Alison	Nutrition Laboratory Manager	6/18/2007-7/31/2010	Yes	Professional
Kellom, Alison	Research Associate	3/1/2006-6/15/2007	Yes	Professional
Kellom, Andrew	Projector Director	11/1/2004-12/31/2007	Yes	Professional
Kenyon, Marc	Widlife Adjunct Instructor	1/6/2004-8/25/2006	Yes	Professional
Kincheloe, Janna	Research Associate	8/15/2001-2/27/2004	Yes	Professional
Konen-Miller, Anne	Program Coordinator	9/1/2005-10/23/2006	Yes	Professional
Kruse, Rosanne	Research Associate	2/1/2003-5/31/2004	Yes	Professional
Law, Darin	PostDoc Researcher	9/1/2003-3/31/2007	Yes	Professional
McDonnell, Mike	Project Coordinator	7/1/2003-8/10/2004	Yes	Professional
Miller, Holly	Program Coordinator	4/1/2004-2/23/2005	Yes	Professional
Miller, Michelle	Project Coordinator	6/12/2006-5/4/2007	Yes	Professional
Moore, James	Regional Sheep Institute Agent	7/1/2005-Present	Yes	Professional
Johson-Nistler, Carolyn	Range/Wildlife Ext. Associate	11/25/2002-8/31/2007	Yes	Professional
Nollmeyer, Virginia	Research Associate	6/16/2000-5/18/2006	No	Professional
Olbert, Heidi	Project Coordinator	4/4/2005-3/23/2006	Yes	Professional
Peck, Clint	Director Montana BQA	7/1/2006-12/31/2010	Yes	Professional
Petroff, Arthur	Pesticide Education Specialist	11/12/1996-9/26/2006	Yes	Professional
Ragen, Devon	Research Associate	7/1/2012-Present	Yes	Professional
Redden, Reid	Research Associate	1/1/2007-5/31/2010	Yes	Professional
Robinson, Brenda	Nutrition Laboratory Manager	11/20/2001-10/15/2006	No	Professional
Robinson, Brenda	Wool Lab Manager	7/1/2007-3/31/2009	No	Professional
Roeder, Brent	Sheep Research Specialist	10/14/2002-Present	Yes	Professional
Rolston, Marni	Research Associate	5/12/1995-Present	Yes	Professional
Roth, Nancy	Research Associate	7/1/1982-8/31/2001	No	Professional

Ruud, Randi	Research Professional	10/1/2006-7/3/2007	Yes	Professional
Schmidt, Lisa	Research Associate	11/3/2003-3/9/2007	Yes	Professional
Selensky, Cindy	Project Coordinator	5/15/2006-10/31/2012	Yes	Professional
Sever, Stephanie	Project Coordinator	11/4/2004-6/30/2008	Yes	Professional
Sherwood, Harrie	Research Associsate	5/24/1993-12/31/2010	No	Professional
Shockley, Andrea	Equine Manager	5/10/1999-Present	No	Professional
Surber, Lisa	Research Scientist	7/1/1992-Present	Yes	Professional
Surber, Lisa	Wool Lab Manager	7/1/2009-Present	No	Professional
Tacza Sota, Edwin	Shepard	1/25/2001-1/27/2006	No	Professional
Tharp, Cecil	Extension Education Specialist	11/1/2003-Present	Yes	Professional
Torstenson, Wendy	Research Associate	10/1/1998-9/30/2005	Yes	Professional
Vanek, Joe	Research Associate	9/1/2007-5/31/2008	Yes	Professional
Wallander, Roseann	Research Associate	7/1/1993-5/31/2001	Yes	Professional
Whitney, Travis	Research Associate	1/6/2004-2/24/2005	Yes	Professional
Wolfe, Thomas	Farrier School Director	6/13/1983-12/31/2012	No	Professional

Facilities

Animal Biosciences Building

Animal Bioscience Building (ABB) –Construction of the 40,463 square foot building began August 18, 2008. The Animal and Range Sciences Department moved in in late July 2010. The building was funded from three main sources: $3M MSU Foundation settlement, $6M State funding, and $7M from 141 Ranchers Circle member ($10,000 or more) plus many smaller donors. The $7M from "private" sources, almost 45% of the funding, is relatively unique for funding a public building, and indicates the strong support throughout the state in the department's future.

Bozeman Agricultural Research and Teaching Farm (BART)

BART, formerly known as '*The Towne Farm*' is located west of 19th Street and the main MSU campus. This farm comprises approximately 430 acres and houses the Oscar Thomas Nutrition Center, Miller Stock Pavilion, Equine Center, Horseshoeing School, Feed Mill, and Beef Center. A new office/shop was completed in 2008. Facilities were remodeled at the Oscar Thomas Nutrition Center in 2008 to house GrowSafe Feeding Systems. An upgrade to the AI barn was completed in 2013 with the addition of 6 new GrowSafe nodes. The farm is dedicated to the service and support of research, teaching and extension activities relating to livestock and livestock management.

Fort Ellis Research Farm

Situated on a historic U.S. Cavalry fort, this research farm is located within a 20 minute drive of the Bozeman campus. Fort Ellis includes approximately 640 acres and was dedicated in 1930 as a "headquarters for the range sheep investigations" as conducted by the Montana Agricultural Experiment Station. New GrowSafe nodes were added during the summer, 2013. This facility continues to play a large part in the research and teaching of the Department of Animal & Range Sciences in the areas of sheep, beef cattle, and horses.

Red Bluff Research Ranch

Red Bluff Ranch is located near Norris in Madison County, Montana, along the west side of the Madison River. The operation comprises 13,750 acres of land, 10,000 deeded and 3,750 leased. Most of this land is rangeland, with limited hay meadows along the valley bottoms. Elevations range from 4,600 feet to 6,200 feet above the Madison River canyon. The ranch occupies most of the once thriving late 19th-early 20th century gold mining

community in the Hot Springs Mining District which was second only in gold production to Alder Gulch. At its peak of activity, there may have been a population of approximately 3,000. The ranch nearly surrounds the town of Norris. The founder of Norris, Alexander Norris may have owned much or all of the Red Bluff Ranch at one time. The Red Bluff Research Ranch (previously known as the Rowe Brothers Ranch) was purchased for $164,000 ($16.83 per acre). The total acreage was 9,746. Two U. S. Forest Service Grazing Permits (Muddy Greek, Cache Creek) in the Gallatin National Forest came with the Rowe property. Some small additional land exchanges and purchases have taken place over the last 45 years. The grazing permits were returned to the Forest Service in 1976. A new lambing facility and mixing barn at the ranch was constructed in about 1990. New cattle working facilities were built in 2005 with new handing facilities built (Silencer squeeze chute and corrals) in 2011. New shop and housing facilities were completed in 2010. This made lambing much easier. There are currently about 170 head of cattle and 900 head of sheep maintained on a year round basis at the research ranch. These livestock along with the range areas are used for both teaching and research.

Plant Growth Center

The Plant Growth Center (PGC) is a teaching and research facility available to the College of Agriculture staff. The current 60,000 square-foot facility, which was completed in 1987 houses 29 glasshouse rooms with 8,300 square feet of bench space - both temperature and light are micro-computer controlled.

Northern Agricultural Research Center (NARC, cooperating)

The Center is located about seven miles southwest of Havre on U.S. Highway 87. The Northern Agricultural Research Center has approximately 500 acres of cropland 6000 acres of rangeland used for crop, beef cattle and range management research. Normally 350 beef cows and 300 calves are used in different projects.

USDA-ARS Fort Keogh Livestock & Range Research Laboratory (LARRL, cooperating)

Fort Keogh is a 55,000 acre USDA - Agriculture Research Service (ARS) rangeland beef cattle research facility. It is 1 of 14 research locations that make up the 8 state Northern Plains Area of ARS. It is run in cooperation with the Montana Agricultural Experiment Station, the agriculture research component of Montana State University. The mission of Fort Keogh is to research and develop ecologically and economically sustainable range animal management systems that ultimately meet consumer's needs.

USDA-ARS U.S. Sheep Experiment Station (USSS, cooperating)

The U.S. Sheep Experiment Station is located in Dubois Idaho. The mission of the station is to produce technology to increase efficiency of livestock production in a manner that assures agricultural and natural resources are available for our grandchildren.

III. RESEARCH

Research is expected of all A & RS faculty proportional to their appointment. All faculty are evaluated annually and for promotion and tenure relative to their appointment. The Extension faculty work in collaboration within and outside the department. Faculty disseminate science-based knowledge synthesized from their projects via refereed publications, newsletters, the Internet, press releases, Extension documents, television and presentations. Audiences include other scientists, Extension Agents, farmers, ranchers, land managers, and government agency personnel. The vitas provided in APPENDIX lists refereed journal articles for individual faculty members.

Table 5. Peer-Reviewed Refereed Journal Articles by A&RS Faculty Members since 2000

Faculty	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Berardinelli	2	2	1	0	0	5	1	5	2	0	2	2	0
Boles	1	1	5	1	1	2	1	1	1	2	3	0	0
Bowman	3	2	4	2	3	1	1	2	4	0	0	0	0
Carr	-	-	-	-	-	-	-	-	-	-	-	-	1
Duff	-	-	-	-	-	-	-	-	-	-	2	1	2
Endecott	-	-	-	-	-	-	0	0	0	0	0	0	3
Hatfield	8	4	4	1	1	2	1	3	1	3	4	4	0
Johnson	3	3	3	0	1	0	0	7	0	0	8	0	3
Knight	1	1	1	1	1	0	0	0	0	0	0	0	0
Kott	5	3	1	1	0	2	1	7	2	0	0	3	5
Marlow	1	0	1	0	0	0	3	3	0	0	0	0	0
Moreaux	-	-	-	-	-	-	-	-	2	1	1	0	0
Mosley	3	0	0	1	0	0	1	1	0	0	2	1	0
Olson	1	1	3	5	1	1	4	2	0	0	0	0	0
Sowell	3	2	3	2	4	0	0	0	0	0	0	0	0
Thomson	-	-	-	-	-	-	-	-	-	-	-	-	4
Yeoman	-	-	-	-	-	-	-	-	-	-	-	-	1
Total	31	18	25	14	12	13	13	31	12	6	22	11	19
Total/FTE	2.8	1.6	2.3	1.4	1.2	1.3	1.2	2.6	1.0	0.5	1.6	0.7	1.1

Funding

The following figure represents A&RS Expenditures since 2000. The peak in 2006 represented several special grants including the Montana Beef Network, Undaunted Stewardship, Barley Feed and Montana Skeen Institute.

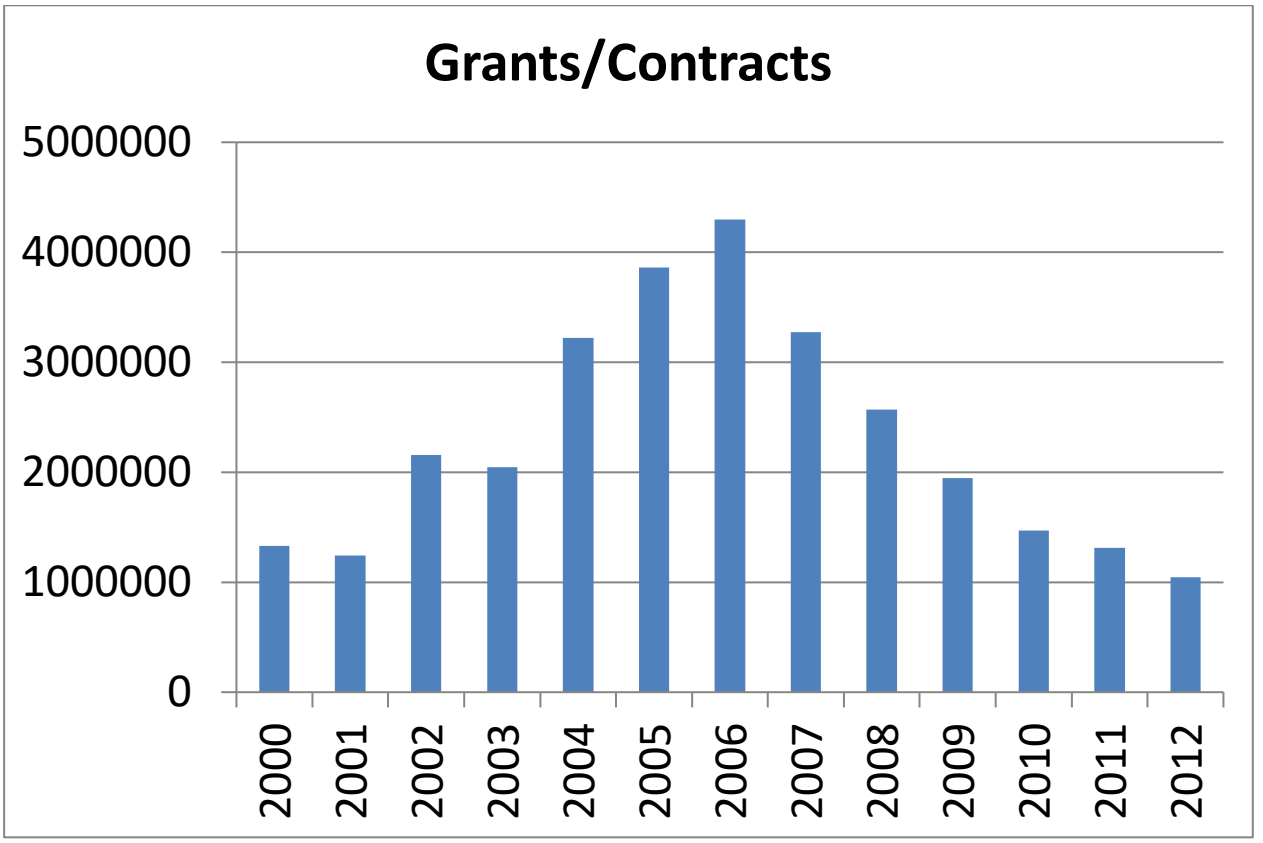


Table 6. Special grants awarded to the Department of Animal and Range Sciences

PI	Grant Name	Budget	Start Date	End Date
Bowman, Jan	Barley Feed II-USDA	$596,265.00	7/1/1999	6/30/2001
Kott, Rodney	Wool Research 2000	$28,065.00	7/1/2000	6/30/2002
Kott, Rodney	Montana Sheep Institute 2001	$19,500.00	6/16/2000	12/31/2001
Mosley, Jeff	Undaunted Stewardship	$3,931,100.00	4/2/2001	10/31/2006
Kott, Rodney	Wool Research 2001	$28,000.00	3/1/2001	6/30/2003
Kott, Rodney	Wool Research 2002	$27,498.00	4/1/2002	3/31/2004
Kott, Rodney	Montana Sheep Institute 2002	$374,145.00	4/15/2002	4/14/2004
Paterson, John	Montana Beef Network 03	$1,864,080.00	6/1/2002	5/31/2005
Bowman, Jan	Feed Barley for Rangeland Cattle	$736,841.00	9/15/2002	9/14/2004
Mosley, Jeff	Undaunted Stewardship	$20,000.00	10/1/2002	9/30/2003
Bowman, Jan	Barley	$399,646.05	9/15/2003	9/14/2007
Kott, Rodney	Wool Research 2004	$25,073.00	4/15/2004	4/14/2006
Kott, Rodney	Montana Sheep Institute 2004	$464,316.00	5/1/2004	4/30/2007
Paterson, John	Montana Beef Network	$831,126.00	7/15/2004	7/14/2006
Brewer, Tracy	Montana SKEEN Institute	$194,297.00	7/1/2004	6/30/2007
Kott, Rodney	Montana SKEEN Institute	$76,679.00	7/1/2004	6/30/2007
Knight, James	Montana SKEEN Institute	$64,000.00	7/1/2004	6/30/2006
Mosley, Jeff	Montana SKEEN Institute	$102,500.00	7/1/2004	6/30/2007
Kott, Rodney	Montana Sheep Institute	$531,517.00	6/1/2005	5/31/2008
Paterson, John	Montana Beef Network	$875,057.00	9/1/2005	8/31/2007
Bowman, Jan	Feed Barley for Rangeland Cattle	$378,062.27	9/1/2005	8/31/2008

Kott, Rodney	Wool Research Montana	$27,780.00	6/1/2005	5/31/2007
Brewer, Tracy	Montana SKEEN Institute	$226,883.27	9/15/2005	9/14/2008
Kott, Rodney	Montana SKEEN Institute	$85,525.37	9/15/2005	9/14/2008
Mosley, Jeff	Montana SKEEN Institute	$112,513.36	9/15/2005	9/14/2008
Gipp, Wayne	Montana SKEEN Institute	$25,000.00	9/15/2005	9/14/2008
Kott, Rodney	Wool Research	$27,542.00	6/15/2006	6/14/2009
Kott, Rodney	Montana Sheep Institute	$551,759.00	7/1/2006	6/30/2009
Paterson, John	Montana Beef Network	$909,433.00	7/1/2006	6/30/2008
Jacobsen, Jeff	Undaunted Stewardship	$1,567,683.25	10/1/2006	9/30/2011
Kott, Rodney	Montana SKEEN Institute	$69,157.35	9/15/2006	9/14/2009
Brewer, Tracy	Montana SKEEN Institute	$159,274.30	9/15/2006	9/14/2009
Mosley, Jeff	Montana SKEEN Institute	$106,211.35	9/15/2006	9/14/2009
Kott, Rodney	Montana Sheep Institute	$138,898.00	7/1/2008	6/30/2010
Kott, Rodney	Wool Research	$20,464.00	7/1/2008	6/30/2010
Paterson, John	Sustainable Beef Supply	$676,899.00	7/1/2008	5/31/2010
Kott, Rodney	Montana Sheep Institute	$236,801.00	8/15/2009	8/14/2011
Kott, Rodney	Wool Research	$19,205.00	9/1/2009	8/31/2011
Paterson, John	Sustainable Beef Supply	$635,820.00	9/1/2009	8/31/2011
Kott, Rodney	Wool Research	$19,172.00	7/1/2010	6/30/2012

Grants and Contracts

The following table list individual grants and contracts by A&RS personnel. The total amount is well over $4,000,000. Funding sources include federal, state agencies and private companies and/or foundations.

Table 7. Active grants and contracts by A&RS personnel.

OFFICE ACCT	End Date	P.I.	Agency
Restoration Strategies for Sulfur Cinquefoil	8/31/2013	Mosley	USDA
Sheep Grazing as a Pest Management Tactic	8/31/2013	Hatfield	USDA NIFA
Draft Best Management Practices and Further	9/30/2013	Olson	National Park Service (NPS)
Integrating Biological Control with Targeting Sheep	6/30/2012	Mosley	WSARE
Western Region SARE Professional Development	12/31/2012	Cash	WSARE
Research and Document NPS-era agricultural prac	9/30/2013	Olson	NPS
Expansion of BEHAVE Research and Tr	9/30/2013	Olson	NPS
Targeting Grazing/Invasive Plant Mgmt	6/30/2012	Kott	USDA NIFA
Determining feasible methodology….	6/1/2015	Marlow	NPS
Alternatives to Traditional Confinement	5/31/2013	Hatfield	5-States Ruminant Consortium
Determining Best Fit Forage	5/31/2012	Endecott	ND State Univ.
Montana Agroemergency Education	9/30/2012	Bass	Montana Disaster and Emergency Services
Degree Day Modeling & Economic Considerations	8/31/2013	Goosey	WSARE
Wildlife Damage Control for Organic Farmers	8/31/2014	Knight	WSARE
Reducing Tilling Intensity in Organic Crop Systems:	8/31/2014	Hatfield	USDA NIFA

Can Biological Control and Targeted Grazing be	10/1/2013	Mosley	Missoula County Weed District
Community Based Agroemergency Planning and	5/31/2013	Bass	Montana Disaster and Emergency Services
CRP Readiness Project-Western Region Subcontract	12/31/2012	Bass	Univ. of Wisconsin
Wool Research and Outreach-MSU & Texas A&M	12/31/2012	Kott	National Sheep Improvement Center
Promote Preservation of Resources Through	3/1/2014	Olson	NPS
Development of a eXtension Sheep Community of Practice	12/31/2013	Kott	Univ. of Wyoming
Provide Science Based Livestock Nutrition, Husbandry, and	9/30/2014	Endecott	NPS
The Influence of livestock grazing on arthropods serving	6/30/2015	Goosey	MT Fish Wildlife and Parks
Best Management Practices for Livestock Protection Dogs	6/15/2015	Mosley	WSARE
Ecological Assessment and Monitoring Lost Trail NWR…	12/30/2014	Marlow	US Fish Wildlife Service
Cooperative Research between Animal and Range Sciences	8/30/2017	Duff	US Fish Wildlife Service
Targeted grazing to reduce tillage: Environmental, ecologica…	8/31/2016	Hatfield	USDA NIFA

Total = $4,168,482

HATCH/MULTISTATE PROJECTS

All research faculty are required to have Hatch and/or Multistate Projects to support research activities. The following list includes all active Hatch and Multistate projects for A & RS faculty. New faculty are given a year grace period before writing Hatch or Multistate project proposals. Drs. Carr, Thomson and Yeoman will have Hatch projects submitted for approval during the fall 2013.

Berardinelli, J. G. MONB00205 Hatch Pheromonal Mediation of the Biostimulatroy Effect of Bulls on Reproductive Processes in the Bovine 10/01/2011 to 10/01/2016

Berardinelli, J. G. MONB00183 Hatch/Multistate Reproductive Performance in Domestic Ruminants 10.012011 to 9/30/2016

Bowman, J. G. P MONB00194 Hatch Nutritional Management of Range Beef Cows and Calves. 10/01/2011 - 09/30/2016

Boles, J. A. MONB00169 Hatch Relationship of Growth Path to Carcass Composition and Meat Quality. 10/01/2012 - 09/30/2017

Duff, G. C. MON00188 State. Exploratory Research in Animal and Range Sciences. 10/01/2010 - 10/01/2015

Hatfield, P. G. MONB00173 Hatch Incorporating Sheep into Farming Systems: Animal Health and Performance, Agronomic, Economic, Social, and Ecological Considerations. 10/01/2012 - 09/30/2017

Johnson, G. MONB00177. Hatch. Investigations of Emerging Anthropod Vectored Diseases of Livestock and Wildlife. 10/01/2012 - 09/30/2015

Kott, R. W. MONB00201.. Hatch. Improve the Profitability and Competitiveness of the Montana Sheep Industry. 10/01/2009 - 09/30/2014

Kott. R. W. MONB00197. Hatch/Multistate. Enhancing the Competitiveness and Value of U.S. Beef. 10/01/2012 - 09/30/2017

Marlow, C. B. MONB00171 Hatch. Clarifying the Linkage Between Upland Plant Community Structure and Riparian Processes. 10/01/2012 - 09/30/2017

Mosley, J. C. MONB00182. Hatch. Is Targeted Sheep Grazing Compatible with Biological Control of Spotted Knapweed. 10/01/2010 - 09/30/2013

Olson, B. E. MONB00176 Hatch. Winter "Grazing in Montana. 10/01/2011 - 10/01/2016

Sowell, B. F. MONB00111. Hatch. Range Ecology. 10/01/2010 - 09/30/2015

Research Areas

Faculty in A & RS has varied and multidisciplinary research programs. Individual projects are often conducted with input from several faculty. This list of research areas is not meant to be all inclusive.

Animal Sciences

Nutrition

A strength of the animal science research program is nutritional management. Several faculty are involved in nutritional management programs. Faculty include Bowman, Duff, Endecott, Hatfield, Kott, Moreaux, Olson, Mosley, Sowell, and Yeoman. More specifically, projects include nutritional management and supplementation programs for cattle (Bowman, Duff, Sowell, Endecott, Olson), sheep (Hatfield, Kott, Mosley, Yeoman) and horses (Moreaux).

Reproduction

Dr. Jim Berardinelli serves as the reproductive physiologist working primarily with pheromonal activity in cattle. Dr. Berardinelli has also worked with sheep and bison on research programs. Other faculty involved with reproduction include Drs. Kott, Moreaux, Duff, and Yeoman.

Genetics

Dr. Jennifer Thomson was hired in 2012 to fill the genetics position. Other faculty working in genetics include Drs. Kott, Boles, Yeoman.

Microbiology

Dr. Carl Yeoman was hired as a ruminal/gastrointestinal microbiologist in 2012. Dr. Yeoman has been working on projects evaluating reproductive tract microbiome in sheep Collaborating faculty include Drs. Kott and Hatfield. In addition Dr. Boles has worked on microbiology of meat products.

Entomology

Dr. Johnson research interest is entomology. Dr. Johnson has worked with mosquitos but is also interested in fly control in cattle. Dr. Johnson has also worked with Dr. Kott with parasite control in sheep. Dr. Hatfield has a current research project with parasites in sheep.

Range Science

The Range Science research programs concentrate efforts on water quality and quantity (Marlow), noxious and invasive weeds (Olson, Mosley, Kott, Hatfield) including animal grazing behavior and grazing management (Mosley), and the interaction of livestock on wildlife habitat ecology (Carr, Mosley, Sowell).

IV. EXTENSION

The A&RS Department has exciting outreach programs. There are currently 6 faculty members with an Extension focus (beef, equine, sheep, range, entomology, and wildlife) and 2 Extension Associates (agro-security/preparedness, pesticide education). These specialist emphasize research-based educational activities. Research activities enhance their extension programs. Research results are disseminated through press releases, presentations, web pages, and Extension documents. Specialists have focused on timeliness of program delivery and programs often receive very good to excellent ratings during evaluations.

Information on the A&RS Extension Service website can be found at http://www.animalrangeextension.montana.edu/. The A&RS Extension Service is dedicated to improving the competitiveness of Montana's agricultural industry and the lives of people working and playing in our communities. Activities involve education, certification, conservation, and research in the fields of cattle, entomology, equine, forage, natural resources, range science, sheep, and wildlife. The Extension Service has hundreds of extension publications and online references providing valuable information for improving and conserving Montana's resources. Extension Specialists housed in the department include Dr. Rachel Endecott, Extension Beef Specialist; Dr. Greg Johnson, Extension Entomology Specialist; Dr. Jim Knight, Extension Wildlife Specialist (post-retirement contract); Dr. Rodney Kott, Extension Sheep Specialist; and Dr. Jeff Mosley, Extension Range Specialist. In addition, Mr. Tommy Bass, Associate Specialist and Mr. Cecil Tharp, Associate Specialist are housed in the department.

Agro–Security and Agro–Emergency Preparedness / Natural Resources Extension Program

Mr. Tommy Bass, Leader

Mission: Provide support to county agents, producers, and other stakeholders in matters of animal waste management, AFO/CAFO management, animal mortality management, agricultural water quality regulations/policy, composting, sustainable agricultural, and agroemergency preparedness.

The Extension Livestock Environment program's goal is to provide education, technical assistance, and applied research answers to all stakeholders in Montana's livestock industry. This program provides ongoing outreach on animal waste and nutrient management, regulatory compliance, non-point source pollution, air emissions, and recommended environmental best management practices.

The program is effective through collaborative programming with key organizations and agencies including the Department of Environmental Quality, Department of Natural Resources and Conservation, Montana Association of Conservation Districts, Natural Resource Conservation Services — USDA, Farm Services Agency — USDA, and other stakeholders.

Technical assistance is provided as requested through the county delivery system, assorted direct correspondence, and site visits. Additional related topics and contacts can be found on the Range Extension Program page, Forage Extension Program page or Extension Water Quality Program page.

Mr. Bass' current responsibilities include providing education and technical assistance to producers and other stakeholders regarding manure and nutrient management, AFO/CAFO compliance, and matters of air and water quality related animal agriculture. In addition, Mr. Bass also conducts programming in agro-security and agro-emergency preparedness. He is the animal agriculture contact for Montana in the national Extension Disaster Education Network (EDEN). Mr. Bass has also provided support to the Division of AgEd program at Montana State as an adjunct instructor.

For seven years Mr. Bass served producers as an animal waste specialist with Cooperative Extension at the University of Georgia and has worked on projects and provided education across the U.S. and Canada. He joined MSU in July of 2007. His experience includes work with all livestock species as well as poultry. Mr. Bass' research and outreach interests also include mortality management, composting, minimum technology waste and water treatment systems, manure and fertilizer equipment calibration, and agriculture's role in watershed planning.

A participant in the Montana Extension Disaster Education Network

This new program seeks to assist agricultural producers in preparing for all emergencies, as well as identifying where to get assistance during and after an event. Emergencies could be the result of bad weather, natural disasters, disease outbreaks, transportation accidents, or as a result of deliberate and malicious acts. In any case, a quick organized response to an emergency event will help protect human health and life while reducing or preventing animal disease and death, crop and facilities damage and economic loss.

Deliberate acts do not necessarily mean attacks by an organized terrorist group or independent agents and "copycats." The perpetrator could also be a disgruntled or former employee. Regardless of the culprit or motivation, aspects of agricultural production may be susceptible; plans for security, prevention of attacks and recovery should be in place at the ranch, farm and local community level.

The term **agro-security** specifically refers to intentional acts, while **agro-safety** refers to general accidents or acts of nature. Both of these issues fall under the auspices of **agro-emergency preparedness**. Another related term is **bio-security**, this refers to management that attempts to prevent introduction of disease causing organisms or pests to an agricultural operation.

Beef/ Cattle Extension Program

Dr. Rachel Endecott, Associate Professor, Beef Extension Specialist

The goal of the Extension Beef Program is to provide scientific, research based information to help producers create "low cost - high profit" cattle that yield a product desired by the consumer and manage resources in a sustainable manner while maximizing profits.

Related Programs

Steer of Merit County Fair Program

Montana Beef Quality Assurance

4-State Backgounding Program

Beef Q&A Newsletter

Rachel Endecott, Extension Beef Specialist, Associate Professor

Rachel Endecott grew up on a family cow-calf operation near Ennis, Montana. She received her BS in Animal Science from Montana State University in 2001, and her MS and PhD in range beef cattle nutrition with a reproductive physiology minor from New Mexico State University in 2003 and 2006, respectively. Rachel recently relocated her program from Miles City at the USDA-ARS Fort Keogh Livestock and Range Research Laboratory to the Animal Bioscience Building. Along with her Extension appointment, Rachel has a 15% COA appointment and is co-teaching ANSC 434R; serves as academic advisor for the Collegiate Stockgrowers Association and has headed up the Academic Quadrathlon competition.

Rachel's graduate research focused on strategic supplementation to improve reproductive performance of young postpartum range cows, and nutrition-reproduction interactions continue to be a research interest. Rachel oversees the Steer of Merit program, is involved in Montana Stockgrowers Association and Young Stockgrowers, and is the membership committee chair for the Northern Great Plains Section of the Society for Range Management. She is also an active member of the Western Section, American Society of Animal Science.

Entomology Extension Program

Dr. Greg Johnson, Professor, Veterinary Entomology

The Extension Entomology Program provides science-based information on insects affecting livestock, wildlife and companion animals. In addition, the program focuses on insects as disease vectors and management of insects of veterinary importance.

The entomology research program complements the Extension program and Dr. Johnson's laboratory focuses on the biology, ecology and management of arthropod pests that attack livestock and wildlife. Field and laboratory studies have been conducted on West Nile virus determining vector distribution in the state, identifying enzootic and epizootic zones of virus transmission and studying the impact of WNV on sage grouse and American white pelicans. Research has also been conducted on biting midges (*Culicoides*) and bluetongue virus focusing on vector competency and midge distribution in the state. I also conduct studies on insecticide management of different livestock pests that cause direct losses and affect livestock production. Included in this group are cattle grubs, horn flies, sheep keds and the African blue louse.

Mr. Cecil Tharp

Cecil Tharp is the coordinator of the private applicator program. The MSU Pesticide Education Program provides education and outreach for the private (farm) pesticide certification program as according to the 2008 Memorandum of Agreement between MSU Extension and the Montana Department of Agriculture. This program assures that restricted use pesticides (RUP's) are used in a manner that increases the safety of approximately 6,100 Montana applicators and their families while minimizing environmental risk and offering cost incentives. Fifty six MSU extension agents and 1 statewide Extension coordinator have provided pesticide education services which have measurable impacts on Montana citizens.

MSU Extension provides education and outreach through a variety of platforms. In 2010, approximately 4,500 Montana citizens received pesticide training at 180 approved certification programs statewide. The Pesticide Specialist is also active in delivering multiple publications over a wide array of topics including calibration, pesticides and the environment, pesticide safety, and toxicity. These publications are delivered via MSU statewide news releases, the Montana IPM Bulletin, pesticide Ag-ALERTS, Mont-Guides, and Northern Ag. Network radio releases.

This position also facilitates the delivery of critical EPA and MDA news releases, while posting the news releases on the MSU Pesticide Education website. This website serves as a hub for private applicators seeking pesticide education publications, guidance or available private applicator programs which the coordinator posts on a weekly basis.

This program has resulted in positive outcomes for pesticide applicators annually. Surveys indicate approximately fifty percent of pesticide applicators (both licensed and unlicensed) change their behaviors as a result of attending MSU Extension sponsored pesticide programs. Applicators often indicate they would be more vigilant when wearing personal protective equipment; washing contaminated clothing, and calibrating their sprayers on an annual basis.

The MSU Extension Pesticide Education Program administers a training program which is necessary to maintain a private applicators private applicator license. This license is needed to purchase a wider range of RUP's for managing pest outbreaks on land that private applicators own rent, or lease. Montana producers, ranchers, and small acreage owners save money by using RUP's annually when managing pests.

Equine Extension Program

Dr. Shannon Moreaux, Assistant Professor

The Equine Extension Program focuses on equine nutrition, metabolism and metabolic diseases. As a DVM, Dr. Moreaux also provides timely Extension information on epidemiologic surveillance of regional infectious diseases and equine facilitated therapy. Dr. Moreaux serves Director: Youth Horsemanship School; Director: MSU Extension Annual Equine Conference.

Forage Extension Program

A search is currently being conducted to replace the Extension Forage Specialist

Sheep Extension Program

Dr. Rodney Kott, Professor, Extension Sheep Specialist

The Montana sheep extension program is a demand driven program which strives to address specific needs of Montana sheep producers. The goal of the sheep extension program is to provide programs, knowledge, and assistance to sheep ranchers throughout Montana and the Rocky Mountain region.

A cooperative project between Montana Wool Growers Association and Montana State University, dedicated to developing and implementing non-traditional adjustment strategies that will increase the competitiveness of Montana's lamb and wool in the world market.

Community of Practice for Sheep (Sheep CoP)
within eXtension

Although sheep inventories have declined, the sheep industry is a still a substantial component of the US livestock industry. There is a need to connect current sheep research outcomes and the extension and industry communities. The purpose of the Sheep CoP is to transfer knowledge regarding sheep production and products to producers, stakeholders, and consumers. The Sheep CoP covers a wide variety of sheep topics of interest, including (among others): Sheep Management Practices; Sheep Breeds; Sheep Purpose (wool vs. meat vs. dual-purpose) ; Markets ; History ; International Perspectives (how the industry differs in other countries) ; Showmanship ; Wool; Meat Products (available products, how to prepare, etc.) ; Producer Profiles; Feed Efficiency; Genetic Selection; Prolificacy; Seasonality; Shearing; Feeding/Nutrition; Feedlot; Grazing/Pasture ;Organic Sheep Production ; Natural Sheep Production; Health; and Veterinary Care.

Accomplishments and Interests includes: Conducts 20 to 30 sheep production workshops yearly throughout Montana on sheep genetics, reproduction, nutrition, health, management & marketing.; coordinates the Montana Central Ram Test and the Montana On-Farm Ram Testing Program; conducts enhanced wool preparation and marketing workshops which are designed to add value to wool produced in Montana.; evaluates the effects of improved wool preparation methods on wool value; evaluates the potential benefits of utilizing Australian Merino sheep on crossbreeding programs with domestic breeds of sheep (cooperative study with U.S. Sheep Station, DuBois; Texas A&M; & University of California).

Range Extension Program

Dr. Jeff Mosley, Professor, Extension Range Specialist

The Extension Range Management program at MSU addresses range management issues facing Montana landowners. The goal of the program is to provide scientific, objective, and research based information that promotes an understanding of range management. The program is led by Dr. Jeff Mosley.

Wildlife Extension Program

Dr. Jim Knight, Professor, Wildlife Extension Specialist, Retired, Post-Retirement Contract

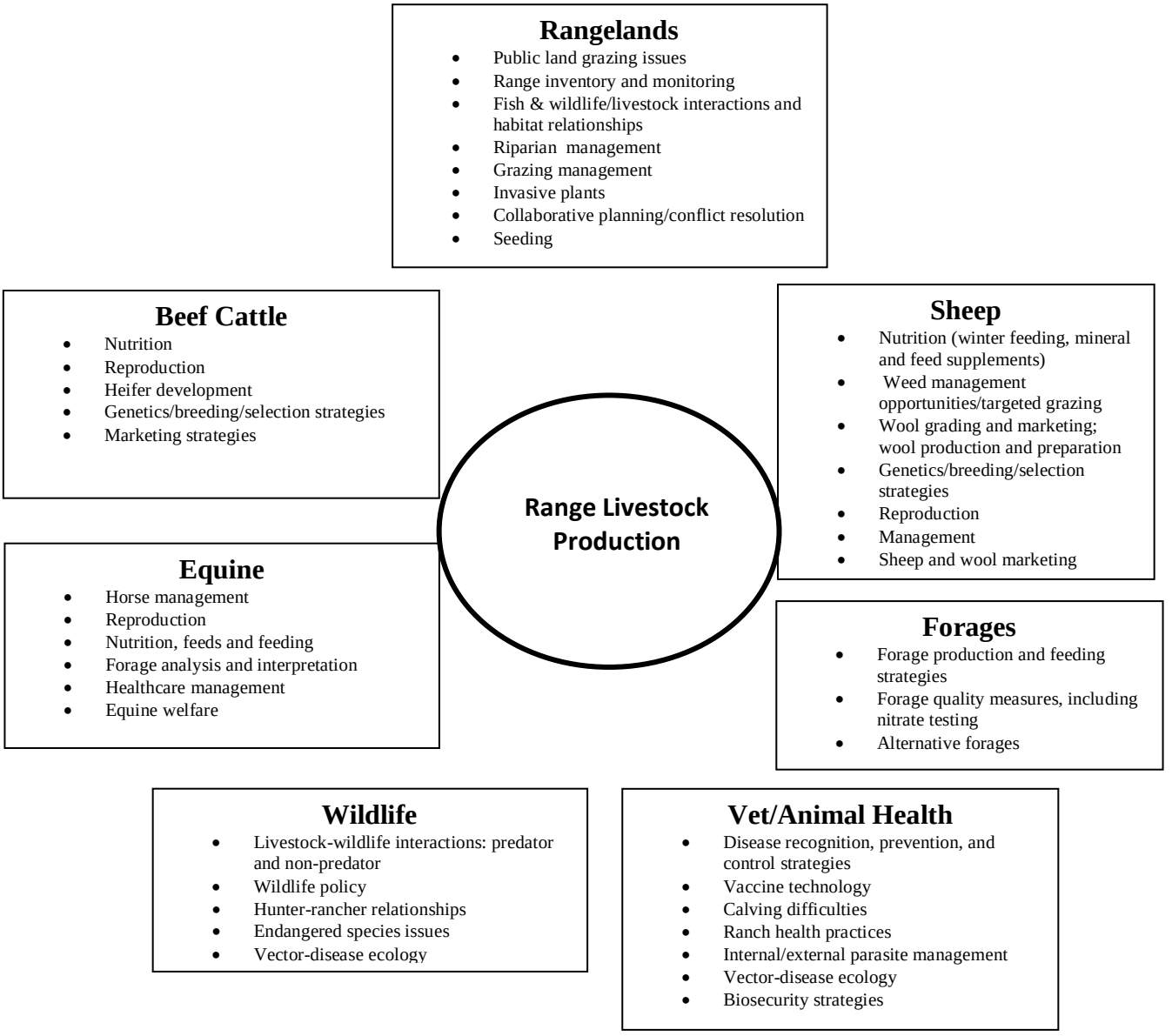
The primary focus of the Extension Wildlife Program is to respond to needs identified by County Agents and Extension clientele. Daily response to clientele questions range from backyard wildlife to predator concerns to agency policies. Benefits of one-on-one contact are hard to quantify, but may be one of the most effective methods of extension education.

The goal of the Extension Wildlife Program is to provide scientific, research based, and pertinent information to promote understanding of all aspects of wildlife management. A second goal is to provide programs and information that will help sustain Montana ranches and farms while increasing the public appreciation for the contribution of agriculture to wildlife and wildlife habitat.

Future Direction of the Extension Program in Animal and Range Sciences

To meet the needs of clientele of Montana, the Extension group met to discuss needs and goals of existing and future extension programs within the Department of Animal and Range Sciences during the fall 2012.

MSU Department of Animal and Range Sciences – Extension Core Program Areas



Due to the variety of Extension Presentations by the Specialist, the following information is provided. Rachel Endecott 2012				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
Pre-Calving Nutrition Considerations	1	1hr	18	18
Where Food Comes From	1	0.5hr	201	201
Impacts of Different Post-Weaning Development on Subsequent Feedlot Performance and Carcass Characteristics	2	0.5hr	47	93
Nutrition and Vaccination programs for Healthy Calves	1	1hr	45	45
Beef Cow Nutrition Considerations	1	1hr	38	38
Cow Body Condition Scoring	1	1hr	10	10
Preparing for Calving Season	1	1hr	42	42
Basic Beef Cattle Production	1	0.25hr	120	120
Brucellosis	1	0.5hr	22	22
Best Utilization of Harvested Forages	4	1hr	13	49
Feeding Risks from Impacted Feeds and Forages- Ag In Uncertain Times Webinar	1	0.5hr	90	90
Beef Cattle Basic Webinar 3: Fall	1	1hr	16	16
Beef Cattle Basic Webinar 4: Winter	1	1hr	19	19
Beef Cattle Production Basics- FSA Borrower Training Webinar	1	2hr	30	30
Beef Cattle Basics Webinar 2: Summer	1	1hr	14	14
Interpreting Feedstuff Analyses- AgriBest Feeds Webinar	1	1hr	20	20
Drought Management Strategies for Beef Cattle Producers- Webinar	1	1hr	28	28
Beef Cattle Basics Webinar 1: Spring	1	1hr	12	12
Using Body Condition Scoring to Your Advantage- AgriBest Feeds Webinar	1	1hr	25	25

Rachel Endecott 2011				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
Selection, Feeding, Carcass Evaluation of 4-H Beef Cattle	2	1hr	18	35
Preparing for Calving Season	11	1hr	23	251
Cow Condition Impacts on Nutrition and Reproduction	4	1hr	21	83
Brucellosis in Montana	1	0.5hr	5	5
Youth Livestock Quality Assurance	6	1hr	27	164

Nutritional Management Impacts on Feedlot Performance and Carcass Characteristics	3	0.5hr	49	116
Where Food Comes From	2	0.5hr	170	339
Beef Cattle Showmanship Workshop	1	1hr	22	22
Grills Gone Wild BBQ Workshop Pilot	1	0.5hr	5	5
Agriculture Advocacy- Telling Your Story	1	0.5hr	18	18
Latest in Montana Agriculture- Fort Keogh and Extension Update	1	0.5hr	60	60
What the Hay? Beef Cattle Forage Analysis	1	1hr	20	20
Current Montana Livestock Issues- Trich and Brucellosis	1	0.5hr	25	25
Beef Cow Nutrition Considerations	5	0.5hr	26	130
Genetically Modified Food	1	0.5hr	6	6

Rachel Endecott 2010				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
Improving the Efficiency of Beef Cattle Reproduction	9	1hr	12	111
Selection, Feeding, and Carcass Evaluation of 4-H Beef Cattle	1	1hr	17	17
Heifer Development	1	1hr	2	2
Youth Livestock Quality Assurance	3	1hr	20	60
Brucellosis in Montana	2	0.5hr	45	23
Basic Beef Cattle Production	1	0.25hr	120	120
Bull Care and Management	1	1hr	35	35
Carcass Grading Training	2	4hr	18	35
Where Food Comes From	6	0.5hr	31	184
Preparing for Winter Feeding	1	1hr	14	14
Agri-Security	1	1hr	2	2
GrowSafe Technology and Tour	1	0.5hr	17	17

Gregory Johnson 2012				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
A survey of Montana Mosquitoes for Canine Heartworm - Looking for the Proverbial Needle in A Haystack	1	30 min	40	40
Management of Winter Insect Pests on Livestock	8	1 hr	35	280
Cache Valley Virus:A preliminary study	1	30 min	40	40
Late Season Parasite Control on Cattle	1	2 hr	35	35
Mosquito Biology and Identification	1	4 hr	15	15

Agent Update - Veterinary Entomology	1	15 min	6	6

Gregory Johnson 2011				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
Ectoparasite management of cattle and sheep	1	0.75 hr	40	
Ectopsrasite Control on Livestock	3	2 hr	32	97
Ectoparasite management on sheep	1	0.75 hr	50	
Cache Valley Virus and Mosquito Control	2	1 hr	22	45
Mosquito Surveillance and Cache Valley Virus in North Dakota	1	3 hr		10
Russian Wheat Aphid - Then and Now	1	0.75 hr		75
Mosquito biology and identification	1	4 hr		12

Gregory Johnson 2010				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
Winter Insect Pests on Livestock	1	2.5 hours		15
Use of Fathead Minnows for Mosquito Control	2	20 min	27	54
Livestock Insect Control Update	1	20 min		40
Mosquito and Disease Surveillance	1	45 min		38

James Knight 2012				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
Controlling Wildlife Damage	5	3 hr	25	125
Wildlife Damage Control on Organic Farms	1	4 hr	25	25
Livestock Grazing to Enhance Wildlife Habitat	1	6 hr	40	40
Agent Training in Wildlife Damage Control	1	2 hr	30	30

James Knight 2011				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
Controlling Wildlife Damage	4	2 hr	25	100
Garden Wildlife damage Control	1	1 hr	100	100
Organic Rodent Control	2	2 hr	10	20
Consequences of relocating bison	2	1 hr	30	60
Wildlife Enterprises	2	3 hr	5	10
Wildlife Damage on Gold Courses	3	2 hr	100	300

James Knight 2010				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
Coping With Wolves	3	1 hr	25	75

Endangered Species Management	2	1hr	50	100
Rodent Control	4	30 min	25	100
Sage Grouse Management	1	45 min	100	100

Rodney Kott 2012				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
NSIP	1	2hr	30	30
Ultrasound	6	4hr	8	48
Wool Marketing	1	3hr	75	75
Ram Selection	1	3hr	50	50
Selection	1	2hr	30	30
Wool Preparation	1	4hr	20	20
Using US Wool	2	1.5hr	15	30
Wool Laboratory	1	3hr	15	15
Wool Management	1	3hr	50	50
Loin Eye Measurement	1	2hr	75	75
Wool Preparation	1	4hr	25	25
Wool Measurement	1	3hr	25	25
Wool Classer	1	4hr	30	30
Wool Laboratory	1	1hr	25	25
Ultra sounding	1	4hr	8	8
Wool Harvesting	1	135hr	50	50
Wool Marketing	1	4hr	50	50
Wool Grading and Marketing	6	4hr	25	150
Wool Selection	1	3hr	15	15
Wool Industry	2	4hr	50	100
Use of US Wool	2	3hr	15	30
Wool Measurement	2	4hr	10	20
Ram Selection	1	2hr	150	150
Blue Tongue Meeting	1	2hr	50	50
Extension	5	2hr	11	55
Ewe Nutrition	1	2hr	150	150
Wool Sock Production	1	1hr	100	100
Wool Industry	1	1.5hr	35	35
Extension- Sheep COP	5	1hr	11	55

Rodney Kott 2011				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
Targeted Grazing- ASI	1	1hr	30	30
Wool Marketing- ASI	1	1hr	30	30
4-H Market Lambs- Missoula	1	2hr	50	50
Wool Marketing- Wibaux	1	2hr	25	25
Wool Marketing- Sidney	1	2hr	25	25

4-H Market Lamb Leader Forum- Missoula	1	2hr	30	30
Shearing School- Bozeman	1	5days	20	20
Sheep Industry- Helena	1	2hr	100	100
Wool Preparation- Twin Bridges	1	4hr	10	10
Sheep Production Practices- Missoula	1	3hr	50	50
Sheep & Wool Production- Broadus	1	4hr	50	50
Ultrasound Management	12	4hr	10	120
Wool Marketing- Dillon	1	4hr	25	25
Sheep Production	1	4hr	100	100
Ram Production- Great Falls	1	4hr	50	50
Sheep & Wool Production	1	4hr	100	100
Wool Skirting	1	4hr	100	100
Wool Preparation and Marketing	6	4hr	42	250
Ram Marketing	1	2hr	15	15
Wool Skirting and Classing- Vermont	1	2days	20	20
Sheep Selection- Douglas, WY	1	4hr	100	100
Wool Research	1	1hr	20	20
Wool Production	1	4hr	50	50
Ultrasound School- Hettinger ND	1	2days	25	25
Sheep Selection- Miles City	1	4hr	150	150
Wool Quality-Idaho	1	6hr	50	50
Sheep Nutrition	1	4hr	50	50
MSU Sheep Program	1	4hr	25	25
Ultrasound School	1	2hr	15	15
4-H Horse and Livestock Leaders Conference	1	1hr	15	15
OFDA Demonstrations	3	2hr	20	60
Tours	5	1hr	25	125
Other Demonstrations	2	1hr	25	50
MWCA Board Meeting	3	1day	15	45
Ultrasound Demonstrations	22	2hr	7	154
4-H Workshops	5	2hr	25	125
Sheep Seminars	4	3hr	20	80
Sheep Advisory Meeting	1	4hr	40	40
Ultrasound Contest Judging	4	3hr	8	32
Noxious Weed Grazing	1	5hr	5	5
Ultra sounding Rams	1	2days	6	6
Plot Work-Miles City	1	5hr	2	2
Plot Work- Chinook	1	5hr	2	2
Ultra sounding Rams- Miles City/Jordan	2	5hr	3	6
Judging Leg Scoring- Billings	1	3hr	50	50
Sheep Program	2	4hr	35	70
Judging Crops	1	4hr	15	15
Ultra sounding Rams- Wolf Point	1	3hr	5	5

Judge Sheep Show- Columbus	1	6hr	50	50
Preparing Lambs	1	6hr	2	2
Current Wool & Lamb Info	1	0.5hr	60	60
Coring Wool	1	5hr	6	6
Plot Work- Columbus	1	5hr	2	2
Judging Sheep Show- Hamilton	1	15hr	50	50
Sheep Shearing Instruction	1	6hr	25	25
Wool Pool Delivery	1	6hr	40	40
Ultra sounding Rams	1	3hr	5	5
Plot Work- Deer Lodge	1	6hr	3	3
Ultra sounding Rams- Joliet	1	2hr	3	3
Producer Wool Grading	1	5hr	10	10
Sheep Program	1	3hr	45	5
Sheep Grazing Noxious Weeds	1	1hr	20	20
Plot Work- Helena	1	3hr	2	2
Plot Work- Absarokee	1	5hr	2	2
Judging Long Wools- Kalispell	1	7hr	25	25
Selecting and Culling Sheep	1	8hr	3	3

Rodney Kott 2010				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
Sheep Production	1	4hr	10	10
Wool Industry	1	1hr	50	50
Markets	1	0.5hr	30	30
MSU Sheep Program	1	1hr	10	10
Youth Ultrasound Education	1	2hr	44	44
Wool Marketing	1	4hr	100	100
Targeted Grazing	1	1hr	10	10
Weed Management with Sheep	1	2hr	50	50
Wool	2	1hr	25	50
Sheep Production	4	0.5hr	20	80
Wool Pool Marketing	1	0.5hr	30	30
Internal Parasites	1	0.5hr	50	50
Sheep Selection	1	1hr	5	5
Culling Ewes & Rams	1	1hr	20	20
Wool	1	1hr	20	20
Wool Marketing	1	4hr	25	25
Wool Preparation	1	4hr	10	10
Culling Ewes	1	0.5hr	30	30
Sheep Selection	1	2hr	150	150
Beginning Shearing School	1	3days	15	15
Wool Pool Meeting	1	1hr	25	25
Alfalfa Weevil	1	0.5hr	15	15
Fiberfest Workshop	1	1hr	15	15

Wool Preparation	1	4hr	30	30
Wool Marketing	6	2hr	30	180
Lamb Survival	1	0.5hr	30	30
Wool Classing	1	0.5hr	50	50
Genetic Records	1	1hr	65	65
Ram Selection- Ultrasound	17	1hr	8	136
Targeted Grazing	1	1hr	10	10
Advanced Shearing School	1	3days	15	15
Internal Parasites	1	0.5hr	30	30
Managing Sheep	1	0.5hr	15	15
Lamb and Wool Market	1	1hr	65	65
Sheep Research	2	1hr	25	50
Wool Harvesting	1	4hr	100	100
Wool Preparation	2	1hr	25	50
4-H Market Lamb	6	1hr	20	120
Targeted Grazing	1	1hr	25	25
Lamb Markets	1	0.5hr	15	15
MSU Sheep Program	1	0.5hr	75	75
Wool Marketing	1	0.5hr	15	15

James Moreaux 2012				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
Lameness of the Horses Foot	1	50 min		30
Equine Nutrition and Forage Analysis	6	1.5 hr	35	210
Horse Colic	1	50 min		30
Equine First Aid and Bandaging	5	2 hr	30	150
Horse Anatomy	2	2 hr	15	30
Laminitis Treatment	2	2 hr	7	15
Parasites in Horses	4	2 hr	15	60
Equine Weight Management and Conditioning	1	3 hr		15
Strep Equi Diagnosis, Prevention, and Control	2	2 hr	20	40
Oral Sedation for Horses	2	50 min	30	60

James Moreaux 2011				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
Forage Analysis	3	1.5 hr	25	75
Equine Parasite Control	2	1.5 hr	25	50
Equine First Aid and Emergencies	2	1.5 hr	35	70
Parasite Control in Horses	1	2 hr	35	35
Equine Thoracic Limb Anatomy	1	1.5 hr	30	30

Equine Anatomy, Biomechanics and Farrier Short Course	2	1.5 days	50	100
Immunology and Vaccine Technology	1	1.5 hr	25	25
Equine Pelvic Limb Anatomy	1	1.5 hr	30	30

James Moreaux 2010				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
Horse Vital Signs and First Aid	1	1.5 hr	30	30
Radiography and Radiographic Interpretation	4	1.5 hr	205	820
Veterinarian - Farrier Short Course	1	1 day	45	45
Back Country First Aid	1	3 hr	15	15
Therapeutic Horse Shoeing	3	1 day	20	60

Jeffrey Mosley 2012				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
Riparian Monitoring Workshop	1	3hr	12	12
MSU Extension New Agent Orientation: MSU Extension Range Management Program	1	0.25hr	5	5
Livestock Grazing Management	15	2hr	2	28
Targeted Livestock Grazing for Weed Control	7	0.5hr	34	241
MSU Extension Spring AG Agent Update: Twice-Over Rotation Grazing	1	0.5hr	31	31
Park County Noxious Weed Fair: Managing Cheatgrass	1	1hr	100	100
Extension: Rangeland Stewardship & Health Community of Practice	2	0.5hr	210	420
MSU Extension Annual Conference: MSU Extension Range Management Institute	1	1hr	15	15
MSU Extension Annual Conference: Small Acreage Workshop for Ag Agents	1	4hr	30	30
Tri-County Weed Tour: Grazing Management to Suppress Weeds	1	1hr	26	26
Pasture Management Professional Development Workshop: Animal Behavior in Pasture Management	1	0.5hr	28	28
Pasture Management Professional Development Workshop: Stocking Rate, Carrying Capacity, and Animal Performance	1	0.5hr	28	28
MSU Extension Fire/Drought Webinar Series: Recovery of Montana Rangeland and Forest Understory After Fire	1	.75hr		

Pasture Management Professional Development Workshop: Grazing Systems	1	0.5hr	28	28
MSU Extension Weed Certification Workshop: Rangeland Ecology 101	2	1hr	38	76
Conifer and Russian Olive Encroachment	1	0.75hr	13	13
Grazing Management after Drought or Wildfire	2	1hr	58	115
Stillwater County Pesticide and Rangeland Education Workshop: Integrated Range Weed Management	1	1hr	50	50
MSU Extension Weed Certification Workshop: Targeted Grazing, A Tool for Invasive Plant Management	2	1hr	38	76
Northern International Livestock Exposition Ag Education for Youth: Range Management	1	24hr	1701	1701
Montana Envirothon Teachers Workshop: Grazing Management and Monitoring	1	3hr	35	35
Montana Range Days: Rangeland Health Assessment	1	8hr	300	
Rangeland Photo Monitoring	1	6hr	1	1
Sheridan County Grazing Management and Monitoring Workshop	1	6hr	24	24
Forest Stewardship Workshop	1	24hr	15	15

Jeffrey Mosley 2011				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
Targeted Livestock for Weed Control	9	2hr	26	221
MSU Extension Spring Ag Agent Update: Maximizing Livestock Profits from Range Resources	1	0.75hr	40	40
Biological Weed Control	2	1hr	29	57
Livestock/Predator Relationships	2	1hr	22	44
Livestock Grazing Management	9	2hr	1	14
Grazing Management to Prevent Weeds	1	1hr	40	40
Northern International Livestock Exposition Ag Education for Youth: Range Management	1	24hr	1800	1800
Rangeland Photo Monitoring	1	6hr	1	1
Conflict Resolution/Collaborative Planning	1	1.5hr	11	11
Rangeland Inventory and Monitoring	1	2hr	22	22
Livestock-Wildlife Relationships	1	3.5hr	3	3
Small Acreage Landowner Education: Montana's Poisonous Plants	1	1hr	42	42
Montana Range Days: Rangeland Health Assessment	1	8hr	300	300
Forest Stewardship Workshop	1	24hr	15	15

Senator Tester's Small Business Opportunity Agriculture Workshop: Grazing Management for Maximizing Long-Term Profits	1	1hr	25	25

Jeffrey Mosley 2010				
Title	Number Locations	Avg. Length	Avg. Attendees	Total Attendees
Livestock Grazing Management	15	4hr	2	27
MSU Extension Annual Conference Ag Update: Grazing Management Guidelines for Montana Rangelands, Pastures, and Forest	1	3hr	18	18
Targeted Livestock Grazing for Weed Control	5	1hr	12	57
Riparian Monitoring Workshop	2	3hr	20	40
MSU Extension Spring Ag Agent Update: Is Rotational Grazing Beneficial?	1	0.5hr	36	36
Northern International Livestock Exposition Ag Education for Youth: Range Management	1	3days	1800	1800
Western Region-National Association of County Agriculture Agents Professional Development Conference: Targeted Livestock Grazing for Vegetation Management	1	1hr	60	60
Montana Range Days	1	1day	300	300
Rangeland Photo Monitoring	1	6hr	1	1
Small Acreage Landowner Education: Pasture Management for Healthy Acres	2	1.5hr	27	53

V. ACADEMIC PROGRAMS: UNDERGRADUATE AND GRADUATE

A & RS Undergraduate Program

Overview

The undergraduate program in the Department of Animal and Range Sciences provides students the necessary education to continue their education or secure positions of their choice. In addition, courses serve students outside A&RS majors. Course offerings vary from traditional classroom settings to laboratory and/or field experiences. The program integrates natural and physical sciences with real-world application. Students graduating with a degree in Animal Sciences, Rangeland Ecology and Management, or the interdisciplinary Sustainable Food and Bioenergy Systems are able to integrate science into critical thinking skills to help solve modern day problems. Faculty in Animal and Range Sciences consider a strong teaching program for educating undergraduate students to be essential for the well-being of Montana's natural resources, the agriculture community, the College of Agriculture and Montana State University.

Departmental Teaching Commitments

Faculty teaching FTE for 2001-2002 to 2011-1012 ranged from a low of 6.4 in 2001-2002 to a high of 11.3 in 2006-2007 (Figure 2). The spike in 2006 most likely represents faculty numbers after creation of Equine Science Option (addition of Dr. Shannon Moreaux) and before retirements of several faculty members. Total student credit hours taught during the same time frame steadily increased from 3,340 to 4,927 (a 47.5% increase; Figure 3). As a result, there has been a substantial increase (23.4%) in student credit hours taught per teaching FTE (Figure 4). Animal and Range Science faculty are teaching an estimated 646 student credit hours/FTE during 2011-2012. A portion of this increase may be attributed to larger class sizes. As a result, there has been an increase in the time commitment for meeting in person with students during office hours, communicating with students via e-mail, and grading assignments. In addition, faculty have commented that they have decreased the writing assignments as a result of increased class sizes. This increase is not unique to Animal and Range Sciences. There has been an increase in overall student numbers at Montana State University during the last few years.

Undergraduate majors have steadily increased from 170 majors during 2001-2002 to 311 in 2011-2012 (an 83% increase; Figure 5). This increase can be primarily attributed to adding the Wildlife Management and Ecology option to the Natural Resource and Ecology major in 2006 and the Equine Science option in the Animal Science major in 2002; Sustainable Foods and Bioenergy Systems Sustainable Livestock Production option added in 2010. Animal and Range Sciences received funding as a result of enrollment growth through the Dean of the College of Agriculture from the Provost's office for Non-Tenure-Track (NTT) faculty to teach newly created Equine Science courses starting fall 2012. This request was made over many years by the A&RS Department after the creation of the option in the Animal Science degree program. In addition, the department recently received approval to hire a NTT faculty member to teach the introductory and 'hands-on' courses and coach the livestock judging team.

Departmental faculty in currently teach 21 formal courses (not including undergraduate research, special topics, independent study, seminar, and internship credits) in Animal Science (ANSC), 6 formal courses in Equine Science (EQUS), 7 Equitation courses

(EQUH), 11 Natural Resources (NRSM), and 5 courses in Wildlife (WILD). Two courses (ANSC 265 and 266) are currently taught by a NTT faculty member in Immunology and Infectious Diseases (ImID). Twelve of the courses are lower division (100 and 200 level) with the remainder are upper division courses (300 and 400 level). Four courses carry core designations, meaning that they meet area requirements under MSU's CORE 2.0 requirements for Contemporary Issues in Science and Natural Science Inquiry (NRSM 240) and Research and Creative Experience (ANSC 416; ANSC 432, ANSC 434 and 490R). The 2012 ratio of majors/student FTE = 1.98 indicates that a majority of students are majors in the courses. However, several of the lower division courses contain students enrolled from multiple majors.

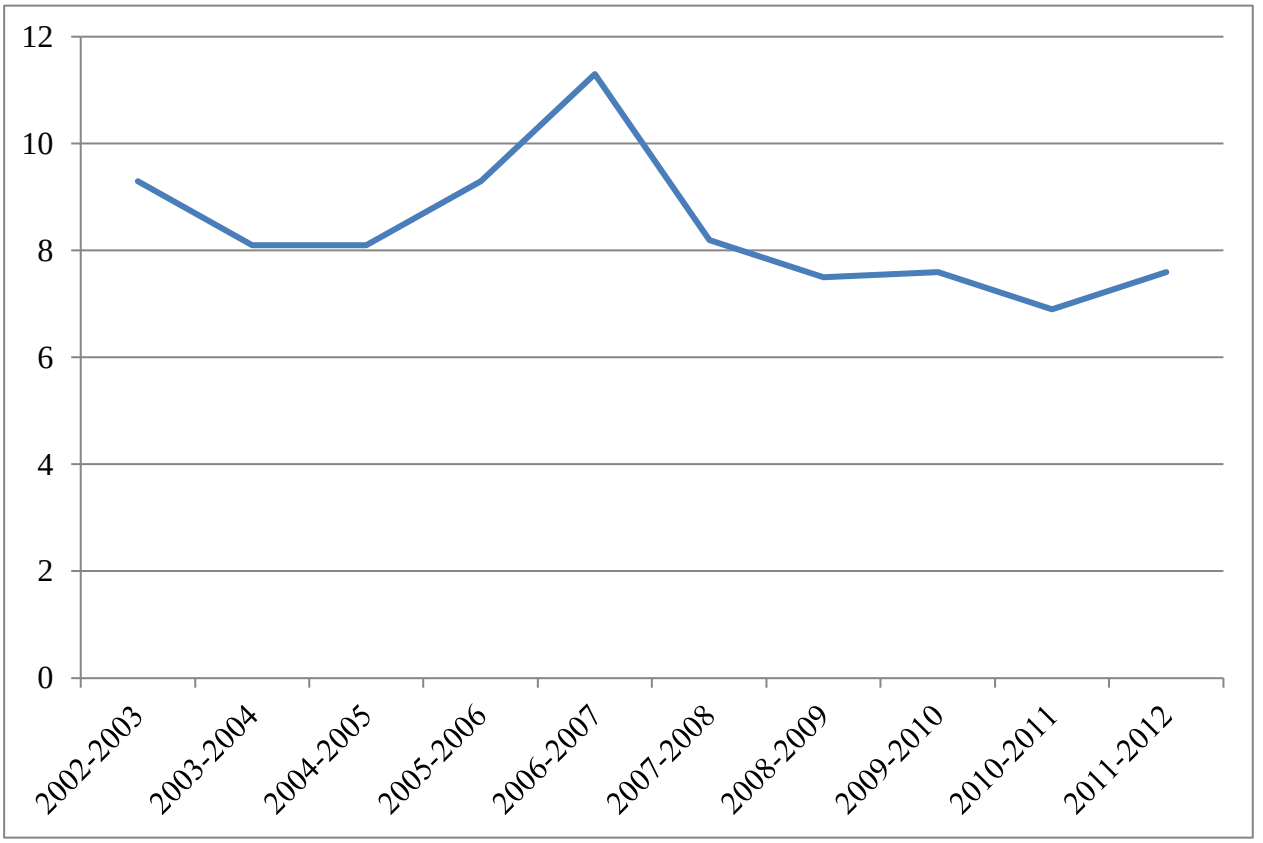


Figure 2. Faculty teaching FTE is shown on the y-axis for academic year (AY). Data Source: MSU Office of Planning and Analysis.

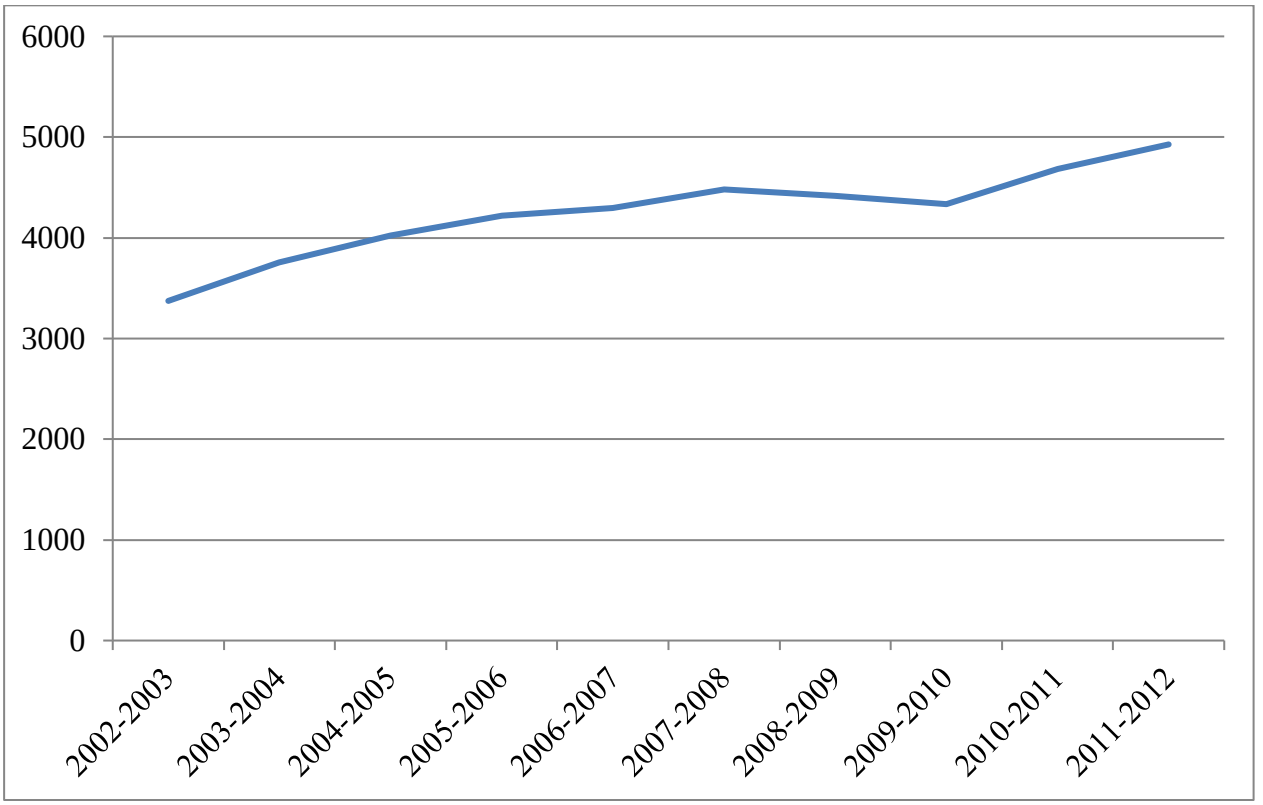


Figure 3. Total student credit hours (SCH) taught by year. Data Source: MSU Office of Planning and Analysis.

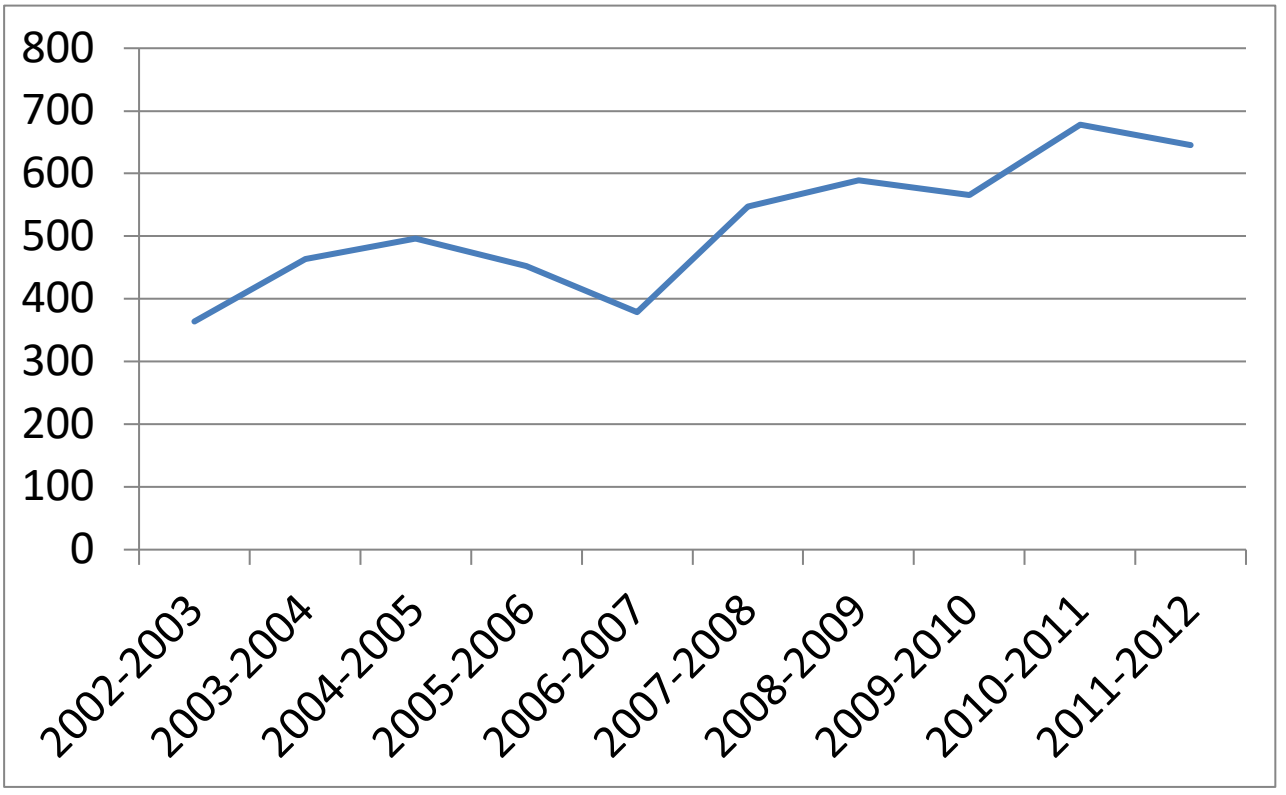


Figure 4. Total student credit hours (SCH) taught divided by faculty teaching FTE by year. Data Source: MSU Office of Planning and Analysis.

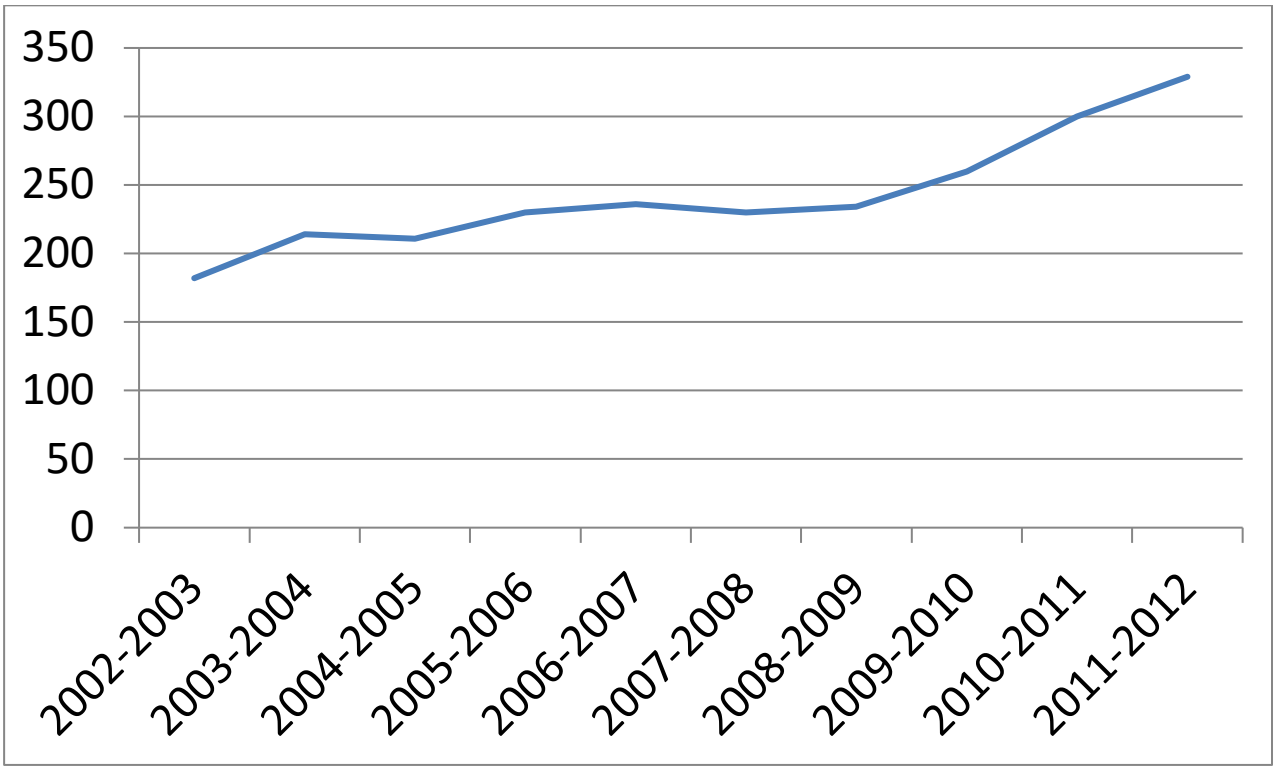


Figure 5. Undergraduate majors in A&RS in by year. Data Source: MSU Office of Planning and Analysis.

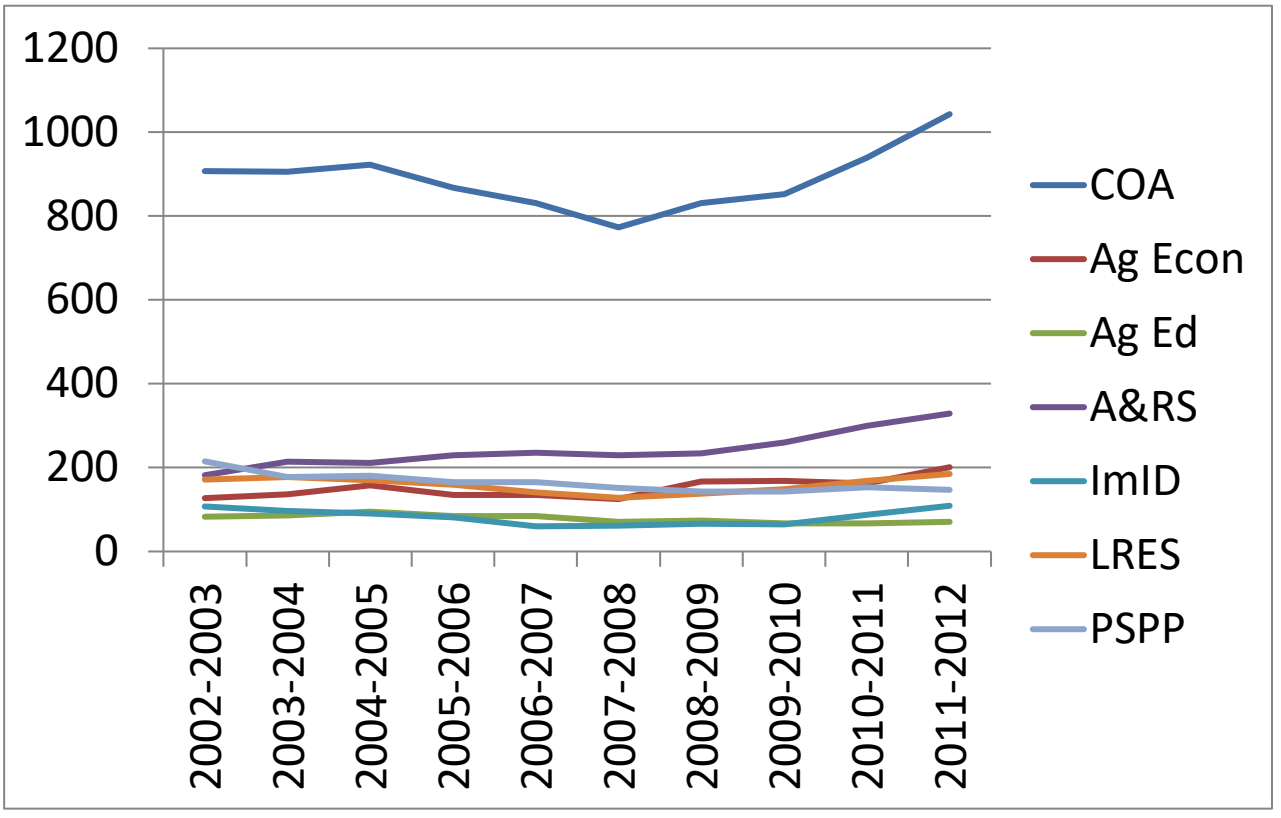


Figure 6. Undergraduate majors in COA. Data Source: MSU Office of Planning and Analysis

Internships and Undergraduate Research Opportunities

Internships or undergraduate research is required for degrees in Animal Science with Livestock Production and Management, Science, and Equine Science options. The Sustainable Livestock Production option in SFBS also requires an internship or research experience. Majors in Natural Resource and Rangeland Ecology are not required to take internships, but are encouraged to do so. Undergraduate research experience is also offered with individual faculty members. These research projects can be paid for by individual grants or through the MSU Undergraduate Scholars Program. Students in the Undergraduate Scholars Program present their final results at the annual MSU Student Research Celebration.

Departmental Majors and Minors

Undergraduate Degree in Animal Science

The animal science curriculum is administered by the Department of Animal and Range Sciences. The curriculum provides students with a firm foundation in the biological and natural sciences, animal breeding, reproductive physiology, nutrition, and livestock production and management. The curriculum emphasizes applications to production environments of the western United States. This includes the close relationships among livestock, rangelands, and natural resources. Three options are offered leading to a B.S. in Animal Science. Proper use of restricted electives allows students to tailor curriculum to meet their individual needs.

- **Livestock Management & Industry Option** (ASLV) stresses the application of science to livestock production. This option incorporates courses in agricultural economics and business. Emphasis is placed on applying skills as they relate to livestock enterprises and service industries closely allied to livestock production. These skills include principles of economics, range science, genetics, business management, and physiology and nutrition in sustainable livestock production systems. This option incorporates flexible coursework choices to prepare graduates to manage livestock enterprises, or to be employed by companies producing and marketing livestock, animal feeds and health products. Graduates can also be employed by a variety of communication and service organizations, including breed associations, commodity groups, livestock publications and government agencies.
- **Science Option** (ASSE) emphasizes greater depth in the basic sciences. This option is designed for highly motivated students who have a strong interest in graduate training or professional school. Individual curriculum can be tailored to prepare students for veterinary school, medical school, or graduate studies in animal biotechnology, physiology, nutrition or genetics.

- **Equine Science Option**(ASEQ) emphasizes science and technology combined with practical aspects of management, horsemanship and training. Graduates of this program will have a firm foundation to meet the growing needs of the equine industry. This program is designed to prepare students for employment in equine breeding or nutrition, or managing facilities and land. Graduates can also be employed in the allied industries, such as sales, feed, tack, and equipment. Students can tailor their program to emphasize science, business, or rangeland ecology and management
- **Animal Science Minor -** A minor is a secondary area of academic specialization. A minor in Animal Science can serve as an excellent complement to several other majors offered at MSU, and to expand career opportunities.

Interdisciplinary degree in Sustainable Foods and Bioenergy Systems

This program is a unique interdisciplinary curriculum designed for students interested in the interconnected processes of crop production, processing, distribution, and utilization of food and bioenergy. The degree focuses on ecologically sound, socially just, and economically viable farming methods, food and health, and related food and bioenergy system topics. Students work closely with faculty to gain hands-on experience enhancing practical skills and knowledge, and in specific, self-selected focus areas through internships. The degree plan is intended to encompass a wide range of food- and bioenergy-related areas in order to prepare students for career opportunities in agricultural business, public health and community food security, natural resource conservation, bioenergy production, marketing, distribution, and local food systems.

- **Sustainable Livestock Production Option**

  Sustainable Livestock Production focuses on the biological understanding of animal agriculture and its continued presence in sustainable grazing systems as well as its potential role in sustainable farming systems. Students will be introduced to the principles, practices and issues impacting the production, processing and preservation of safe, wholesome, nutritious, and palatable meat along with the regulatory requirements for selling animal products. Sustainable Livestock Production focuses on the science of animal production, but expands student learning to a larger systems understanding to the role of domestic livestock in sustainable systems. In addition, students will be exposed to the role of strategic grazing in landscape management as well as using livestock to manage potential waste streams from other industries.

Undergraduate degree in Natural Resources and Rangeland Ecology

Natural Resources and Rangeland Ecology is concerned with managing the soil-plant-animal complex on rangelands. Students acquire an understanding of grazing and other land uses within the framework of total resource management. The curricula, administered by the Department of Animal and Range Sciences, includes course work in basic and applied plant and animal sciences, and wild land management.

Additionally a B.S. in Natural Resources and Rangeland Ecology prepares students for employment with state and federal land management agencies. Other career opportunities include range livestock production, land resource consulting and general agriculture.

- **Rangeland Ecology and Management Option** emphasizes the interactions between natural resources and using rangelands for sustainable livestock production. This option prepares students for careers in livestock production, allied industries, and agencies related to managing rangelands for livestock.
- **Wildlife Habitat Ecology and Management Option** offers students with an interest in wildlife habitat the opportunity to study a multidisciplinary approach to wildlife, livestock, and their habitats. Career opportunities in federal agencies are at an all-time high for students with bachelor degrees that emphasize habitat ecology and management.
- **Natural Resources and Rangeland Ecology (NRRE) Minor -** A minor is a secondary area of academic specialization. A minor in NRRE can serve as an excellent complement to several other majors offered at MSU to expand career opportunities.

Course requirements for a B.S. Animal Science - Science

A minimum of 120 credits is required to graduate, 42 must be 300 level or above.

DEPARTMENTAL REQUIREMENTS FOR THIS OPTION CREDITS: 76						
Dept/Course #	Course Title	Credits	Class/Semester		Year	Sub/Transfer
ANSC 100	Intro Animal Science	3	FR	S		
NRSM 101	Natural Resource Conservation	3	FR	F		
NRSM 102	Montana Range Plants Lab	1	FR	F		
ANSC 222	Livestock in Sustainable Systems	3	SO	S		
NRSM 240	Natural Resource Ecology	3	SO	F		
ANSC 320	Animal Nutrition	4	JR	F		
ANSC 321	Physiology of Reproduction	4	JR	F		
ANSC 322	Principles of Animal Breeding & Genetics	3	JR	S		
ANSC 490R **OR** ANSC 498	Undergrad Research Internship	3 3	JR JR	FS FSSu		
AGED 140 US OR COM 110 US	Leadership Dev for Ag & Ind Employee Public Communication	3 3	FR FR	FS (F) FSSu (F)		
BCH 380	Biochemistry	5	JR	FSSu (F)		
BIOB 170	Princ of Biological Diversity	4	FR	FS (F)		
BIOB 160	Princ of Living Systems	4	FR	FS (S)		
CHMY 141	College Chemistry I	4	FR	FSSu (F)		
CHMY 143	College Chemistry II	4	FR	FSSu (S)		
CHMY 211	Elements Organic Chemistry	5	SO	FS (S)		
WRIT 101 W	College Writing I	3	FR	FSSu (F)		
BMGT 205 OR	Mgmt Communication Fundamentals	3	SO	FSSu (F)		

WRIT 221	Intermediate Tech Writing	3	SO	FS		
M 161 Q	Survey of Calculus	4	SO	FSSu (F)		
BIOB 318 OR STAT 216 Q	Biometry Elementary Statistics	3 3	SO SO	F FSSu (S)		
BIOB 105CS	Intro to Biotechnology	3	SO	F		
ANSC 265	Functional Anatomy of Dom Animals	3	SO	S		
ANSC 266	Functional Anatomy of Dom Animals Lab	1	SO	S		
LIVESTOCK MANAGEMENT ELECTIVES REQUIRED: 6						CREDITS
ANSC 316	Meat Science	4	JR	S		
EQUS 430	Horse Management	4	SR	S		
ANSC 432	Sheep Management	3	SR	S		
ANSC 434R	Beef Cattle Management	4	SR	F		
RESTRICTED ELECTIVES						CREDITS REQUIRED: 12
ANSC 337	Diseases of Domestic Livestock	3	JR	S		
ANSC 410	Veterinary Entomology (Alt Yrs 2014)	2	SR	S		
BIOB 375	General Genetics	3	JR	FS (F)		
BIOO 310	Comp Vertebrate Anatomy	4	JR	S		
BIOH 323	Human Developmental Biology	4	JR	S		
BIOH 454	Microanatomy (Histology)	4	SR	F		
BIOO 412	Animal Physiology	3	JR	F		
BIOM 360	General Microbiology	5	JR	FS		
PHSX 205	Physics I	4	JR	FSSu		
PHSX 207	Physics II	4	JR	FSSu		
FREE ELECTIVES						

CORE 2.0

Seminar (US)	
Writing (W)	
Quantitative Reasoning (Q)	
Diversity (D)	
Contemporary Issues in Science (CS)	
Arts (IA or RA)	
Humanities (IH or RH)	
Natural Sciences (IN or RN)	
Inquiry Social Science (IS or RS)	
Research & Creative Exper. (R, RA, RH, RS, RN)	

Completion of at least **two** of the following courses with a grade of C- or better satisfies both the Contemporary Issues in Science and the Natural Science Inquiry requirements: NRSM 240; BIOB 110, 160, 170, 256, 258, 260; BIOH 201, 211; BIOM 210, 250; BIOO 220; CHMY 121, 123, 141, 143, 151, 153, 211; GEO 101, 103, 205, 211; GPHY 111; LRES 201; PHSX 205, 207, 220, 222, 224, 240, 242.

Course requirements for a B.S. Degree Animal Science - Livestock Production and Management

A minimum of 120 credits is required to graduate, 42 must be 300 level or above.

DEPARTMENTAL REQUIREMENTS FOR THIS OPTION CREDITS: 68						
Dept/Course #	Course Title	Credits	Class/Semester		Year	Sub/Transfer
ANSC 100	Intro Animal Science	3	FR	S		
NRSM 101	Natural Resource Conservation	3	FR	F		
NRSM 102	Montana Range Plants Lab	1	FR	F		
ANSC 222	Livestock in Sustainable Systems	3	SO	S		
NRSM 240	Natural Resource Ecology	3	SO	F		
ANSC 316	Meat Science	4	JR	S		
ANSC 320	Animal Nutrition	4	JR	F		
ANSC 321	Physiology of Reproduction	4	JR	F		
ANSC 322	Principles of Animal Breeding & Genetics	3	JR	S		
ANSC 337	Diseases of Domestic Livestock	3	JR	S		
ANSC 498	Internship	3	SR	FSSu		
AGBE 210 IS	Economics of Agricultural Business	3	SO	S		
AGED 140 US OR COM 110 US	Leadership Dev for Ag & Ind Employee Public Communication	3 3	FR FR	FS (F) FSSu (F)		
CHMY 123	Intro to Organic & Biochem	4	SO	FSSu (F)		
BIOB 160	Princ of Living Systems	4	FR	FS (S)		
BGMT 205 OR WRIT 221	Mgmt Communication Fundamentals Intermed Tech Writing	3 3	SO SO	FSSu (F) FS (F)		
CHMY 121 IN	Intro General Chemistry	4	FR	FSSu (F)		
ECNS 101 IS	Economic Way of Thinking	3	FR	FSSu (S)		
WRIT 101 W	College Writing I	3	FR	FSSu (F)		

STAT 216 Q	Elementary Statistics	3	SO	FSSu (S)		
ANSC 265	Functional Anatomy of Dom Animals	3	SO	S		
ANSC 266	Functional Anatomy of Dom Animals Lab	1	SO	S		
LIVESTOCK & RANGE PRACTICUM ELECTIVES TAKE TWO						
ANSC 205 OR ANSC 308	Introduction to Meat Evaluation Livestock Evaluation	2 2	SO JR	F F		
ANSC 232	Lvstk Mgmt-Sheep	1	SO	S		
EQUS 233	Horse Science and Mgmt Lab	1	SO	F		
ANSC 234	Lvstk Mgmt-Beef	1	SO	S		
NRSM 235	Range and Pasture Monitoring	1	SO	F		
LIVESTOCK MANAGEMENT ELECTIVES CREDITS REQUIRED: 6						
ANSC 416R	Meat Processing	3	SR	F		
EQUS 430	Horse Management	4	SR	S		
ANSC 432	Sheep Management	3	SR	S		
ANSC 434R	Beef Cattle Management	4	SR	F		
ECON AND BUSINESS ELECTIVES CREDITS REQUIRED: 9						
ACTG 201	Princ of Financial Accounting	3	SO	FSSu		
ACTG 202	Princ of Managerial Accounting	3	SO	FSSu		
ACTG 220	Survey of Accounting	3	SO	On demand		

AGBE 321	Econ of Ag Marketing	3	JR	F		
AGBE 337	Ag Law	3	JR	FS		
AGBE 341	Farm and Ranch Management	3	JR	S		
AGBE 345	Ag Finance & Credit Analysis	3	JR	F		
AGBE 421	Advanced Ag Marketing	3	SR	S		
AGED 353	Coop Bus Principles & Practices	3	JR	F		
BMGT 335	Management & Organization	3	JR	FSSu		
BMKT 325	Marketing	3	JR	FSSu		
BGEN 361	Princ of Business Law	3	JR	FSSu		
BGEN 242 D	Intro to Global Markets	3	SO	FS		

CORE 2.0

Seminar (US)	
Writing (W)	
Quantitative Reasoning (Q)	
Diversity (D)	
Contemporary Issues in Science (CS)	
Arts (IA or RA)	
Humanities (IH or RH)	
Natural Sciences (IN or RN)	
Inquiry Social Science (IS or RS)	
Research & Creative Exper. (R, RA, RH, RS, RN)	

Completion of at least **two** of the following courses with a grade of C- or better satisfies both the Contemporary Issues in Science and the Natural Science Inquiry requirements: NRSM 240; BIOB 110, 160, 170, 256, 258, 260; BIOH 201, 211; BIOM 210, 250; BIOO 220; CHMY 121, 123, 141, 143, 151, 153, 211; GEO 101, 103, 205, 211; GPHY 111; LRES 201; PHSX 205, 207, 220, 222, 224, 240, 242.

Course requirements for a B. S. Degree Animal Science – Equine Science

DEPARTMENTAL REQUIREMENTS FOR THIS OPTION CREDITS: 78						
Dept/Course #	Course Title	Credits	Class/Semester		Year	Sub/Transfer
ANSC 100	Intro Animal Science	3	FR	S		
NRSM 101	Natural Resource Conservation	3	FR	F		
NRSM 102	Montana Range Plants Lab	1	FR	F		
ANSC 222	Livestock in Sustainable Systems	3	SO	S		
NRSM 236	Small Pasture Management	1	SO	S		
ANSC 320	Animal Nutrition	4	JR	F		
ANSC 321	Physiology of Reproduction	4	JR	F		
ANSC 322	Principles of Animal Breeding & Genetics	3	JR	S		
EQUS 327	Equine Lameness	3	JR	F		
ANSC 337	Diseases of Domestic Livestock	3	JR	S		
EQUS 347	Equine Form to Function	3	JR	F		
EQUS 346	Equine Reproduction Mgmt	4	SR	S		
EQUS 423	Equine Nutrition (Alt Yrs 2013)	2	SR	S		
EQUS 430	Horse Management	4	SR	S		
ANSC 498	Internship	3	SR	FSSu		
AGED 140 US OR COM 110 US	Leadership Dev for Ag & Ind Employee Public Communication	3 3	FR FR	FS (F) FSSu (F)		
CHMY 123	Intro to Organic/Biochm	4	SO	FSSu (F)		
BIOB 160	Princ of Living Systems	4	FR	FS (S)		
BMGT 205 OR WRIT 221	Mgmt Communication Fundamentals Intermed Tech Writing	3 3	SO SO	FSSu (F) FS (F)		
CHMY 121 IN	Intro General Chemistry	4	FR	FSSu (F)		
ECNS 101 IS	Economic Way of Thinking	3	FR	FSSu (S)		
ECNS 202	Princ Macroeconomics	3	SO	FSSu (F)		

or ECNS 204 IS	Microeconomics	3	SO	FS (F)		
WRIT 101 W	College Writing I	3	FR	FSSu (F)		
BIOB 318 OR STAT 216 Q	Biometry Elementary Statistics	3 3	SO SO	F FSSu (S)		
ANSC 265	Functional Anatomy of Dom Animals	3	SO	S		
ANSC 266	Functional Anatomy of Dom Animals Lab	1	SO	S		
APPLIED COURSES						CREDITS REQUIRED: 8
EQUH 110	Western Equitation	2	FR	FS		
EQUH 114	English Equitation	2	FR	FS		
EQUH 207	Intermediate English Equitation	2	SO	S		
EQUH 210	Intermediate Western Equitation	2	SO	FS		
EQUH 253	Starting Colts	2	SO	F		
EQUH 256	Developing the Young Horse	2	SO	S		
EQUS 233	Horse Science & Mgmt Lab	1	SO	F		
NRSM 235	Range and Pasture Monitoring	1	SO	F		
EQUH 314	Equestrian Instruction Methods	2	JR	FS		
ECON AND BUSINESS ELECTIVES CREDITS REQUIRED: 9						
ACTG 201	Principles of Financial Accounting	3	SO	FSSu		
ACTG 202	Principles of Managerial Accounting	3	SO	FSSu		
ACTG 220	Survey of Accounting	3	SO	On demand		
AGBE 210 IS	Economics of Agricultural Business	3	SO	S		
AGBE 321	Econ of Ag Marketing	3	JR	F		
AGBE 337	Ag Law	3	JR	S		
AGBE 341	Farm and Ranch Management	3	JR	S		
AGBE 345	Ag Finance & Credit Analysis	3	JR	F		
AGBE 421	Advanced Ag Marketing	3	SR	S		

AGED 353	Coop Bus Principles & Practices	3	JR	F		
BMGT 335	Management & Organization	3	JR	FSSu		
BMKT 325	Marketing	3	JR	FSSu		
BGEN 361	Princ of Business Law	3	JR	FSSu		
BGEN 242 D	Intro to Global Markets	3	SO	FS		
MANAGEMENT AND INDUSTRY ELECTIVES CREDITS REQUIRED: 12						
ANSC 232	Lvstk Mgmt-Sheep	1	SO	S		
ANSC 234	Lvstk Mgmt-Beef	1	SO	S		
NRSM 240	Natural Resource Ecology	3	SO	F		
NRSM 455	Riparian Ecology & Management	3	JR	S		
NRSM 353	Grazing Ecology & Management	3	JR	S		
ANSC 410	Veterinary Entomology (Alt Yrs 2014)	2	SR	S		
ANSC 418	Topics in Beef Nutrition (Alt Yrs 2014)	2	SR	S		
ANSC 432	Sheep Management	3	SR	S		
ANSC 434R	Beef Cattle Management	4	SR	F		
NRSM 453	Habitat Inventory and Analysis	3	SR	F		
ENSC 245 IN	Soils	3	SO	F		
AGSC 341	Field Crop Production (Alt Yrs 2014)	3	JR	S		
AGSC 342	Forages	3	JR	F		
FREE ELECTIVES						

CORE 2.0

Seminar (US)	
Writing (W)	
Quantitative Reasoning (Q)	
Diversity (D)	
Contemporary Issues in Science (CS)	

Arts (IA or RA)	
Humanities (IH or RH)	
Natural Sciences (IN or RN)	
Inquiry Social Science (IS or RS)	
Research & Creative Exper. (R, RA, RH, RS, RN)	

Completion of at least **two** of the following courses with a grade of C- or better satisfies both the Contemporary Issues in Science and the Natural Science Inquiry requirements: NRSM 240; BIOB 110, 160, 170, 256, 258, 260; BIOH 201, 211; BIOM 210, 250; BIOO 220; CHMY 121, 123, 141, 143, 151, 153, 211; GEO 101, 103, 205, 211; GPHY 111; LRES 201; PHSX 205, 207, 220, 222, 224, 240, 242.

Course requirements for a B.S. in Natural Resources and Rangeland Ecology

B.S. Degree in

A minimum of 120 credits is required to graduate, 42 must be 300 level or above.

DEPARTMENTAL REQUIREMENTS FOR THIS OPTION CREDITS: 90						
Dept/Course #	Course Title	Credits	Class/Semester		Year	Sub/Transfer
ANSC 100	Intro Animal Science	3	FR	S		
NRSM 101	Natural Resource Conservation	3	FR	F		
NRSM 102	Montana Range Plants Lab	1	FR	F		
ANSC 222	Livestock in Sustainable Systems	3	SO	S		
NRSM 235	Range and Pasture Monitoring	1	SO	F		
NRSM 240	Natural Resource Ecology	3	SO	F		
NRSM 455	Riparian Ecology & Management	3	SR	S		
NRSM 350	Vegetation of Western Wildlands	3	JR	S		
NRSM 351	Biomes of Western Wildlands	2	JR	S		
NRSM 353	Grazing Ecology & Management	3	JR	S		
NRSM 330	Fire Ecology & Management	3	JR	F		
WILD 438	Wildlife Habitat Ecology	3	SR	S		
NRSM 453	Habitat Inventory & Analysis	3	SR	F		
AGED 140 US OR COM 110 US	Leadership Dev for Ag & Ind Employee Public Communication	3 3	FR FR	FS (S) FSSu (S)		
CHMY 123	Intro to Organic & Biochem	4	SO	FSSu (S)		
BIOB 170	Princ of Biological Diversity	4	FR	FS (F)		
BIOB 160	Princ of Living Systems	4	FR	FS (S)		
BIOO 230	Identification of Seed Plants	4	SO	S		
BIOE 370	General Ecology	3	SR	S		
BMGT 205 or WRIT 201 or WRIT 221	Mgmt Communication Fundamentals College Writing II Intermediate Tech Writing	3	SO	FS (F)		

CHMY 121 IN	Intro General Chemistry	4	FR	FSSu (F)		
ECNS 101 IS	Economic Way of Thinking	3	FR	FSSu (F)		
WRIT 101 W	College Writing I	3	FR	FSSu (F)		
WILD 301	Principles of F&WL Management	3	SO	Su		
GPHY 284	Intro to GIS Science	3	JR	FS (F)		
ENSC 245	Soils	3	SO	F		
ENSC 454	Landscape Pedology	3	SR	F		
BIOB 318 OR STAT 216 Q	Biometry Elementary Statistics	3 3	SO SO	F FSSu (S)		
BIOO 433	Plant Physiology	3	SR	S		
AGSC454 OR BIOO 435	Agrostology (Alt Yrs 2013) Plant Systematics (Alt Yrs 2012)	3 3	JR JR	F F		
MUST CHOOSE ONLY ONE OPTION BELOW TO COMPLETE:						
RANGELAND ECOLOGY AND MANAGEMENT OPTION						***CREDITS REQUIRED: 15***
WILD 325	Wildlife-Livestock Nutrition	3	JR	S		
ENSC 461	Restoration Ecology	3	JR	F		
AGSC 342	Forages	3	SO	F		
CHOOSE 6 CREDITS FROM THE FOLLOWING:						
AGBE 210	Economics of Ag Business	3	JR	S		
ANSC 232 OR	Lvstk Mgmt-Sheep	1	SO	S		

ANSC 234	Lvstk Mgmt-Beef	1	SO	S		
ANSC 320	Animal Nutrition	4	SR	F		
ANSC 337	Diseases of Domestic Livestock	3	JR	S		
ANSC 410	Veterinary Entomology (Alt Yrs 2014)	2	JR	S		
ANSC 432 OR ANSC 434R	Sheep Management Beef Cattle Management	3 4	SR SR	S F		
BIOE 428	Freshwater Ecology	3	SR	F		
NRSM 421	Holistic Thought & Management	4	SR	S		
ENSC 443	Weed Ecology & Management	3	SR	F		
ENSC 444	Watershed Hydrology	4	SR	F		
ERTH 101IN	Intro to Physical Geology	4	FR	F		
WILDLIFE-HABITAT ECOLOGY AND MANAGEMENT OPTION REQUIRED: 15						***CREDITS***
WILD 325	Wildlife-Livestock Nutrition	3	JR	S		
WILD 355	Wildlife-Livestock Habitat Restoration	3	JR	F		
WILD 426	Wildlife Habitat Management	3	SR	S		
CHOOSE 6 CREDITS FROM THE FOLLOWING:						
ARNR 529 or WILD 429	Yellowstone Wildlife Habitat Ecology	2	JR	Su		
BIOE 405	Behavioral & Evolutionary Ecology	3	SR	S		
BIOO 475	Mammalogy	3	SR	F		

BIOO 470	Ornithology	3	SR	S		
BIOE 428	Freshwater Ecology	3	SR	F		
GPHY 411	Biogeography (Alt Yrs 2013)	3	JR	S		
ENSC 444	Watershed Hydrology	4	SR	F		
BMGT 473	Modern Mgmt of Western Resources	3	JR	On demand		
NRSM 430	Natural Resource Law	3	SR	S		
PSCI 362	Natural Resource Policy	3	JR	S		
ANSC 265/266 OR BIOO 310	Functional Anatomy of Dom Animals/Lab Comparative Vertebrate Anatomy	4 4	JR JR	F S		
FREE ELECTIVES						

CORE 2.0

Seminar (US)	
Writing (W)	
Quantitative Reasoning (Q)	

Diversity (D)	
Contemporary Issues in Science (CS)	
Arts (IA or RA)	
Humanities (IH or RH)	
Natural Sciences (IN or RN)	
Inquiry Social Science (IS or RS)	
Research & Creative Exper. (R, RA, RH, RS, RN)	

Completion of at least **two** of the following courses with a grade of C- or better satisfies both the Contemporary Issues in Science and the Natural Science Inquiry requirements: NRSM 240; BIOB 110, 160, 170, 256, 258, 260; BIOH 201, 211; BIOM 210, 250; BIOO 220; CHMY 121, 123, 141, 143, 151, 153, 211; GEO 101, 103, 205, 211; GPHY 111; LRES 201; PHSX 205, 207, 220, 222, 224, 240, 242.

Course requirements for a B.S. Sustainable Livestock Production

A minimum of 120 credits is required to graduate, 42 must be 300 level or above.

DEPARTMENTAL REQUIREMENTS FOR THIS OPTION						CREDITS: 91
Dept/Course #	Course Title	Credits	Class/Semester		Year	Sub/Transfer
ANSC 100	Intro Animal Science	3	FR	S		
NRSM 101	Natural Resource Conservation	3	FR	F		
NRSM 102	Montana Range Plants Lab	1	FR	F		
SFBS 146	Intro Sustainable Food/Bioenergy	3	FR	S		
ANSC 222	Livestock in Sustainable Syst	3	SO	S		
ANSC 316	Meat Science	4	JR	S		
ANSC 416R	Meat Processing	3	SR	F		
ANSC 432 Or ANSC 434R	Sheep Management Beef Cattle Management	3 4	SR	S F		
ANSC 498	Internship	3	JR	FSSu		
SFBS 499	Capstone	3	SR	F		
AGBE 210 IS	Economics of Agricultural Business	3	SO	S		
AGED 140 US OR COM 110 US	Leadership Dev for Ag & Ind Employee Public Communication	3 3	FR FR	FS (F) FSSu (F)		
BIOB 160	Principles of Living Systems	4	FR	FS (S)		
ANSC 265 ANSC 266	Functional Anatomy of Dom Animals Functional Anatomy of Dom Animals Lab	3 1	SO	S		
BMGT 205 Or WRIT 221	Mgmt Communication Fundamentals Or Intermediate Tech Writing	3	SO	FS (F)		
ECHM 205CS	Energy & Sustainability	3	JR	FS (F)		
CHMY 121 IN	Intro General Chemistry	4	FR	FSSu (F)		

CHMY 123	Intro to Organic & Biochem	4	SO	FSSu (S)		
ECNS 101 IS	Economic Way of Thinking	3	SO	FSSu (S)		
ECNS 202 Or ECNS 204 IS	Princ of Macroeconomics Microeconomics	3	JR	FS (S)		
NUTR 221 CS	Human Nutrition	3	SO	FSSu (S)		
NUTR 351	Nutrition and Society	3	SR	S		
SFBS 445 OR SFBS 451R	Culinary Marketing: Farm to Table Sustainable Food Systems	3 3	SR SR	Su S		
ENSC 110	Lnd Res Environ Sciences	3	FR	F		
ENSC 245	Soils	3	SO	F		
BIOB 110 CS	Intro to Plant Biology	3	FR	S		
STAT 216 Q	Elementary Statistics	3	SO	FSSu (S)		
WRIT 101 W	College Writing	3	FR	FSSu (F)		
LIVESTOCK & RANGE PRACTICUM ELECTIVES						TAKE ONE
ANSC 205	Introduction to Meat Evaluation	2	SO	F		
ANSC 232	Applied Technique Lvstk Mgmt-Sheep	1	SO	S		
ANSC 234	Applied Technique Lvstk Mgmt-Beef	1	SO	S		
NRSM 235	Rangeland Monitoring	1	SO	F		
ANIMAL DISCIPLINES						TAKE TWO
ANSC 320	Animal Nutrition	4	JR	F		
ANSC 321	Physiology of Reproduction	4	JR	F		
ANSC 322	Principles of Animal Breeding/Genetics	3	JR	S		
ANSC 337	Diseases of Domestic Livestock	3	JR	S		

ECON AND BUSINESS ELECTIVES						TAKE ONE
AGBE 321	Econ of Ag Marketing	3	JR	F		
AGBE 337	Ag Law	3	JR	FS		
AGBE 345	Ag Finance & Credit Analysis	3	JR	F		
AGED 353	Coop Bus Principles & Practices	3	JR	F		
BMGT 335	Management & Organization	3	JR	FSSu		
BMKT 325	Marketing	3	JR	FSSu		
BGEN 361	Princ of Business Law	3	JR	FSSu		
CROP AND RANGE ELECTIVES						TAKE ONE
NRSM 353	Grazing Ecology & Management	3	JR	S		
AGSC 428	Sustainable Cropping Systems (alt odd yrs)	3	JR	S		
AGSC 341	Field Crop Production (alt even years)	3	JR	S		
AGSC 342	Forages	3	JR	F		
DIVERSITY ELECTIVES						TAKE ONE
BMKT 242 D	Intro Global Markets	3	JR	FS (F)		
NASX 232 D	Montana Indians: Cult, Hist, Current Issues	3	JR	S		
PSCI 230 D	Intro International Relations	3	JR	F		
						CROSS DISCIPLINE TAKE ONE
ANSC 410	Veterinary Entomology (alt even yrs 2014)	2	SR	S		
ENSC 353	Environmental Biogeochemistry	3	SR	F		
AGSC 401	Integrated Pest Mgmt	3	SR	F		
ENSC 443	Weed Ecology & Mgmt	3	SR	F		

FOOD AND ENERGY						TAKE ONE
SFBS 429	Small Business in Food & Health	3	SR	S		
NRSM 421	Holistic Thought/ Mgmt	4	SR	S		
NASX 415	Native American Food Systems	3	SR	F		
PSCI 436	Politics Food/Hunger	3	SR	S		
PSCI 406	Political Economy of Energy (alt odd yrs)	3	SR	F		

CORE 2.0

Seminar (US)	
Writing (W)	
Quantitative Reasoning (Q)	
Diversity (D)	
Contemporary Issues in Science (CS)	
Arts (IA or RA)	
Humanities (IH or RH)	
Natural Sciences (IN or RN)	
Inquiry Social Science (IS or RS)	
Research & Creative Exper. (R, RA, RH, RS, RN)	

Completion of at least **two** of the following courses with a grade of C- or better satisfies both the Contemporary Issues in Science and the Natural Science Inquiry requirements: NRSM 240; BIOB 110, 160, 170, 256, 258, 260; BIOH 201, 211; BIOM 210, 250; BIOO 220; CHMY 121, 123, 141, 143, 151, 153, 211; GEO 101, 103, 205, 211; GPHY 111; LRES 201; PHSX 205, 207, 220, 222, 224, 240, 242.

Common Course Numbering

Starting in the Fall of 2009, MSU began to make changes to its course numbers and titles. This is part of a state-wide project requiring all Montana University System colleges and universities to use the same subject designations, numbers and titles for equivalent courses. This project will be continuing until all courses have been reviewed and renumbered.

The new course numbers and titles will count in exactly the same way as the old numbers and titles did in the past. However, for students who transfer to other campuses within Montana, the courses will transfer with the same numbers and titles. Both the old and new versions will count toward curricular requirements in the same way.

COURSE DESCRIPTIONS

Animal Science Courses:

ANSC 100 INTRODUCTION TO ANIMAL SCIENCE
S 3 cr. LEC 3
-- Introductory Animal Science includes basic principles of animal genetics, nutrition, live animal evaluation, reproduction, and their application to the production of beef and dairy cattle, sheep, swine, horses, and poultry.

ANSC 205 INTRODUCTION TO MEAT EVALUATION
F 2 cr. LAB 2
PREREQUISITE: ANSC 100
-- Techniques for the evaluation of carcasses. Procedures include U.S. grading standards, introduction to carcass pricing and objective carcass measurements.

ANSC 215 CALVING MANAGEMENT
S 2 cr. LEC 1 LAB 1
PREREQUISITE: ANSC 100 or consent of instructor.
-- Procedures to correctly identify calving problems and subsequently assist the birthing process and application of techniques to maximize calf survival.

ANSC 222 LIVESTOCK IN SUSTAINABLE SYSTEMS
S 3 cr. LEC 3
PREREQUISITE: Sophomore standing and ANSC 100 is recommended, or consent of instructor.
-- The role of livestock in balanced sustainable and organic systems will be explored with a primary focus on incorporating targeted grazing into farming systems. The principles of sustainable animal production and the regulations associated with organic animal production will be presented.

ANSC 232 LIVESTOCK MANAGEMENT-SHEEP
S 1 cr. LAB 1
PREREQUISITE: ANSC 100.
-- Management practices associated with farm flock and range sheep enterprises.

ANSC 234 LIVESTOCK MANAGEMENT-BEEF
S 1 cr. LAB 1
PREREQUISITE: ANSC 100
-- Hands-on laboratories to familiarize students with the principles of beef cattle handling and management.

ANSC 265 ANATOMY AND PHYSIOLOGY OF DOMESTIC ANIMALS, LECTURE
F 3 cr. LEC 3.
PREREQUISITE: BIOB 160, Sophomore standing.
COREQUISITE: ANSC 266
-- The lecture defines and identifies the organization of cell types into tissues and organ systems. The lecture explains the physiology of organ systems in domestic farm animals.

ANSC 266 FUNCTIONAL ANATOMY OF DOMESTIC ANIMALS LAB
F 1 cr. LAB 1.
PREREQUISITE: BIOB 160, Sophomore standing.
COREQUISITE: ANSC 265
-- Location, structure and identification of various tissues, organs, and systems of domestic animals through dissection of cadaver animals through dissection of cadaver animals. Lab utilizes ruminants and monogastric species.

ANSC 290R UNDERGRADUATE RESEARCH
F,S 1-6 cr. IND may be repeated
-- Directed undergraduate research which may culminate in a written work or other creative project. Course will address responsible conduct of research.

ANSC 291 SPECIAL TOPICS
On Demand 1 - 4 cr. Maximum 12 cr.
PREREQUISITE: None required but some may be determined necessary by each offering department.
-- Courses not required in any curriculum for which there is a particular one-time need, or given on a trial basis to determine acceptability and demand before requesting a regular course number.

ANSC 292 INDEPENDENT STUDY
On Demand 1 -3 cr. IND Maximum 6 cr.
PREREQUISITE: Consent of instructor and approval of department head.
-- Directed research and study on an individual basis.

ANSC 305 ADVANCED MEAT EVALUATION
F 2 cr. LEC 2
PREREQUISITE: ANSC 205 or consent of instructor.
-- Advanced skills in carcass evaluation, U.S. grading standards, and carcass pricing.

ANSC 308 LIVESTOCK EVALUATION
F 2 cr. LAB 2
PREREQUISITE: ANSC 100 and ANSC 205, or consent of instructor.
-- Techniques and experience in live animal evaluation. Practical use of production data and other evaluation techniques.

ANSC 316 MEAT SCIENCE
S 4 cr. LEC 3 LAB 1
PREREQUISITE: ANSC 100 and BIOB 160 and CHMY 121.
-- The meat industry within North America and beyond will be discussed. Live animal evaluation, pricing and carcass evaluation will be discussed. The class will include an explanation of muscle structure and function and its effect on tenderness and functionality.

ANSC 320 ANIMAL NUTRITION
F 4 cr. LEC 3 LAB 1
PREREQUISITE: ANSC 100, ANSC 265/266 and CHMY 123 and or consent of instructor.
-- Digestion and metabolism of nutrients, nutrient requirements, feed composition, diet formulation, and practical feeding of various classes of domestic animals.

ANSC 321 PHYSIOLOGY OF ANIMAL REPRODUCTION
F 4 cr. LEC 3 RCT 1
PREREQUISITE: ANSC 265/266.
-- A study of the anatomy and physiology of reproduction of vertebrates with major emphasis on mammalian domestic animal and wildlife species. This class introduces students to emerging concepts and current technologies for altering reproductive efficiency in a variety of animal species, including humans.

ANSC 322 PRINCIPLES OF ANIMAL BREEDING AND GENETICS
S 3 cr. LEC 3
PREREQUISITE: ANSC 100, BIOB 160, and either STAT 216 or STAT 332 or PSPP 318.
-- Genetic improvement of farm animals through performance testing, methods of selection, and application of mating systems such as crossbreeding.

ANSC 337 DISEASES OF DOMESTIC LIVESTOCK
S 3 cr. LEC 3.
PREREQUISITE: ANSC 265/266.
-- This course is structured to familiarize students with the common diseases of domestic livestock. Infectious and non-infectious diseases of horses, cattle, sheep and swine will be covered. Particular emphasis will be placed on regional diseases.

ANSC 395 FIELD EXPERIENCE:LIVESTOCK
On Demand 1 cr. LAB 1
PREREQUISITE: ANSC 100 and junior standing.
-- Exposure of students to livestock operations and related business enterprises in different geographical locations. One three-day field trip. Graded P/F.

ANSC 408 ADVANCED LIVESTOCK EVALUATION
F,S 3 cr. LEC 3
PREREQUISITE: ANSC 308 or equivalent.
-- Advanced skills in evaluation of animals and data associated with growth and genetic improvement. Develop decision making and oral communication skills.

ANSC 410 VETERINARY ENTOMOLOGY
S alternate years, to be offered even years 2 cr. LEC 2
PREREQUISITE: BIOB 470, BIOO 262.
-- This course will provide an overview of the importance of arthropods and their effects on human and animal health. Topics covered will include classification and identification of insects, mites, and ticks, basic biology, behavior and ecology, feeding mechanisms, pathogen transmission, vector competency, production impacts, integrated management and prevention.

ANSC 416R MEAT PROCESSING
F 3 cr. LEC 2 LAB 1
PREREQUISITE: ANSC 316 or instructor approval.
-- Students will learn to manufacture processed meat products such as fresh sausage, ham, bacon and cooked sausages. They will also be developing new flavor profiles and new products that will be presented to a panel with proposed marketing plans.

ANSC 418 TOPICS IN BEEF CATTLE NUTRITION
S alternate years, to be offered even years 2 cr. LEC 2
PREREQUISITE: ANSC 320 and Junior standing or consent of instructor.
-- Critical evaluation of current issues and related scientific literature in beef cattle nutrition; application to decision making and problem solving.

ANSC 421 ASSISTED REPRODUCTION TECHNOLOGIES
F 4 cr. LEC 2 LAB 2
PREREQUISITE: ANSC 321.
-- Reproductive management programs applying physiological knowledge to increase meat and milk production in cattle. Experience in the techniques of artificial insemination and pregnancy evaluation in cattle.

ANSC 432 SHEEP MANAGEMENT
S 3 cr. LEC 2 LAB 1
PREREQUISITE: ANSC 232, ANSC 320, and ANSC 321 or consent of instructor.
-- Management of the ewe flock, nutrition, reproduction, economics, breeding, and health related to efficient sheep production will be discussed. Production preparation and wool marketing in U.S. and world markets and economics of Montana wool production will be covered.

ANSC 434R BEEF CATTLE MANAGEMENT
F 4 cr. LEC 2 LAB 2
PREREQUISITE: NRSM 240, ANSC 320, ANSC 321, ANSC 322 and AGEC 210 or AGBE 341.
-- Integration of the principles of nutrition, genetics, physiology, range ecology, and economics into practical and profitable ranch management and business plans. Utilization

of performance and financial records, budgeting, feed resource planning, marketing strategies, breeding plans, computer applications, and case studies.

ANSC 490R UNDERGRADUATE RESEARCH
F,S,Su 1-6 cr. IND May be repeated. Max 12 cr.
-- Directed undergraduate research which may culminate in a research paper, journal article, or undergraduate thesis.

ANSC 491 SPECIAL TOPICS
On Demand 1 - 4 cr. Maximum 12 cr.
PREREQUISITE: Course prerequisites as determined for each offering.
-- Courses not required in any curriculum for which there is a particular one-time need, or given on a trial basis to determine acceptability and demand before requesting a regular course number.

ANSC 492 INDEPENDENT STUDY
On Demand 1 - 3 cr. IND Maximum 6 cr.
PREREQUISITE: Junior standing, consent of instructor and approval of department head.
-- Directed research and study on an individual basis.

ANSC 494 SEMINAR
On Demand 1 cr. SEM 1 Maximum 4 cr.
PREREQUISITE: Junior standing and as determined for each offering.
-- Topics offered at the upper division level which are not covered in regular courses. Students participate in preparing and presenting discussion material.

ANSC 498 INTERNSHIP
On Demand 2 - 12 cr. IND
PREREQUISITE: Junior standing, consent of instructor and approval of department head.
-- An individualized assignment arranged with an agency, business, or other organization to provide guided experience in the field.
On Demand 1 cr. SEM 1 Maximum 4 cr.
PREREQUISITE: Graduate standing or seniors by petition. Course prerequisites as determined for each offering.
-- Topics offered at the graduate level which are not covered in regular courses. Students participate in preparing and presenting discussion material.

EQUH 110 - WESTERN EQUITATION
2 credit lab
Fall, Spring semesters
Western equitation techniques including introductory training techniques.

EQUH 114 - BEGINNING ENGLISH EQUITATION
2 credit lab
Fall, Spring semesters
- Beginning English equitation technique, including horse behavior, horse handling, equipment and basic horse anatomy .

EQUH 207 - INTERMEDIATE ENGLISH EQUITATION
2 credit lab
Spring semesters
Prerequisite: EQUH 114.
- Advanced English equitation techniques including collecting, lateral movements and beginning jumping.

EQUH 210 - INTERMEDIATE WESTERN EQUITATION
2 credit Lab
Fall, Spring semesters
Prerequisite: EQUH 110 or permission of instructor.
- Students will learn advanced movements and maneuvers such as collection, roll-backs, turn-arounds, and lead changes. Students must have secure seat and hands. Training methods for the green horse and tuning techniques for the older broke horse will be covered.

EQUH 253 - STARTING COLTS
2 credit lab
Fall semesters
Prerequisite: EQUH 210.
- Principles and techniques of breaking and training young horses.

EQUH 256 DEVELOPING THE YOUNG HORSE
2 credit lab
Spring semesters
Prerequisite: EQUH 210.
- Advanced techniques and training for reining, cutting, or working cow horses. For experienced riders.

EQUH 314 - EQUESTRIAN INSTRUCTION METHODS
3 credit lecture
Fall semesters
F,S 2 cr. LEC 1 LAB 1 Maximum 2 cr.
Prerequisite: EQUH 110, EQUH 210, or consent of instructor.
- The object of this course is to develop competent riding instructors who can communicate effectively and motivate students to higher riding skills.

EQUS 233 - HORSE SCIENCE AND MANAGEMENT LAB
1 credit lab
Fall semesters
Prerequisite: ANSC 100.
- Laboratory designed to familiarize students with approved management practices for horse enterprises.

EQUS 290R - UNDERGRADUATE RESEARCH
1-6 credit independent study; may be repeated
Fall, Spring semesters
- Directed undergraduate research which may culminate in a written work or other creative project. Course will address responsible conduct of research.

EQUS 291 - SPECIAL TOPICS
On Demand 1 - 4 cr. Maximum 12 cr.
Prerequisite: None required but some may be determined necessary by each offering department.
- Courses not required in any curriculum for which there is a particular one-time need, or given on a trial basis to determine acceptability and demand before requesting a regular course number.

EQUS 292 - INDEPENDENT STUDY
On Demand 1 -3 cr. IND Maximum 6 cr.
Prerequisite: Consent of instructor and approval of department head.
- Directed research and study on an individual basis.

EQUS 327 EQUINE LAMENESS
F 3 cr. LEC 3
Prerequisite: ANSC 265/266.
- This course is structured to familiarize students with the many types of lameness in the horse. Students will be instructed on the correlation between anatomy, conformation, locomotion and lameness. Selected diseases of the bones, joints, and soft tissue will be discussed. Significant time will also be spent on lameness diagnosis, treatment, prognosis, as well as shoeing principles for sound and lame horses.

EQUS 346 - EQUINE REPRODUCTIVE MANAGEMENT
S 4 cr. LEC 3 LAB 1
Prerequisite: ANSC 265/266, ANSC 321.
- This course is designed to familiarize students with the reproduction in horses. Students will be instructed on the appropriate methods for management of the stallion, mare and foal. The curriculum will also include equipment and facilities use, as well as management of a breeding facility.

EQUS 347 - EQUINE FORM TO FUNCTION
F 3 cr. LEC 2 LAB 1
Prerequisite: ANSC 265/266 and Junior standing.
- Development of methods for analyzing a horse's conformation along with a good understanding of anatomy and its relationship to performance.

EQUS 423 - EQUINE NUTRITION
S alternate years, to be offered odd years 2 cr. LEC 2
Prerequisite: ANSC 320 and Junior standing or consent of instructor.
- Critical evaluation of current issues and related scientific literature in equine nutrition; application to designing effective feeding programs.

EQUS 430 - HORSE MANAGEMENT
S 4 cr. LEC 3 LAB 1
Prerequisite: ANSC 265/266, ANSC 320, ANSC 321, ANSC 322, or consent of instructor.
- Horse management and problems with emphasis on behavior, nutrition, reproduction, and management programs.

EQUS 490R - UNDERGRADUATE RESEARCH
1-6 credit independent study; may be repeated
Fall, Spring semesters
- Directed undergraduate research which may culminate in a research paper, journal article, or undergraduate thesis.

EQUS 491 - SPECIAL TOPICS
On Demand 1 - 4 cr. Maximum 12 cr.
Prerequisite: Course prerequisites as determined for each offering.
- Courses not required in any curriculum for which there is a particular one-time need, or given on a trial basis to determine acceptability and demand before requesting a regular course number.

EQUS 492 - INDEPENDENT STUDY
On Demand 1 - 3 cr. IND Maximum 6 cr.
Prerequisite: Junior standing, consent of instructor and approval of department head.
- Directed research and study on an individual basis.

EQUS 494 – SEMINAR
On Demand 1 cr. SEM 1 Maximum 4 cr.
Prerequisite: Junior standing and as determined for each offering.
- Topics offered at the upper division level which are not covered in regular courses. Students participate in preparing and presenting discussion material.

NRSM 101 NATURAL RESOURCE CONSERVATION
F 3 cr. LEC 3
- An overview of soils, water, rangelands and wildlife conservation from the global to the local level. Impacts of human population growth, economics, ethics and agriculture on the sustainability of natural resources will be examined using basic principles of ecology.

NRSM 102 MONTANA RANGE PLANTS LAB
F 1 cr. LAB 1
COREQUISITE: NRSM 101
- The laboratory exercises are designed to complement the lectures of NRSM 101. Rangeland inventory and classification methods will be reviewed. Sixty common native and introduced plants will be identified in the field and the classroom.

NRSM 235 RANGE AND PASTURE MONITORING
F 1 cr. LAB 1
PREREQUISITE: ANSC 100, NRSM 101, NRSM 102.
- Methods which can be used by private operators as well as state and federal land managers to identify site potential, inventory forage resources, evaluate range and pasture condition, estimate stocking rates, and measure forage utilization by wildlife and livestock.

NRSM 236 SMALL PASTURE MANAGEMENT
S 1 cr. LEC 1
PREREQUISITE: ANSC 100, NRSM 101, NRSM 102 or permission of the instructor.
- Management of small acreages (< 50 acre) to produce forage for horses and non-commercial livestock. Topics include determination of site productivity, plant and animal response to grazing, forage production, protection of water quality and controlling invasive plants. Field trips include operations with successful grazing programs and problem areas.

NRSM 240 NATURAL RESOURCE ECOLOGY
F 3 cr. LEC 2 LAB 1
PREREQUISITE: NRSM 101.
- Focus on the role of physical and biotic processes on ecosystem function, including natural and managed ecosystems. Emphasis on rangelands, wildlife habitat, watersheds, and disturbed environments.

NRSM 290R UNDERGRADUATE RESEARCH
F,S 1-6 cr. IND may be repeated
- Directed undergraduate research which may culminate in a written work or other creative project. Course will address responsible conduct of research.

NRSM 291 SPECIAL TOPICS
On Demand 1 - 4 cr. Maximum 12 cr.
PREREQUISITE: None required but some may be determined necessary by each offering department.
- Courses not required in any curriculum for which there is a particular one-time need, or given on a trial basis to determine acceptability and demand before requesting a regular course number.

NRSM 292 INDEPENDENT STUDY
On Demand 1 -3 cr. IND Maximum 6 cr.
PREREQUISITE: Consent of instructor and approval of department head.
- Directed research and study on an individual basis.

NRSM 330 FIRE ECOLOGY AND MANAGEMENT
F 3 cr. LEC 2 LAB 1
PREREQUISITE: NRSM 101 or NRSM 240 or BIOE 370.
- This course covers the wildlife patterns that shape and define western rangeland and forest ecosystems. Discussions on the historical role of fire will provide the background for using prescribed fire to accomplish a broad range of habitat management goals.

NRSM 350 VEGETATION OF WESTERN WILDLANDS
S 3 cr. LEC 2 LAB 1
PREREQUISITE: NRSM 240, BIOO 230, and either AGSC 454 or BIOO 435.
COREQUISITE: NRSM 351.
- Identification of commonly occurring plants of western North America biomes. Important ecological and management relationships of the plants will be emphasized.

NRSM 351 BIOMES OF WESTERN WILDLANDS
S 2 cr. LEC 2
PREREQUISITE: NRSM 240, BIOO 230.
COREQUISITE: NRSM 350.
- Climatic, physical, and biological interactions of natural biomes. The structure of western North America biomes will be considered in detail.

NRSM 353 GRAZING ECOLOGY AND MANAGEMENT
S 3 cr. LEC 2 LAB 1
PREREQUISITE: NRSM 101, NRSM 102, and NRSM 240.
- Ecological perspectives of livestock grazing in the major biomes of the western United States and southern Canada. Impacts on soils, individual plants, plant communities, livestock, wildlife, and hydrology will be reviewed in the scientific literature.

NRSM 453 HABITAT INVENTORY & ANALYSIS
F 3 cr. LEC 2 LAB 1
PREREQUISITE: NRSM 240 or BIOE 370, STAT 216 or BIOB 318, and Junior standing.
- Focus on collecting, analyzing, and interpreting measures of rangeland resources including plant, animal, soil, and watershed components. Emphasis on sampling objectives, field procedures, monitoring, and evaluation.

NRSM 455 RIPARIAN ECOLOGY AND MANAGEMENT
S 3 cr. LEC 2 LAB 1
PREREQUISITE: ENSC 245 and NRSM 240 or ENSC 272 or ERTH 303 or BIOE 370
- This course will provide an overview of one of the most ecologically diverse ecosystems in western North America. Students will have the opportunity to study the physical and biological processes which shape and maintain riparian ecosystems. A field laboratory will provide experience in biological and physical monitoring methodologies that are central to land management decisions.

NRSM 490R UNDERGRADUATE RESEARCH
F,S,Su 1-6 cr. IND May be repeated. Max 12 cr.
- Directed undergraduate research/creative activity which may culminate in a research paper, journal article, or undergraduate thesis.

NRSM 491 SPECIAL TOPICS
On Demand 1 - 4 cr. Maximum 12 cr.
PREREQUISITE: Course prerequisites as determined for each offering.
- Courses not required in any curriculum for which there is a particular one-time need, or given on a trial basis to determine acceptability and demand before requesting a regular course number.

NRSM 492 INDEPENDENT STUDY
On Demand 1 - 3 cr. IND Maximum 6 cr.
PREREQUISITE: Junior standing, consent of instructor and approval of department head.
- Directed research and study on an individual basis.

NRSM 494 SEMINAR
On Demand 1 cr. SEM 1 Maximum 4 cr.
PREREQUISITE: Junior standing and as determined for each offering.
- Topics offered at the upper division level which are not covered in regular courses. Students participate in preparing and presenting discussion material.

WILD 325 WILDLIFE-LIVESTOCK NUTRITION
S
PREREQUISITE: ANSC 100 and NRSM 101 and NRSM 102.
- Nutrition of free ranging ungulates including deer, elk, antelope, bison, sheep, cattle and feral horses. Topics will include digestive systems, intake, food habits, feeding behavior and management.

WILD 355 WILDLIFE/LVSTCK HABITAT RESTORATION
F
PREREQUISITE: NRSM 101 or ENSC 110 or F&WL 301, and BIOO 230, and NRSM 240 or BIOE 370.
- Improvement and rehabilitation of habitats used by wildlife and free-ranging livestock in the western United States. Topics include methods used to improve wildlife habitat as well as livestock forage. Design criteria for stock ponds, off-site water development, construction of bird/small mammal guzzlers, use of prescribed fire, mechanical, chemical and biological techniques to rehabilitate and improve wildlife and livestock habitats.

WILD 426 WILDLIFE HABITAT MANAGEMENT
S
PREREQUISITE: NRSM 240 or BIOE 370 or consent of instructor.
- Emphasis is placed on wildlife habitat management in coordination with other land uses (i.e. agriculture, recreation, and development). Students gain insight into the details of wildlife habitat management by delving into the historical and current literature on the subject. Real world issues and solutions based on case study examples are emphasized.

WILD 429 YELLOWSTONE WILDLIFE HABITAT ECOLOGY
Su
PREREQUISITE: Junior standing and a Biology course or consent of instructor.
- This course will describe the native communities of the internationally prominent northern Yellowstone winter range for wild ungulates. The ecology of many organisms, both plant and animal will be studied. Plant identification skills will be incorporated with an emphasis on the recognition of the Yellowstone northern rang's flora and its importance as wildlife habitat. Ecosystem interrelationships will form the basis for understanding the ecology of the range and interpreting the consequences of management alternatives.

WILD 438 WILDLIFE HABITAT ECOLOGY
S
PREREQUISITE: NRSM 240 or BIOE 370 or consent of instructor.
- Principles of habitat importance and management. Habitat requirements within wildlife population constraints will be emphasized with consideration of other natural resource demands.

Teaching Equipment

Audio/Visual equipment in the ABB were purchased in 2010 with funds from the Montana Beef Council. The state of the art equipment are located in all classrooms in the ABB. Future classes may be offered as real-time at remote locations in Montana.

The A&RS Department has received funding from the COA during FY2012 and 2013 to enhance teaching activities. During FY2012, Dr. Jim Berardinelli received funding to purchase a Breed em Betsy artificial cow. This teaching aid will allow in class demonstrations on reproductive techniques. The unit was built in Australia and was purchased for $15,000. During FY2013, the COA supported upgrading the sprinkling system at the Miller Pavilion for improved dust suppression. The new overhead sprinkler system included PVC pipe installation and new sprinkler heads and control pump. Funding for the system was approximately $25,000.

Clubs and Activities

Undergraduate and graduate students have opportunities for extracurricular activities within the department. Most of the organizations hold meetings in the Animal Bioscience Building (except equine activities) during regularly scheduled dates and times. These organizations create an excellent learning experience for participants.

Academic Quadrathlon

The Academic Quadrathlon is a local or a regional event involving undergraduate student teams from within a school or university or between students from various schools or universities. The emphasis of an Academic Quadrathlon is on participation by students

rather than on competition. At the local level, teams must be organized by the students and consist of four individuals or fewer. Any student from any major may participate at the local level. To be an eligible member on a regional team one must not have previously represented their school at the regional level. They must be undergraduates in a nonprofessional degree program at the time of their local competition. The regional team must be the winning team at the local competition.

Teams participate in four events: Laboratory Practicum, Written Exam, Oral Presentation, and Quiz Bowl. In the Laboratory Practicum, the team demonstrates its ability to perform physical skills. Work at each station lasts 15 to 20 minutes and involves the entire team. The work at each station usually involves a species such as beef or swine or a disciplinary area such as nutrition or meats. The Written Exam has a time limit. The questions may involve any area related to animal production and products. Each team writes one exam, dividing the questions as they wish. In the Oral Presentation, the students are given a topic to discuss dealing with animal agriculture. This is an exercise in cooperative problem solving. In the Quiz Bowl questions may be on any topic that relates to animal agriculture and that are answerable in a short period of time. Quiz games will be organized as double elimination tournament.

Collegiate Cattlewomen

The Collegiate Cattlewomen's organization is open to women enrolled at MSU who are interested in the future of beef, agriculture, and their communities. Their goals include public education and promotion of the business of agriculture. The club also assists Montana Cattlewomen and the Montana Beef Council in their efforts to promote the welfare of the beef industry.

The club has three main projects: "The Perfect Cheeseburger" where a short presentation is given to an elementary class, a campus beef promotion in which they hand out beef samples and answer questions, and an educational forum where guest speakers present current topics within the beef industry. Members also attend national and state conventions, have fundraisers, BBQ's, and much more. The club offers women an opportunity to expand their communication and leadership skills while working with their peers to educate the community.

Collegiate Stockgrowers

Collegiate Stockgrowers at Montana State University is a committee within the Montana Stockgrowers Association designed to develop collegiate students into tomorrow’s leaders. This is a place for young ranchers and supporters of the beef industry to get together, share ideas, promote the industry, and have fun!

Membership is open to all students if they pay dues of ten dollars per year and are a student in good-standing at Montana State. Meetings are held the 2nd and 4th Wednesday of each month, while school is in session. We hope to see you at our meetings!

Horseman's Club

The Horseman's Club is about networking horse people and non-horse people alike, while having an option to be a member of the MSU IHSA Equestrian Team. Through the Intercollegiate Horse Show Association team, riders of all levels compete against schools in Montana, Idaho, and Utah. The Horseman's Club welcomes any and all students interested in horses. Ownership of a horse is not required.

Intercollegiate Horse Show Association Team

The Intercollegiate Horse Show Association (IHSA) team travels and competes throughout Montana, Idaho, and Utah in four disciplines, Hunt Seat Equitation, Equitation Over Fences, Western Horsemanship, and Reining.

Livestock Judging Team

Students involved in livestock judging learn how to sharpen their decision making and communication skills, and gain knowledge about a wide variety of segments of the livestock industry in different parts of the country. Livestock Judging Team members have the opportunity to travel to different National Livestock Judging Contests, and through judging, students learn valuable skills that they will use for the rest of their lives. Students take two separate classes with formal coursework to compete on the team. Courses are ANSC 308 – Livestock Evaluation and ANSC 408 – Advanced Livestock Evaluation. The department recently received approval to hire a NTT Instructor (M.S. degree) or Teaching Assistant Professor (Ph.D. degree) to coach the livestock judging team.

Meat Judging Team

The MSU Meat and Meat Processing Center is a state-inspected facility with the capability for processing meat animals. It has much of the equipment necessary for sausage and ham manufacturing. In addition, there is a chemistry laboratory for analysis of a wide range of physical and chemical properties of meat. Students learn to cut carcasses and manufacture sausages and ham in this facility. The MSU Meat Lab also supports the Meats Judging Team and provides hands-on experience for students interested in meat and carcass evaluation.

Polo Team

Montana State University - Bozeman collegiate equine polo club was formed in 2005. As a club we compete in the Northwest region of USPA intercollegiate polo. It's a great group to join if you enjoy equine activities. All interested students are welcome regardless of riding/playing experience. Horse ownership is not necessary. Look for us at the MSU pavilion on Tuesday and Thursday nights.

Range Management Club

The Range Management Club is open to any student who is interested in range ecosystems and the principles of their management. This club has close ties to the International Society for Range Management. Functions include sponsorship of an Undergrad Range Management Exam Team (URME), and an International Range Plant Identification team; promotion of guest speakers that are controversial, entertaining, and informative; and field trips. We also support a variety of social functions.

Students interested in Range Science should try out for the competitive Range Plant Identification Team and the Undergraduate Range Management Exam Team. These teams are sent to represent MSU at the annual contests held in conjunction with the annual International Society for Range Management Convention. The club meets on the 2nd and 4th Tuesday of each month in Room 238 of the Animal Bioscience building.

Stock Horse Team

The Stock Horse Team is dedicated to enhancing the pleasure of owning and riding horses through creating better horses and horsemen. The original organizers of the American Stock Horse Association viewed the trend of emphasizing specialized horses over versatile horses as not being good for the equine industry. Rider skills were also becoming specialized, relating only to a single discipline or event. There was not a link between a truly well-trained horse and the versatile horse that could perform many tasks. Become a member and prove the versatility of your stock horse in four categories: stock horse pleasure, reining, trail, and working cow horse.

Weekly meetings: Mondays, 6:30 pm, MSU Animal Bioscience Building, Room 238
Weekly practices: Sundays, 2-5 pm, MSU Miller Stock Pavilion

MSU Driving Team

MSU Driving Team is a group of individuals interested in learning the dying art of driving teams of draft horses. We show Draft Horses at horse shows and teamster competitions during the school year. We are located on the Campus of Montana State University in Bozeman, Montana. We go for the original horse power!

UNDERGRADUATE ADVISING

Advising for the Animal and Range Science undergraduate students is provided by TT faculty members. The number of advisees per teaching faculty ranges from a low of 4 to 6 for new faculty members to approximately 45 for established TT faculty. With approximately 30 minutes/ advising session during the fall and spring semester, advising amounts to a significant amount of time. With the implementation of Degreeworks by MSU (a web-based degree planning and tracking system), the amount of time required for each advising session may decrease.

The Academic Programs Coordinator (a classified staff) supports undergraduate and graduate students and faculty to ensure student needs are met. In addition, the coordinator assigns students to faculty advisors.

The Animal and Range Sciences Department has two certifying officers to ensure all requirements are met. One certifying officer handles all Animal Science majors and one certifying officer evaluates all Natural Resources and Rangeland Ecology majors.

The Animal and Range Science Department provides a survey to undergraduates for Student Evaluation of Advising. These forms are provided to the Department Head and not to individual faculty members. There is a good response rate for returning surveys to the Academic Programs Coordinator. The Department Head reads individual surveys. Overall, students rate their faculty advisors with a 3 (agree) to 4 (strongly agree). There hasn't been any issues with students and their faculty advisors.

The MSU Office of Admissions recruits for Animal and Range Sciences in-state and out-of-state by sending representative to recruitment fairs across the U.S. In addition, the Animal and Range Sciences website serves as a resource for recruiting efforts. Letters from the department are sent out to prospective students during the summer. In addition, the Department Head has participated in phone-a-thons with the Admissions office. The MSU College of Agriculture Ag Ambassador program serves to recruit and retain students in the College of Agriculture. Animal and Range Sciences students regularly participate in the Ag Ambassador program, thus promoting our program.

SCHOLARSHIPS

The College of Agriculture awards more than 50 scholarships each year, the greatest amount by any college on the MSU campus. A total of approximately $210,000 was awarded by the COA during the 2012-2013 AY. The COA host an annual Scholarship Banquet each fall to recognize scholarship recipients and donors.

FARRIER SCHOOL

Montana State University Farrier School offers an eleven-week program designed specifically for those who wish to pursue careers as farriers. This professional course provides students with the opportunity to obtain a solid background in the field of farrier science through the application of sound principles in a practical hands-on setting. Students will have the opportunity to obtain the knowledge and develop the skills necessary to establish their own practice, qualify for licensing at major race tracks, and prepare for the American Farrier Association Certification exam. Further study in an advanced class is also offered. The Animal and Range Sciences Department at Montana State University sponsors the Farrier Program. The Farrier School, which was established in 1970, receives no state funding and is supported entirely with student fees.

Instructor

Bryce Kawasaki, Instructor

Bryce Kawasaki graduated from the MSU Horseshoeing School in 1994. After this training he started working with several Certified Journeyman Farriers, including Jerry Kawasaki, Carl Jolliff, and Tom Wolfe. Bryce has had his own farrier business working with his wife, Jenny, for the last fifteen years. In 2000 when Bryce met Bob Marshall his career changed dramatically. Bob has never nailed on a "keg" or factory made shoe. His skill at forging handmade shoes, shoeing horses, and his teaching ability are unprecedented. To this day well over half the shoes that Bryce puts on are made by him in his shop or on the job. Bryce served as president of the Montana Professional Horseshoers Association for six years, and sat on the Board of Directors for the American Farriers Association for those same six years. He has been helping Tom Wolfe out at the Farrier School for ten years. During this time he has conducted a tool making workshop at his forge in Gallatin Gateway, MT. Bryce has also presented week long horseshoeing workshops for practicing farriers looking to improve. Bryce was born and raised in Montana and feels very privileged to have been able to work and live in this great state, and now be able to teach at the MSU Farrier School. Bryce and his wife own several horses and enjoy riding every chance they get, especially getting into the back country.

Professional Course

- 8 hours daily; 11 weeks
- Offered Fall, Winter, Spring
- Sponsor: Animal & Range Sciences Department
- Objective: Preparation for career as professional horseshoer
- Maximum enrollment: 12

- Financial Aid for Students: Applicants who need financial assistance should contact the following offices for eligibility:
    - Veterans Office (GI Bill)
    - Division of Vocational Rehabilitation
    - Local Job Service
    - SALLIEMAE.com
    - Rural Employment Opportunities (for Montana Residents) 1-800-546-1140

A&RS Graduate Program

The Animal and Range Sciences Department offers a Master of Science and a Doctor of Philosophy degree in "Animal & Range Sciences". The department has historically offered only M.S. degrees, however, during the 2004-2005 Academic Year, a Ph.D. program was approved for the department. The number of graduate majors has remained fairly constant over the years with an average of approximately 20 students with a low of 18 students and

the greatest number of 23 during 2003-2004 (Figure 6). The number of M.S. degree graduates have ranged from a low of 5 in 2006-2007 to a high of 10 in 2011-2012. The department has awarded 5 Ph.D. degrees since the Ph.D. program inception. There are currently 4 Ph.D. student in the program and this is an item in the MSU strategic plan to increase the number of doctoral degrees awarded.

Both the MS and PhD degrees require that the student choose either an Animal Science emphasis or a Range Science emphasis. Students in these programs receive a solid science-based education in Nutrition, Reproduction, Livestock Management, Equine Science, Rangeland Ecology, and Wildlife Ecology and their research program mirrors the research activities of the department. Independent research conducted under the direction of a faculty advisor is a major component of all these programs. As a result, admission into the programs is contingent upon the students identifying potential faculty advisors with similar research interest and goals. All graduate students are required to develop an approved program of study with their graduate advisor and graduate committee.

Most graduate students are provided a stipend (approximately $12,000/year) plus either tuition remission or added stipend to total $20,000/year. During FY13, funding for graduate student stipends and/or tuition allowance was $39,000 COA (16.5%), $61,037 MAES (20.9%), $24,863 Bayard (10.5%), $79,141 Grants (33.6%), and $31,785 other (13.5%). Funding sources and percentages vary from year-to-year, dependent on grants.

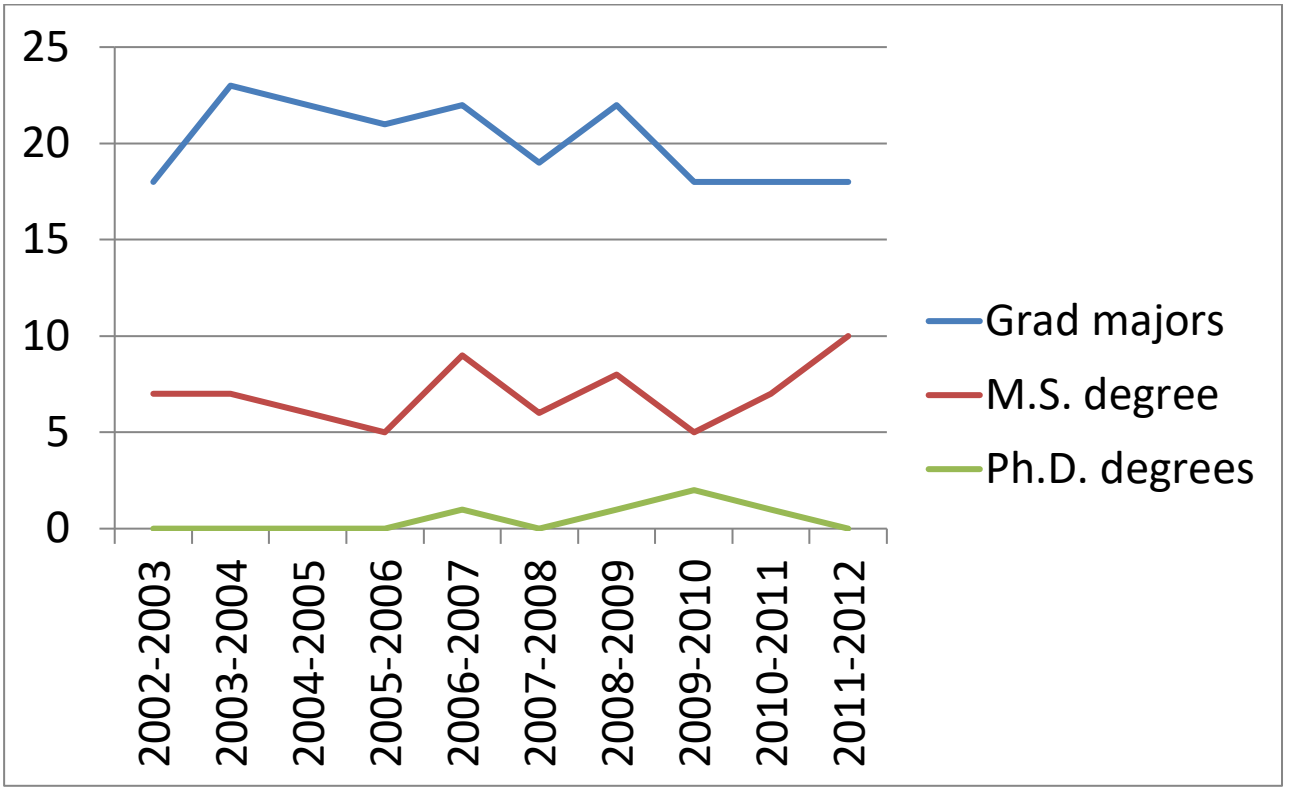


Figure 6. Graduate majors, M.S. degrees and Ph.D. degrees awarded by year. Data Source: MSU Office of Planning and Analysis.

Departmental Application Process

Applicants must take the GRE. Official scores must be sent to the Graduate School directly from the testing agency. Unofficial scores can be used for initial evaluation by the Department, but the official scores must arrive at the University before the application package and evaluation process will be considered finalized. Official transcripts must be sent directly to the Department from **all** higher education schools attended (universities, colleges, and/or community colleges). Three reference letters are required. These letters cannot be from the intended major professor or potential committee members. The letters must be on official letterhead, dated (current within 3 months), signed by the reference, and must be sent directly from the reference to the Department. These letters should be either in a sealed envelope or sent electronically directly to the Department with an electronic signature. The personal statement must be sent directly to the Department either by mail or electronically. All additional requirements for International students must be sent directly to the University or Department, not delivered by the student.

Complete application package must be received by the department by the following deadlines:
For admission Fall semester - June 1
For admission Spring semester - November 1
For admission Summer semester - April 1

Animal Science Emphasis

Graduate students in the Animal Science emphasis receive broad based training resulting in experiences that qualify them for many agricultural jobs. Areas of emphasis include nutrition, breeding and genetics, physiology, production systems, and meat science/muscle growth. Research problems may involve beef cattle, sheep and biochemical or other properties of agricultural products. Supporting course work may be taken from Animal Science, Range Science, Biology, Wildlife Management, Biochemistry, Statistics, Plant Sciences, Land Resources and Environmental Sciences, and Economics.

Research laboratories are available in the department and specialized equipment is also available through cooperation with other departments.

The department conducts cooperative research with the U.S. Livestock and Range Research Station at Miles City, Montana, and the U.S. Sheep Experiment Station at Dubois, Idaho. Facilities for the maintenance of beef cattle and sheep are available at the Red Bluff Research Ranch, 30 miles west of Bozeman, the Fort Ellis Research Center, near Bozeman, and the Northern Agricultural Research Center at Havre. The main station has facilities for sheep, horses and beef cattle (a cattle feedlot and nutrition laboratory). A wool laboratory is located on campus.

Range Science Emphasis

Research and training opportunities in the Range Science programs are diverse, and students with a wide variety of backgrounds, goals, and educational needs are accepted. Major areas of study are range ecology, habitat management, watershed management, grazing management, monitoring, riparian ecosystems, measurements, and plant-animal (livestock and wildlife) interactions. A graduate degree in range science prepares for careers in rangeland management, wildlife management, habitat management, natural resource conservation and restoration, research, land-use planning, and consultation. Research facilities include the Red Bluff Research Ranch, several research centers of the Montana Agricultural Experiment Station, U.S. Livestock and Range Research Station at Miles City, Montana, and the U.S. Sheep Experiment Station at Dubois, Idaho. Cooperative projects with ranchers and federal and state agencies are also conducted. Supporting courses at the graduate level include botany, wildlife biology and management, soils, animal science, earth science, plant science, statistics and biochemistry.

Requirements for M.S. and Ph.D. in Animal & Range Sciences

Admission Requirements

Students are expected to have completed the equivalent of a B.S. degree (for application for the M.S. degree) or M.S. degree (for application for the Ph.D. degree) in Animal Science, Range Science, or a closely related area. In selecting applicants, the Animal & Range Sciences Graduate Committee will consider the prospective student's statement of purpose, undergraduate and graduate achievement (university transcripts), GRE scores, and letters of recommendation (3 required). ***Generally, a minimum GPA of 3.0/4.0, and minimum GRE scores of 150 verbal and 146 quantitative (450 verbal and 550 quantitative in previous GRE scoring system) are required for full admission.***

International students whose native language is not English must submit scores from the Test of English as a Foreign Language (TOEFL) before admission and/or award of an assistantship. These scores must meet the minimum standards required by The Graduate School at Montana State University.

Current MSU Graduate School policy specifies a six year limit on coursework for M.S. degrees. Students must have a minimum 3.0 GPA for their cumulative program and last semester of attendance.

Minimum Requirements for M.S. in Animal & Range Sciences

1. At least one upper level (400 or 500) course in statistics.
2. Two semesters of ARNR 507 — Research Methods.

3. Students must declare either the Animal Science, Range Science, or Biology Emphasis:
    - Course requirements for students in the **Animal Science Emphasis**:
        - At least two courses from the Graduate Animal Science block (must be 500 level)
    - Course requirements for students in the **Range Science Emphasis**:
        - At least two courses from the Graduate Range Science block (must be 500 level)
    - Course requirements for students in the **Biology Emphasis**:
        - At least two biology-related 500-level courses in their area of emphasis
        - AND
        - At least one course from the Graduate Animal Science block, or Graduate Range Science block
        - NOTE: Students emphasizing meat science in the Biology Emphasis can substitute BCH 441– Biochemistry of Macromolecules for one of the two 500-level courses.
    - **Graduate Animal Science Block**
      ARNR 520 – Nutrient Metabolism in Domestic Animals
      ARNR 521 – Advanced Ruminant Nutrition
      ARNR 523 – Advanced Physiology of Reproduction
      ARNR 524 – Advanced Animal Breeding
      ARNR 525 – Muscle and Growth Biology
    - **Graduate Range Science Block**
      ARNR 541 – Range Ecophysiology
      ARNR 543 – Riparian Processes and Function
      ARNR 544 – Advanced Grazing Management & Ecology
4. Students must meet the Proficiency Requirements for their emphasis.

Proficiency Requirements

By the time a student completes a M.S. in Animal & Range Sciences, they must have successfully completed undergraduate or graduate coursework in the content areas given below depending on their degree emphasis. Examples of MSU courses that fulfill these requirements are given. Students who have successfully completed an equivalent course may apply that course toward the proficiency requirements, subject to the approval of the student's Graduate Committee. Undergraduate courses in these categories are not intended to comprise a substantial portion of a student's graduate curriculum. These courses should be taken in addition to, not in lieu of, other courses in a graduate program. While some courses may apply to Requirements for the M.S. in Animal & Range Sciences, and Proficiency Requirements, the student's Graduate Committee must not allow the need to meet Proficiency Requirements to detract from a student completing a rigorous graduate degree program.

A. Proficiency Requirements for Animal Science Emphasis *(must complete 3 of the 4 areas)*

1. Breeding/Genetics *(ANSC 322 – Principles of Animal Breeding & Genetics, or BIOB 375 – General Genetics)*
2. Physiology/Reproduction *(ANSC 321 – Physiology of Animal Reproduction)*
3. Nutrition *(ANSC 320 – Animal Nutrition)*
4. Production/Management *(ANSC 434R – Beef Cattle Management)*

B. Proficiency Requirements for Range Science Emphasis *(must complete 4 of the 5 areas)*

1. Grazing Management *(NRSM 353 – Grazing Ecology and Management)*
2. Plant Ecology *(NRSM 240 – Natural Resource Ecology, or BIOE 370 – General Ecology, or BIOE 534 – Vegetation Ecology)*
3. Plant Identification *(NRSM 350 – Veg of Western Wildlands, or AGSC 454 – Agrostology)*
4. Plant Physiology *(BIOO 433 – Plant Physiology, or ARNR 541 – Range Ecophysiology)*
5. Vegetation Measurements *(NRSM 453 – Habitat Inventory and Analysis)*

C. Proficiency Requirements for Biological Science Emphasis *(must complete 15 credits from the areas listed, at least 9 credits upper division)*

1. Biology *(BIOB 256, 258, 260 – Introductory Biology)*
2. Ecology *(BIOE 370 – General Ecology, BIOE 405 – Behavioral & Evolutionary Ecology)*
3. Chemistry *(CHMY 141, 143 – College Chemistry I & II, CHMY 211 – Elements of Organic Chemistry, CHMY 311 – Fundamental Analytical Chemistry, CHMY 321, 323 – Organic Chemistry I & II)*
4. Biochemistry *(BCH 380 – Biochemistry)*
5. Entomology *(BIOO 262IN – Intro to Entomology)*
6. Food Science/Meat Science *(Introductory Food Science or upper division food science or food safety course)*

Minimum Requirements for Ph.D. in Animal & Range Sciences

The Ph.D. program is based upon an area of specialization in research and intensive coursework that would normally require three years of full-time work beyond the M.S. degree. **In addition to departmental requirements candidates must fulfill the requirements of The Graduate School.** The general requirements include:

1. In addition to requirements set forth by The Graduate School, Ph.D. students must complete the following:
    1. 3 credits of ARNR 507 (within the Ph.D. period).

2. A graduate (400– or 500–level) course in experimental design and 2 graduate statistical methods courses must be completed within the Master's and Ph.D. program.

2. The major professor and the student's graduate committee will determine additional specific course requirements for completion of the Ph.D. degree.
3. Students must choose either the Animal Science option or the Range Science option.

GRADUATE COURSE DESCRIPTIONS

ARNR 507 - RESEARCH METHODS
F,S 1 cr. SEM 1 Maximum 5 cr.
Prerequisite: Graduate standing.
- Application of scientific method and research techniques, including design of experiments and use of appropriate statistical procedures.

ARNR 520 - NUTRIENT METABOLISM OF DOMESTIC ANIMALS
F alternate years, to be offered odd years 3 cr. LEC 3
Prerequisite: ANSC 320, and either CHMY 123 or BCH 380 or consent of instructor.
- Energy and protein utilization, emphasis on how energy and protein requirements are determined.

ARNR 521 - ADVANCED RUMINANT NUTRITION
F alternate years, to be offered even years 3 cr. LEC 2 LAB 1
Prerequisite: ANSC 320 or consent of instructor.
- Physiological and microbiology aspects of ruminant digestion and their influence on the metabolism of extraruminal tissues.

ARNR 523 - ADVANCED PHYSIOLOGY OF REPRODUCTION
S alternate years, to be offered odd years 3 cr. LEC 3
Prerequisite: BIOB 412, BCH 380, ANSC 321 or consent of instructor.
- Study of the basic concepts of reproductive process of mammals with special emphasis on the application of recent techniques in solving reproductive problems associated with fertility and infertility.

ARNR 524 - ADVANCED ANIMAL BREEDING
S alternate years, to be offered even years 3 cr. LEC 3
Prerequisite: ANSC 322.
- Quantitative genetics applied to the improvement of animals. Biometrical relationships among relatives, methods of estimating genetic parameters, application of crossbreeding systems and selection techniques.

ARNR 525 - MUSCLE AND GROWTH BIOLOGY
S alternate years, to be offered even years 3 cr. LEC 3
Prerequisite: BCH 380 AND BIOB 160.
- Growth and development of muscle, muscle structure and how growth is controlled by hormones and DNA will be studied. The impact of growth manipulation on the final product, meat, will also be evaluated.

ARNR 529 - YELLOWSTONE WILDLIFE HABITAT ECOLOGY
Su 2 cr. LEC 2
Prerequisite: WILD 426 or WILD 428 or Equivalent.
- This course will describe the native communities of the internationally prominent northern Yellowstone winter range for wild ungulates. The ecology of many organisms, both plant and animal will be studied. Plant identification skills will be incorporated with an emphasis on the recognition of the Yellowstone northern range's flora and its importance as wildlife habitat. Ecosystem interrelationships will form the basis for understanding the ecology of the range and interpreting the consequences of management alternatives.

ARNR 541 - RANGE ECOPHYSIOLOGY
S alternate years, to be offered even years 3 cr. LEC 3
Prerequisite: NRSM 240 or BIOE 370 or BIOE 433.
- Lectures and selected readings on the response of range plants and animals to daily and seasonal changes in their environment, including physiology, animal behavior, and plant population biology.

ARNR 543 - RIPARIAN PROCESSES AND FUNCTION
S alternate years, to be offered odd years 3 cr. LEC 3
Prerequisite: NRSM 455, BIOE 370 and ERTH 432.
- This course involves an in depth investigation of the geomorphological physical and biological parameters unique to riparian areas of the Northern Rocky Mountains and Great Plains. Emphasis will be placed on how these parameters interact to create the biotic communities associated with riparian areas.

ARNR 544 - ADVANCED GRAZING MANAGEMENT AND ECOLOGY
S alternate years, to be offered odd years 3 cr. LEC 3
Prerequisite: NRSM 240 or NRSM 350 or NRSM 351 or BIOE 370.
- Review of management principles for livestock grazing grasslands and shrub lands and their ecological relationship to other areas. Study design and scientific results will be examined to critically review information.

ARNR 575 - RESEARCH OR PROFESSIONAL PAPER/PROJECT
F,S,Su 1 - 4 cr. IND Maximum 6 cr.
Prerequisite: Graduate standing.
- A research or professional paper or project dealing with a topic in the field. The topic must have been mutually agreed upon by the student and his or her major adviser and graduate committee.

ARNR 589 - GRADUATE CONSULTATION
F,S,Su 3 cr. IND Maximum credits unlimited
Prerequisite: Master's standing and approval of the Dean of Graduate Studies.
- This course may be used only by students who have completed all of their course work (and thesis, if on a thesis plan) but who need additional faculty or staff time or help.

ARNR 590 - MASTER'S THESIS
F,S,Su 1 - 10 cr. IND Maximum credits unlimited.
Prerequisite: Master's standing.

ARNR 591 - SPECIAL TOPICS
On Demand 1 - 4 cr. Maximum 12 cr.
Prerequisite: Upper division courses and others as determined for each offering.
- Courses not required in any curriculum for which there is a particular one time need, or given on a trial basis to determine acceptability and demand before requesting a regular course number.

ARNR 592 - INDEPENDENT STUDY
On Demand 1 - 3 cr. IND Maximum 6 cr.
Prerequisite: Graduate standing, consent of instructor, approval of department head and Dean of Graduate Studies.
- Directed research and study on an individual basis.

ARNR 594 - SEMINAR
On Demand 1 cr. SEM 1 Maximum 4 cr.
Prerequisite: Graduate standing or seniors by petition. Course prerequisites as determined for each offering.
- Topics offered at the graduate level which are not covered in regular courses. Students participate in preparing and presenting discussion material.

ARNR 690 - DOCTORAL THESIS
F,S,Su 1 - 10 cr. IND
Prerequisite: Doctoral standing.

Delaware Study of Instructional Costs and Productivity

MSU participates in a study of academic productivity and costs as conducted by the University of Delaware's Office of Institutional Research and Planning, allowing comparisons at the department level with peer departments. Delaware comparators for A & RS are 01.09, Animal Sciences.

Results from the study are included in Appendix and are presented with a general description of the report format, followed by definitions and graphs used in the report where peer comparisons are made both relative to the national benchmark and relative to other departments at MSU. The following are some relevant points to be taken from the graphs:

• A & RS instructional expenditures per SCH are 78% relative to benchmark.

• A & RS is below the MSU mean for instructional expenditures per student credit hour (SCH)

Total SCH taught by T/TT FTE is greater than comparative research institutions as well as total sections and student FTE taught by T/TT faculty.

Research expenditures per T/TT FTE in A & RS are only 79% of the Delaware benchmark and have decreased significantly since 2006.

Public service expenditures per tenured/ tenure-track FTE in A & RS are also greater than comparative Benchmarks and to the MSU average, which is above peers. This result is in part because Extension is included in these calculations.

Graduate student SCH and Graduate student sections are lower than Animal Science Research Institutions. Graduate student course offerings are lacking in A & RS which is most likely a result of a relatively new Ph.D. program.

In summary, the A & RS Department has a relatively large number of undergraduate per tenure-track instructional FTE; has an above average SCH and courses taught by tenured/tenure-track faculty. Areas to improve relative to peer institutions include research expenditures and graduate SCH (via increasing the number of graduate students) and courses offered to graduate students.

VI. OUTREACH AND SERVICE

As part of each faculty member's appointment, service accounts for 10% of assigned duties. Animal and Range Science faculty assume leadership and service commitments at state, regional, national, and international levels. The faculty advise agency, business, and agriculture and natural resource groups in Montana, the region, and the nation. Faculty and staff contribute to numerous college and university committees, programs, and institutes and annually participate in MAES project reviews and other activities. Faculty are active in professional societies and provide leadership at top agency levels.

APPENDIX A

Previous Review Reports (1985, 1995 and 2000) for Animal and Range Sciences

REVIEW OF THE

DEPARTMENT OF

ANIHAL AND RANGE SCIENCES

AGRICULTURAL EXPERIHENT STATION

MONTANA STATE UNIVERSITY

BOZEHAN

March 25-29, 1985

TABLE OF CONTENTS

I. INTRODUCTION

The March 25-29, 1985, review of the Animal and Range Sciences Department at Montana State University was developed cooperatively by administrators from the Montana Agricultural Experiment Station and the Cooperative State Research Service (CSRS) of the U.S. Department of Agriculture. The review team (Appendix C), the agenda (Appendix A), and this narrative report were coordinated by CSRS. The objectives for the review (Appendix B) and the 168 page background document were developed by the Department in cooperation with the SAES Director. Pre-review discussions with the Department Head, the Director, and the President were beneficial to the team participants.

The review team members visited with research scientists, and to a much lesser degree, with undergraduate and graduate students as well as Extension personnel associated with the Department. Laboratories and other Department facilities on campus were also briefly visited.

An attempt has been made to orient the narrative report under the outline presented in the Table of Contents. The duplication evident can serve to re-emphasize specific points of interest.

II. ANIMAL BREEDING

The Department has a long history in animal breeding research. As a leader in record of performance work with beef cattle, Montana was one of the first States to form a beef cattle improvement association.

Project 190 is concerned with the productivity profile of beef cattle crosses varying in proportion of Hereford and Simmental breeding. The project provides useful information on average genetic and heterosis effects related to growth rate, quantity of milk, reproduction, and mature size. The information published and planned should aid producers in devising breeding programs that optimize total lifetime production in a range environment.

A unique contribution of this experiment, gained by interdisciplinary cooperation of range nutritionists, was the evaluation of grazing patterns and forage intake of the different breed groups. The project is near its termination date. A new proposal addresses crossbred combinations of Hereford with Tarentaise, Brahman, and Simmental. The proposal will again provide for interdisciplinary studies of a gradient of genetic types and provide for estimates of individual, maternal, and paternal heterosis. The leaders should consider including all reciprocal backcross types in the design and should consider using semen from the same sires of corresponding breeds involved in other crossing experiments in the United States. Using some common sires would provide genetic ties to enhance the evaluation of genetic-environmental interactions. Evaluating maternal aspects of breeds and crosses of various biological types should definitely be a part of the beef program in Montana.

Project 193 has two breeding components. The first component involves an evaluation of factors affecting calving difficulty and the importance of genetic-environmental interactions. Utilizing the data bank of the American Simmental Association, analyses have provided a series of publications on calving difficulty that have gained international recognition. The proposed analyses of maternal grandsire data and the Simmental x Brahman crosses offer added opportunities to evaluate maternal influences. Individual and maternal genetic effects of the Brahman breed on birth weight appear to differ in direction and Brahman heterosis effects

exceed those of Bas taurus crosses. Whereas a great deal of information was gleaned from the early analyses of the Simmental herd records, future studies may have more problems associated with non-random mating and selection bias, particularly in relation to calving ease.

The second breeding component of Project 193 is a selection index to minimize the increase in birth weight while selecting for increased yearling weight. Linear body measurements were also obtained. Keeping birth weight in check to avoid calving difficulty is important to breeders throughout the world. Time trends based on repeat matings suggest genetic trends that were negative for birth weight and positive for post-weaning gain. Age of dam correction, unbiased by selection, will be necessary to properly evaluate the genetic and environmental trends.

The progeny test of foundation and selected sires will provide a direct comparison of genetic change including correlated responses. The planned termination in 1987 seems appropriate. If genetic change cannot be demonstrated in two generations, the selection system will likely not be of enough benefit to justify its use by breeders.

Sheep breeding carried out under Project 195 emphasizes diet and indirect selection for prolificacy, growth rate, and fleece weight. Selection for high and low prolificacy was initiated in 1968. A control line based on foundation ewes was established in 1972. Time trends indicate prolificacy declined in the low line but the high and control lines did not differ significantly. A more detailed analysis of selection applied is needed. Also, the possibility of an environmental ceiling from nutrition or management under the range environment may have limited upward response for this all or none trait. Planned evaluation of physiological parameters will provide a valuable characterization of selection response. Selection may have changed some components of reproduction without altering the net effect on prolificacy.

Selection for scrotal circumference was initiated in the Columbia flock in 1983. Two lines were established; one based on circumference at a constant age and the other circumference adjusted for body weight. Scrotal circumference appears to be a good criterion for indirect selection for improved reproductive performance. The method of adjusting for body weight by evaluating the average rate of intra-animal change in scrotal circumference and body weight should be examined as an alternative to the adjustment currently used.

The selection for growth rate and fleece weight in the Targhee flock does not seem to offer much likelihood of producing new information for breed improvement. Including the Targhees in the selection scheme for scrotal circumference would provide a valuable replicate of the Columbia selection and would permit accurate assessment of selection effects in less time. Alternatively, random selection and mating using a maximum number of males may provide a more efficient design for estimating genetic parameters and correlated response. Each generation is a mini high, low, and control selection experiment unbiased by selection.

The international programs project on genetic improvement of small ruminants can provide data useful to breeders in many parts of the world, including Montana. The project offers an opportunity to expand the horizons of staff and graduate students. However, all efforts come at a cost of time. Staff involvement in too many projects may prevent completion of other needed work unless careful budgeting time is followed. It takes a long time and much effort to become an "expert" in a foreign field.

The swine breeding project from LARRS is being moved to MSU, Although it appears worthwhile to analyze accumulated records, it may not be necessary to continue a comprehensive swine breeding project. Again, a random selection and mating scheme might be the most useful

breeding design to follow. Other SAES stations can supply supportive breeding information for use by Montana swine producers.

The stress related project is difficult to assess. Measuring stress is complex. Unless an intensive physiologically oriented study is conducted, interpretable results may not be forthcoming. Certainly some limited use of past records documenting death losses in the various species may offer clues to directions to take and at least document the extent of the problem.

III Nutrition

The nutrition area is developing into a critical mass of young, enthused, and energetic scientists. The change in the ruminant nutrition program is dramatic and generally timely and appropriate. It is important to continue the atmosphere of cooperation and mutual stimulation.

The primary livestock resource in the State is cow/calf production on rangelands. Range is the primary feed resource. Maximizing use of that forage resource has to be (and is) the primary objective of the ruminant nutrition group. It appears that research in the past has been quite applied and routine. Current research is somewhat more basic in nature.and aimed at determining mechanisms and basic requirements which can lead to improved efficiency of production. This fits closely with the departmental goal of increasing efficiency of livestock (protein) production.

It is important that the ruminant nutrition research be intimately tied to the range management research. This tie should be maintained and enhanced. Perhaps there could be more emphasis on the interaction of the plant and the animal, especially as range management strategies affect the quality of the diet of the animal.

The greatest "nutrient" need of the beef cow is for energy. Energy needs of the cow in the Montana environment are not well documented. It is appropriate that these be studied in detail. It is important that these studies be carefully designed (including techniques employed) so that appropriate, statistical conclusions can be drawn. The scientists are attempting to obtain absolute estimates in some cases and not just relative differences. It seems that energy usage (or requirement) on a given January day could easily be confounded among voluntary activity, energy to maintain body temperature, fetal growth, and cow maintenance. On the one hand, it is important to conduct the research in an applied setting. On the other hand, it must be controlled sufficiently to be able to draw scientific, publishable conclusions.

Supplementation to enhance rumen fermentation or to meet the metabolic needs of the cow is an important objective and research area. Techniques are very important to successful research in this area. Much can be done economically with the in vitro and in situ techniques. The cost is primarily for labor. Sophisticated laboratory equipment is not needed.

Appropriate design and application of techniques is very important. Also, many factors may interact to affect microbial activity. One should not be satisfied with looking for one factor that is limiting. Rate phenomena need to be studied in detail. It is necessary to verify rates in the animal because in vitro and in situ techniques may not accurately integrate the rate phenomena.

The opportunity to use the ability of Dr. Sands to produce genetically engineered bacteria for ruminants should be exploited. This opportunity is of great value for research and also capturing the attention of the public and legislative bodies. Realistically, this must be considered "high risk" research in that the chances of easy success or even eventual success are not great.

Determination of the amino acid requirements of the range cow in Montana is a tremendous goal but may be impossible to achieve. The range is the valuable but low cost feed resource for the beef cow. The important out-of-pocket costs are for supplemental feed, energy, and protein. The nutritionist primarily has the opportunity to minimize these costs.

Protein is the most expensive nutrient. Knowing the precise amino acid needs of the cow is necessary to provide least cost supplementation. The difficulty is in the techniques for determining amino acid needs. Supplementation with protected amino acids "may" give the level of supplemental amino acid needed in a given situation. To obtain this requirement, it is necessary. to know the metabolizable amino acid·flow from the rumen at the same time. It has not been conclusively shown that plasma amino acid concentrations will reflect amino acid status of the ruminant. Finally amino acid use for energy via glucose must be considered. The opportunity to enhance performance by enhancing propionate production may exist if amino acids are being used for gluconeogenisis. The opportunity for success should be carefully studied before large amounts of support are committed to amino acid analyses.

Research aimed at quantifying the nutrient consumption and needs of the nursing calf is justified. Techniques outlined are appropriate but close attention should be paid to correct application of techniques and correct interpretation. This research is innovative and interesting. Administrators should encourage continuation of the research.

The sheep nutrition research is similar to that in beef nutrition. This is appropriate. Careful consideration should be given to: a) "tagging" much of the sheep nutrition research to the beef research, and b) using the sheep as an inexpensive model for the beef research. Some of this is obviously being done but even more may be appropriate. The best ideas generated in the total nutrition group should be applied to the sheep studies as well as beef. The primary difference between sheep and cattle in grazing selectivity reinforces the need for selectivity studies.

Some of the objectives suggested for the sheep program may have answers in the beef nutrition research (or the literature). Encourage application of innovative thinking in this research. Perhaps more attention should be given to development of the ewe lamb. The type of sheep production in the State and the unique opportunity to study nutrition of the range ewe and lamb support the thought that this research should be given priority over farm-flock research. Protein and (or) amino acid requirements (or supplementation needed) for optimum wool growth appear worthwhile as wool growth may be more sensitive to protein nutrition than bodyweight gain. Also, importance of least cost production as is emphasized by the beef group, is likely important. Analysis for numerous metabolites is discouraged unless the analysis will enable tests of differences between specific biochemical mechanisms.

Swine production in the State is much less important economically than beef, continued research in nutrition and management seems warranted. This is a mature, well-established research program that has been very productive. It is an excellent example of applying good nutritional principles to solve applied problems. Also it is a good example of determining the important nutritional problems based on feedstuffs available and then solving those problems. Collaboration with a variety of scientists has been achieved successfully.

Comments and Recommendations

Addition of another staff member should solidify the "critical mass of nutritionists. Research interests of the individual will have a strong impact on the direction of the total group. Perhaps the direction desired is as important as the individual.

Continued cooperation of the total group is absolutely essential. It is important that leadership be developed within the group. However, it is also important for each member to be challenged appropriately. Administrators must encourage this cooperation. Proper credit must be given to those individuals who sacrifice their professional growth and personal satisfaction for the greater good of the total program.

Formation of a N utrition Institute is probably appropriate There appears to be a sufficient core of faculty and courses to offer a Ph.D. program. The spirit of cooperation also seems present in the larger nutrition group. Graduate students, both quantity and quality, are critical for the success of the nutrition program. This may be the greatest additional support needed, even above further facility development.

The plans and enthusiasm shown by the ruminant nutrition group are excellent .However, it is now necessary for this group to produce. It is important that they not be satisfied with good plans, innovative techniques, and adequate facilities. They must now show productivity primarily in the form of peer reviewed refereed publications.

The Red Bluff facility provides a good opportunity to conduct needed research Further development is needed to facilitate the research including a "rough" laboratory. It is important that the facilities, livestock, and management not get "spread too thin." It is great that these things are getting multiple and efficient use but the concept should not be carried to extremes.

It is assumed that laboratory and metabolism facilities will be developed as planned. These are necessary for adequate functioning of the group.

Several of the concepts being researched by the nutrition group are quite complex. Some type of modeling should be considered as a means of focusing the research. Modeling as an end in itself may not be warranted but using the model to evaluate feasible alternatives may be It is recommended that someone's model be borrowed and modified rather than building a new one.

No mention was made of studying the nutrition of the replacement heifer or the yearling. In fact, these two may be the same. Is some potential being overlooked?

Straw ammoniation research at Havre seems to need involvement by nutritionists. It does address the nutrition of the replacement heifer and nay deserve some further attention.

Research at the Huntley Station should be incorporated into the total nutrition program of the Department. Growing/finishing research appears to be needed to meet the needs of the Feeders in the area. To obtain and keep a quality researcher, it is necessary that the person be allowed to participate in graduate programs, seminars, etc., in the Department.

It is important that the young nutrition scientists grow and mature professionally. Interaction with other scientists is important. Attending and participating in National scientific meetings and regional committee meetings should be supported. Visiting professors may also be very useful in stimulating these scientists. Two-day visits or longer to MSU are encouraged.

These young scientists should not go too far too fast with too many techniques. They should develop areas of expertise and stay with them and not jump to other areas and techniques too rapidly.

Greater interaction of the nutrition group with all the range management group may be indicated.

IV. REPRODUCTIVE PHYSIOLOGY

The objectives of Projects 193, 217 and 210 are appropriate and fit the overall departmental objective. Project 207 objectives appear directed to producer problems or to fit within objectives of animal breeding projects.

The scientists in reproductive physiology are extremely competent and are well perceived by their peers. The productivity of these scientists is good. Productivity could be increased by increasing the "critical mass" with an additional physiologist. The area of reproductive management should be enhanced and supported within the beef management research position. Acquisition of new technology as well as application of new technology to increase protein production from Montana range requires both basic and applied research.

Reproductive physiology offers the opportunity for the Department to enhance the reputation of Montana State University. With proper encouragement and support, this area could become fundable through grants in the near future. The nature of reproductive physiology research is such that research goals can be met rapidly and end user benefits accrue rapidly.

The basic research in Projects 210 and 217 should attract external funding which in turn would stimulate further funding. The basic information generated from these research efforts will have more value if an additional applied physiologist is working with this research to hasten its utilization.

Research should continue and be enhanced in the area of genetic control of reproductive processes. Research characterizing physiological differences of the high and low prolificacy lines of sheep should be exploited. Research with the records from the Simmental Association in Project 193 should be continued but should be subordinate to the understanding of genetic mechanisms controlling reproduction. The animal models available should be fully utilized to develop an understanding of the genetic control of reproduction.

Current research in Project 210 should continue as planned. Emphasis should be upon the developmental process leading to puberty and return to reproductive competence after parturition. Collaborative efforts should be maintained and strengthened with genetic and nutritional research projects. Collaboration with LARRS scientists should be of great value in these research efforts.

Principal investigators in Projects 193, 210, and 217 should increase their collaborative efforts with Project 207. This association could lead to greater productivity of all four projects.

Animal availability and scientific expertise are not limiting factors. Operational budgets are adequate but do not meet all needs for equipment. The current condition of the departmental laboratory facilities is not adequate to encourage maximal research effectiveness. Lack of a dust-free, temperature-controlled laboratory will make it difficult to maintain low coefficients of variation in radioimmunoassay results. The laboratory as it is can be made to produce acceptable results but efficiency will be relatively low due to environmental problems. Adequate numbers and classes of sheep seem to be available but some difficulty may be met in obtaining appropriate types of cattle.

Potential research output in reproductive physiology should make this area attractive for increased funding. The fundamental theme of efficiency of range livestock production utilizing the breeding female in all of the beef and sheep research projects in genetics and nutrition makes reproductive physiology integral to their success.

V. RANGE MANAGEMENT

The range science faculty consists of three assistant professors, two associate professors, and one research associate/range manager for a total of 3.59 FTE's funded by the Agricultural Experiment Station. The three assistant professors and research associate have all joined the range science faculty since 1980. Project 215 "Improving Range Production" has served as an umbrella research project for much of the range research since 19 82. New projects currently are being written to guide future research.

The Department's goal is to improve the efficiency of protein production from rangelands and livestock with programs where ".•• efforts are directed to the solution of range livestock production problems through interdisciplinary research. provide an appropriate and realistic objective for departmental research and teaching programs.

Faculty within the range science program obviously have made an effort to direct research toward departmental objectives, but the group does not appear to have come to a consensus on priorities for research and how closely work should adhere to the departmental objectives.

Several of the range scientists have three or four specific investigations in progress, often without a clear overall direction for the research. Some of these investigations appear to be designed as if they were separate thesis projects.

The range research objectives for individual investigations as they relate to Department objectives are discussed by areas.

The range nutrition research provides the major interface between range and livestock nutrition, breeding, and physiology. The objectives of the range nutrition research definitely match departmental objectives to increase livestock production by interdisciplinary effort. Research to determine forage intake differences among breeds is an excellent example of cooperative research. Cooperative efforts between range nutrition and animal research obviously are due to efforts of enthusiastic young scientists, an effort which the Administration should encourage with financial support and close contact to help avoid problems which might decrease effectiveness of this cooperation. Individual scientists should be careful not to over-commit themselves to the point that obligations incurred in the cooperative effort cannot be fulfilled.

Range plant introduction and reseeding trials have been conducted at Red Bluff with two scientists involved. Reseeding research receives a great deal of effort in Canada and at the ARS Livestock and Range Research Station at Miles City. What level of reseeding research should be conducted at Red Bluff? Should work primarily be on large plots and designed so that the seedlings can be used in conjunction with livestock grazing studies?

The research at Red Bluff on time controlled grazing and a separate study on the effect of hoof action on cryptogamic crusts both relate to questions being asked about influences claimed for time and density control of livestock grazing under Holistic Grazing Management. The greenhouse grass clipping experiment also fits into the general area of influences associated with grazing systems. The review team was pleased to see the researchers conducting research related to grazing systems at the specific effects level rather than attempting to "test" a system. What priority should grazing system research receive? How important is it to meet departmental objectives and do any faculty members wish to build their careers on this kind of research? The range and livestock facilities are available to conduct some good research which relates to animal and range response associated with grazing systems.

The riparian grazing study addresses a problem being asked about grazing influences on riparian ecosystems, especially on public lands. Environmental groups point to grazing da age on riparian areas and demand removal of livestock grazing from these areas. He must know how to manage grazing on riparian areas to optimize livestock production and minimize environmental damage. Harry range researchers are conducting riparian research. What level of priority should Montana devote to this research? We suggest that the current effort is too small to satisfy needs or to build a scientist's professional reputation. Either increase efforts with more input from other scientists or drop the research in this area when current objectives are met.

The proposed research on range monitoring methods is in a topic area which currently is popular in range research, because grazing capacity on Federal ranges are being established by range vegetation monitoring studies. Is this a big enough problem in Montana to justify a major research effort? Perhaps the proposed vegetation measurement techniques studies and current floristic investigations related to range condition efforts could be combined into a research project to characterize range condition and sites with data that could be correlated with site ability to produce nutrition for grazing animals. The effort available for measurement technique studies and range condition studies could also be directed toward research on weed ecology, including poisonous plants, as these weeds influence red meat production from rangelands.

The Artemesia and Chrysothamnus ecology and forage relationship studies can provide a data base to show how some of these species or subspecies may provide much needed protein and phosphorous to grazing animal diets. Perhaps this aspect of the project should be emphasized and the aspect of growth form as influenced by clipping reduced. Because growth form is a function of site as well as history of utilization, the team has little confidence in developing reliable growth form information to document grazing use.

In summary, there appears to be a need for the range faculty, along with the range extension specialist, ARS scientists at Miles City and other cooperators to identify problems which relate to departmental objectives and establish priorities for a few research projects to be written as

experiment station projects. Perhaps the SPUR livestock production model could be used to help identify priorities for research. Criteria for selecting projects should include:

1. Departmental objectives
2. Anticipated level of effect on livestock production
3. Relative time frame to show results
4. Matches with faculty and facilities available
5. Contribution to professional recognition of the SAES and researchers
6. Will data obtained provide published results?

It is suggested that projects be specific-problem oriented studies with one or more scientists involved.

Many of the range faculty are relatively new. Range research often is slow to produce results. The range faculty, therefore, is low on quantity and quality of refereed journal articles. The faculty should make a major effort to improve their record of publications.

The livestock and research areas available for research are a unique and valuable resource which should be exploited in research efforts. Funding appears to be at a reasonable level.

The faculty has a minimum number of scientists to provide a basic range teaching and research program The faculty composition is heavy on individuals trained in range ecology. They need to emphasize the differences which exist among them and strengthen appropriate interests to provide diversity within the existing faculty. As future appointments are made, definite efforts should be made to hire individuals to fit specific needs and complement current faculty.

The scientists are well known to their peers through participation in activities of the Society for Range Management, their participation in regional committees, and other professional activities They are not well known for publications.

The strengths of this group of scientists include young, ambitious faculty and excellent livestock-range resources on which they can work. Their principal weakness stems from an apparent lack of a united goal and a developed plan of action. The range scientists need to work together and with cooperators to develop a plan of action. Resources, except laboratory facilities, are good and appear to be well allocated. Utilization of existing resources appears to be good.

VI. LAND RECLAMATION

The Reclamation Research Unit was established in 1964 with initial work on roadside revegetation research. This is a soft money unit assigned to the Department. The unit has two scientists, who are adjunct associate professors, each is paid 45 percent FTE on teaching, and one research associate funded at 10 percent FTE on teaching funds. The balance of salaries, capital, and operation funds are from grants and contracts. The unit provides guidance for !.S. graduate students and teaches courses in reclamation. An M.S. degree in Land Reclamation is awarded.

Some research, especially that related to effect of toxic minerals on livestock and forage production developed from revegetation of mine spoils, relates directly to departmental objectives. Overall, however, the objectives of the unit are to respond to problems for land rehabilitation specified in grants and contracts.

The research done by the unit is mostly short-term and often band aid type research to satisfy a legislative requirement imposed on a company. The work done by the unit personnel appears to be of good quality.

Publications are primarily reports to companies and printed symposia, but publication in refereed journals is at a good level.

The two adjunct associate professors have Ph.D. degrees in Soil Physics and Botany. The research associate has an M.S. in Range Management. These scientists provide much needed depth to the range program within the Department.

The Land Reclamation major helps provide a critical mass in terms of students and provides added course offerings to the graduate program in range management. Graduate students in reclamation, however, feel as if they are orphans in the Department. This feeling apparently arises in part from a lack of access to xeroxing and assistantships because of the grant and funding situation.

The unit seems to have functioned well for its established purpose. Units such as this must respond quickly to complete their research. Scientists cannot be tied down to teaching and a long-term research project and still respond in the time frame required. We see no need for any major change except to investigate the concerns of the graduate students and rectify the problem associated with their feeling that they are outsiders. Some Experiment Station funding to solve specific problems would be helpful.

VII. MEAT SCIENCE

There is a need for research in this area to verify the quality and quantity of the end products resulting from investigations in breeding, nutrition, management and reproductive physiology. Valuable "spin offs" from this research effort can include the student hands on courses, the evaluation of live animal and carcass composition, anatomy, meat processing, meat storage, sanitation, and a better insight of the place for meat animals in agriculture.

Problems could appear relative to location of the present facility and also costs of renovation needed to meet Federal inspection. One must evaluate whether it would be more advantageous to enlarge the processing area and completely remove the "kill" portion of the present facility or to maintain both the slaughtering and processing capabilities. This, of course, depends on the direction chosen for future researchers and teaching needs by the scientists involved. There can be advantages or disadvantages to either selection.

The meat scientist has been aboard some 95 days which is not sufficient time to develop a coordinated project. After considerable discussion to assess the support and needs of the Department and also the aspirations of cooperating scientists, a project should be formulated that best fulfills and provides the greatest support and benefit to the Department goals.

VIII. WOOL RESEARCH

The scientist in this area of research has been investigating wool and related characteristics for over three decades. It is not known if these investigations were of design

and magnitude to permit accepted statistical analyses. This needs to be determined as soon as feasible. The scientist should then be encouraged to analyze these data independently or in cooperation with others and publish the interpretations in the popular and scientific media for users. It is highly unlikely that anyone can interpret these data as well as the scientist that is knowledgeable of the method(s) used in obtaining the data and the questions that were originally intended to be addressed. No doubt, several relevant present day questions concerning wool can also be addressed from studies of these same data. Perhaps all that is needed is some gentle persuasion, computer time, statistical assistance, and an interested helper. In light of the need for wool grade and yield specification for the wool markets, these analyses are opportune and could prove to be very rewarding. The scientist in control of these data is judged to be knowledgeable concerning wool and its ramifications. To the best of the team members' knowledge, he is well respected by his discipline peers in other States The principal Recognized weakness is the void in disseminating written information to producers and other wool investigators. An effort should be made to ensure that any future wool research initiated is adequately designed statistically to provide publishable results. Future wool research efforts should also be coordinated to complement, but not duplicate, wool research in Wyoming and Texas.

IX. PRODUCERS' POINT OF VIEW

The breeding research in Project 190 can be meaningful to the industry. The team approach utilizes the talents of many workers and the project is in keeping with the principal goal of the Department which is the efficient use of range resources. The cooperating scientists involved in this research are enthusiastic. Their enthusiasm should be supported and encouraged.

An excellent opportunity exists to use a wealth of good information in Project 193 that is available from the Simmental Association. Could this be the basis for more definitive research in the future?

There is a lot of existing information available in the literature that could be used to develop a more useful ammoniated straw study. Ammoniated straw has a lot of potential in the Havre area. Although straw has been used in a lot of different places, there could be value in additional investigations

External linear measurements of animals are interesting but this is not high priority research.

The benefits to the Department from the international sheep research are worthwhile! The high and low sheep prolificacy study (Project 195) seems to have made its impact and should be summarized soon. There may be other studies developed with the same animals as a base. The effect of out-crossing might be considered.

The project on Range Ruminant Nutrition has excellent cooperation among staff and fits well with work being done by other scientists. This combined effort produces very good, useful research. The staff is enthusiastic and this must be continually reinforced. Additional contact with other researchers in other areas could be useful. The work with young calves is a very important aspect and certainly a challenge.

The sheep management and nutrition project is not as clearly defined as it should be. The review team does caution not to get too many things started. The industry needs results it can use. Lamb mortality is the most costly problem the industry has. Getting

lambs raised is more of a challenge than getting them born. Cooperative work between range and breeding people is very necessary.

The meats lab kill area perhaps could be sound-proofed and ventilated. It may be fruitful to look for a more remote location for this laboratory.

Feeding and other uses of barley may be more important to the swine industry than anything done in swine breeding in Montana.

Monitoring rangeland vegetation is crucial to livestock use of public lands which constitutes nearly 40 percent of the State. The goals and methods must be well defined to have this project succeed. Range inventory and monitoring techniques are used to establish livestock grazing capacities. Many techniques have their limitations. Decisions made using data from existing techniques can be very abusive to livestock producers depending upon their interpretation by specific agencies. This could be a very important study for the industry.

The riparian zone grazing study is valuable for the livestock industry. Good reliable information is necessary for the industry to react to the BU1, Forest Service, and environmentalists, not only on public land but also on private land in view of the recent State court decision.

Information should be recorded for ongoing studies not only as to how range improvements affect livestock but also as to how livestock affects the range improvement. Opportunities exist in this area for research.

Extension specialists should be involved more closely with departmental staff. Extension should be more closely aligned with researchers rather than being semi-outsiders to resident staff. Extension should be returned to the Agricultural School. Livestock people at branch stations should also be a part of resident staff.

Potential for high technology research seems more appropriate in the Veterinary Sciences or Microbiology than in the Animal and Range Sciences Department at the present time.

Some portable laboratory amenities at the Red Bluff Center including such items as heat and refrigeration appear needed.

Measuring the grade of wool is important if the State producers are to successfully compete in world wool market. More wool will be sold in the future on a specification basis, i.e., grade and yield. This is the way of the future in international marketing and we need to be involved.

Animal and Range in one department is unique. Host Bill and Forest people are trained in Biology or Botany or wildlife.

X. OTHER RANDOM CONSIDERATIONS

1. Administrators must reward researchers for cooperative efforts. No research should be totally service or cooperative in activity. Each scientist should have some independent research. There is a good sense of interdisciplinary cooperation evident among the scientists

2. The scientists should not apologize for the size of the Department, specific programs, etc., but should maintain a positive, aggressive, cooperative, excited attitude. The perception of the scientists by their peers is much better than they apparently believe. A poor self- image hinders effectiveness. Efforts to "Combat this problem should be made continuously.

3. Animal scientists at outlying research centers should be responsible to the Department Head for research and direction. Administrative separation of academic disciplines at research centers may be leading to lowered research effectiveness. Scientists at these centers should be a part of the academic department for project and promotion review. Budgetary separation does not appear to be the problem but academic responsibilities could be.

4. Extension personnel in the animal and range disciplines should be encouraged to become more involved in research planning and seminars. Subject matter programs may better meet the State's needs if extension personnel hold joint teaching and/or research appointments. Also, the Department Head should be involved in development of extension programs.

5. Does the extensive nature of beef cow/calf range or sheep/range industry fit with high tech research? Good, solid, relatively basic research may be the best compromise; however, it may not always be the most popular.

6. Technologically, in lantana, an increase in number of sheep to be grazed in conjunction with cattle may be indicated.

7. An increased interaction in joint planning and discussions of research by MSU, NARC, and LARRS personnel could enhance research in all units. The staff appears to be aware of this need and it should be encouraged.

8. The review team does not expect research in the Department to be "high tech" in the sense of gene and molecular engineering except, perhaps, in instances where microbiology or reproductive physiology are involved.

9. There is a possibility for beneficial interaction to develop with Veterinary Sciences in the areas of reproductive physiology and microbiology in the near term and perhaps in other areas later.

10. Grazing management plans should be developed for the Red Bluff and Havre Centers.

11. Out-of-State travel restrictions hurt professional development of faculty.

12. The opportunity to increase sheep and goats on course grass range land may not be as strong as some think. Goats prefer brouse and sheep prefer forbs.

13. A. Some strengths of the Department include:

a) Excellent young scientists
b) Land and animal resources
c) Strong collaborative efforts in some areas
d) Administrative support for research at all levels
e) Research centers--out State
f) Relatively stable budget
g) Acceptable Master of Science program

B. Some weaknesses of the Department include:

a) Poor self image
b) Some non-productive scientists c) Poor physical plant and laboratories d) Outmoded laboratory equipment
e) Wide variation in publication rate among scientists f) Very few grants or contracts

14. Expansion of graduate teaching to include the need for a Ph.D. program should be approached very cautiously. The M.S. program is quite good but might be diluted too much if the higher, more expensive degree program was initiated.

15. Research productivity should be rewarded and lack of productivity should also be taken into consideration during resource allocations. Nonproductive programs should be stimulated or eliminated.

16. Establishment of a visiting professor stipend, at one-half salary, which rotates between disciplines could help stimulate the Department's research effort.

17. A field laboratory with minimal facilities and equipment should be established at the Red Bluff Center.

18. The review team perceived that Some difference may exist among administrators relative to the future basic and applied research effort of the Department.

19. The present outlook for increased funding from the State and CSRS sources is not very bright. Changes in research emphasis will have to be made principally by internal adjustments. This means that new research will probably have to be funded by internal fund shifts, product sales, outside grants, contracts, and greater research efficiency. Only research that is accountable under the Montana situation should be maintained, yet a solid research foundation must be maintained to support research potential if and when funds do become available.

20. Lacto bacillus fermentum barley export write up for support of the agriculture research budget has arrived in CSRS. We will make good use of it.

21. The Department Head is providing good leadership and has the confidence of scientists.

22. The review team members appreciate the preparation, patience, and professional skill exhibited by the scientists and Administrators during this short visit. Thank you, also, for the many small courtesies that were extended in the team members' behalf.

APPENDIX A

AGENDA

Monday, March 25

6:30p.m.	**Dinner for Review Team** Experiment Station and University Administration Topper Restaurant- 1235 N, 7th Ave.

Tuesday, March 26

Orientation

7:00- 8.30 a.m.	Breakfast with Department Head 4-B's Cafe
8:30-10:00 a.m.	t1eet with University and Experiment Station Administration Johnson Hall, Room 325
10:00-11:45 a.m.	Tour Facilities
12:00- 1:30 p.m.	Lunch with Selected Undergraduate Students SUB, Garden Room of Cafeteria
	Animal Breeding Section Johnson Hall, Room 325
1:30- 2:45 p.m.	Cattle **Kress** Burfening
2:45- 3:00 p.m.	Break
3:00- 3:30p.m.	Sheep Burfening
3:30- 4:00p.m.	**International** Blackwell
4:00- 4:15 p.m.	Swine **Burris**
4:15- 4:45p.m.	Discussion by Review Team of Animal Breeding **Section**
4:45- 5:30 p.m.	**Reception for Review Team** Administration, Faculty and Graduate Students Helcome Museum of the Rockies

Wednesday, !1arch 27

Nutrition Section

8:00-10:00 a.m.	Ruminants Havstad Petersen Ansotegui Thomas
10:00-10:15 a.m.	Break
10:15-11:15 a.m.	Nonruminants Newman
11:15-11:45 a.m.	Discussion by Review Team of Nutrition Section
12:00- 1:30 p.m.	Lunch with Graduate Students SUB, Garden Room of Cafeteria

Range Science Section
Johnson Hall, Room 325

1:30- 3:00p.m.	Systems and Improvements Sindelar Harlow Havstad Ayers
3:00- 3:15 p.m.	Break
3:15-4:15 p.m.	Monitoring and Sagebruah Taylor Wambolt
4:15- 5:00p.m.	Discussion by Review Team of Range Science Section

Thursday, t1arch 28

8:00- 9:30a.m.	Reproductive Physiology Berardinelli Burfening
9:30-10:00 a.m.	Discussion by Review Team of Reproductive Physiology Section
10:00-10:15 a.m.	Break
10:15-10:45 a.m.	Meats Gray
10:45-11:45 a.m.	Land Reclamation Dollhopf

Thursday (Continued)

12:00- 1:30 p.m.	Lunch with Extension Specialists SUB, Garden Room of Cafeteria
1:30- 2:00p.m.	Wool - Coleman
2:00- 5:00p.m.	Preparation of Reports by Review Committee

Friday, March 29

Reports by Review Committee
Johnson Hall Room 325

7:30- 8:15 a.m.	Report to Department Head
8:15- 9:30a.m.	Report to Total Department
9:30-11:30 a.m.	Report to University and Experiment Station Administration

APPENDIX ll

REVIEW OBJECTIVES

The objectives of the CSRS review of the MSU Animal and Range Sciences Department is to evaluate present situations and future direction in the following areas:

1. Research

    a. Are the research objectives of the Department as a whole appropriate?

    b. Are the research objectives of the individual projects in line with the Department objectives?

    c. Is the productivity of the scientists of sufficient quantity and quality?

    d. Are the research resources appropriate for the kinds of research being done?

2. Personnel

    a. Is the composition of the faculty appropriate?

    b. What is the status of the scientists in the eyes of their peers?

3. General

    a. To assess the strengths and weaknesses of the Department and to make suggestions for improvement.

    b. To evaluate resources available to the Department and to evaluate their allocation and utilization within the Department.

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COOPERATIVE STATE RESEARCH,
EDUCATION AND EXTENSION
SERVICE
UNITED STATES DEPARTMENT OF
AGRICULTURE COMPREHENSIVE REVIEW
DEPARTMENT OF ANIMAL AND RANGE
SCIENCES
MONTANA STATE
UNIVERSITY
JUNE 5-9, 1995

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INTRODUCTION

A comprehensive review of the teaching, research and extension programs of the Department of Animal and Range Sciences at Montana State University, was requested by the then Dean and Director, Dr. Barry Jacobsen. Dr. Thomas J. McCoy was appointed Interim Dean and Director, effective July 1, 1994. This appointment became permanent May 1, 1995. The previous review of this department was conducted in 1985.

Review Team members were provided with an extensive program review document prior to the review that described the Department and current programs quite well. This document clearly reflected the careful thought and attention of the faculty in preparation for this review. The material provided was very complete, and was most helpful in conducting this review.

The purposes and objectives for this review were clearly presented in the Program Review Document. It was emphasized that this should be a program review rather than stressing and evaluating individual programs and discipline areas.

Efforts of the faculty and administration in preparation for this review were greatly appreciated. The Dean and Director and the Department Head were very candid in providing the Review Team with relevant information pertaining to present challenges for the college and department and in articulating their expectations from this review. The presentations were presented seminar style and in a format that encouraged questions and discussion. There was good attendance by the faculty during all review sessions. The Review Team also held meetings with: (1) undergraduate students, (2) graduate students, and (3) other department heads in the college. There were two ad hoc members of the Review Team that attended most program review sessions and participated in discussions with the Review Team. They were very helpful to the Review Team in understanding the present situation. They are: (1) Dr. Rod Heitschmidt, Program Leader, USDA-ARS, Ft. Keogh Livestock and Range Research Laboratory, Miles City, Montana, and (2) Mr. Scott Wiley, cattle producer from Musselshell, Montana. He received a B.S. and M.S. degrees from the department, serves on the Agricultural Experiment Station Advisory Committee and represented the Montana Stock Growers Association.

The agenda for the review is presented in Appendix I, and the organizational structure of the College of Agriculture and Agricultural Experiment Station is presented in Appendix II.

Agriculture is the predominant industry to Montana's economy, generating $2.19 billion in income in 1993. This far exceeds the second most important industry, travel, which contributed $1.45 billion to gross income in the State. Over the past five years, livestock sales have generated 56 percent of Montana's agricultural cash receipts. Of the total cash receipts from livestock, 85 percent of it comes from the sale of beef cattle and calves.

GENERAL

The Department of Animal and Range Sciences is a diverse department with major programs in Animal Science, Range Science, and Reclamation Science. The faculty and staff are well qualified and very devoted to conducting comprehensive teaching, extension and research programs that make significant contributions to agricultural industries and natural resources of major importance to Montana.

A major attribute of this department is the large animal numbers and land resources available to support the research and education programs of the department. Unlike many departments and universities that have experienced reduced budgets over the past five years, the budget for this department has been relatively stable. It has ranged from 1.8 to 1.9 million dollars, with 78-80% expended on personnel costs.

The department does face some major challenges which include: (1) pending budget reductions, (2) increasing pressure to relocate some livestock facilities that are located near campus due to development of buildings and businesses in the area, and (3) loss of eight faculty positions in the past 10 years, despite increased student enrollment in the Department. The loss of faculty positions by this department is relatively larger than most other departments in the College.

A new Department Head is providing very capable and effective leadership of the department. His leadership has resulted in many progressive and beneficial changes in the department. These accomplishments are recognized by the Dean, other Department Heads in the College, and most importantly by the faculty and students in the department. The Department Head and faculty have a very positive attitude and are committed to working together to successfully meet current and future challenges and opportunities.

The Review Team offers the following general recommendations for enhancing and strengthening the department:

1. More fully integrate the three major program areas of Animal Science, Range Science and Reclamation Science.

   The department needs to take full advantage of having these three successful program areas in the same department. There is evidence of considerable collaboration occurring among these programs, however, much more is possible. More integration and collaboration among these program areas has the potential of greatly enhancing the total research and education program of the department and will lead to a more cohesive and focused department.

2. Develop a comprehensive strategic plan for the department that will be used to guide the department in its future activities and development.

Given the challenges and constraints of this department, it is particularly important to develop and use an effective strategic plan. This plan should be very complete and include an objective evaluation of present programs and their relevance to the changing needs of the animal industries and natural resources of Montana. You should identify areas of strength that should be kept strong, those that need to be sustained at some lower level of priority, and you may even identify programs to be discontinued. It is also important to develop a long range staffing plan, and it could also include a prioritized list of equipment and facility improvement needs. Such a strategic plan can be very effective in guiding the future decision making of the department. It will also position the department to take full advantage of opportunities whenever they occur.

3. More aggressively seek external grant support.

The department has been successful in obtaining external grant support, and some programs in the department have been more successful than others. Competition for grant support will most likely increase, but realistically the future success of individual faculty and the department will largely be determined by their success in obtaining grant support.

4. Re-evaluate the seminar program for the department.

An effective seminar program should be very important to the faculty and the graduate students. Our understanding is that the present seminar program mainly consists of student presentations, and that each student is required to make two presentations during their graduate program. Typically this consists of a presentation of proposed thesis research and a presentation based on thesis results.

The proposed thesis research may be more appropriately presented to the student's graduate committee. What may be more beneficial for the student and more interesting to the seminar audience would be a topical seminar where literature is summarized regarding some currently relevant topic of general interest. Some concern was expressed regarding low attendance at seminars by faculty. If you consider the seminar to be an important activity, faculty should place a very high priority on attending, particularly for the seminars presented by the students. Some concern was expressed by graduate students about the

determination of the seminar grade. This process should be reviewed to make sure the criteria are clear to the students and that it is fair and equitable for all students. For example, a small number and varying faculty making the evaluations could result in some unintended variation in grade determination.

5. Give a high priority to seeking development foundation funds to support scholarships and other activities in the department.

A good scholarship program is a highly effective way to recruit high quality undergraduate students. The present level of scholarship support within the department is very low relative to similar departments at other universities. This is an activity that requires little extra time. All faculty can take advantage of their contacts with the citizens of Montana to make them aware of the need for more scholarship funds or for other departmental needs and present them with the opportunity to participate.

6. Invite appropriate USDA-ARS faculty at Fort Keogh to officially become affiliate faculty members of the department.

There has been good cooperation between the two groups. There likely will be good opportunities in the future to increase the amount of truly collaborative efforts that will be mutually beneficial to both units. Other departments, as indicated by the undergraduate catalogue, have already done this. Granting an official status within the department to the USDA-ARS faculty should help bring the two groups of scientists together and facilitate future collaboration.

TEACHING PROGRAM

UNDERGRADUATE EDUCATION

The Department of Animal and Range Sciences is to be commended for its commitment to undergraduate education. It is clear that undergraduate education is a priority in the department and that many of the faculty are excellent teachers. Advising is a priority and appears to be well done. Establishment of the computer lab for undergraduates is commendable and will provide long-term benefits to the students and the quality of the teaching program. The department should be complimented for offering general education course work which puts agriculture in a favorable light (e.g. ARNR 201) to students outside the departmental majors.

The teaching goals identified by the faculty are very appropriate. There are a number of concerns, however, with the undergraduate teaching programs including: (1) the large number of majors and options offered, (2) the strong overlap in course work between the three options within the Animal Science major and within the Range Science major, (3) the strong overlap between the Watershed Management and Abused Land Rehabilitation programs and the Range Science program (Watershed and Land Rehabilitation appear to be more options of the Range program rather than separate programs), (4) overlap of subject matter among various courses, (5) very minimal use of Range Science courses in the Animal Science curricula and vice versa, and (6) the excessive number of required courses and lack of electives in each program.

The following recommendations address these concerns as well as other issues to improve the undergraduate program:

1. Streamline program offerings by reducing the number of options.

   Provide students with a basic core of courses for each major and identify groups of electives that will allow them to emphasize areas of interest (e.g. improve their range conservationist rating or focus on business or management). Students within each major academic area should be expected to take a basic core of courses important to that degree. In Range Science, this core may or may not be one that would qualify students as range conservationists. Through advising, students should select additional courses (which may be identified for the more common emphasis in each program) that will strengthen areas of interest.

2. Consider treating Watershed Management and Abused Land Rehabilitation as options of Range Science than as two separate majors.

There is strong overlap in course work between the Watershed Management and Abused Land Rehabilitation curricula and the Range Science curriculum. It would appear that students in there majors need to have the same basic education expected of Range Science students. A block of electives can be identified that provide students with an emphasis on land rehabilitation.

3. Continue evaluating for overlapping material and eliminate unnecessary duplication through revising, combining and/or eliminating courses.

The department offers a large number of courses, especially in the Range Science Area. The faculty have determined that some material may be presented in several courses. Courses should continue to be evaluated to identify those with overlapping material, and unnecessary duplication should be eliminated. This may result in the combination of some courses or the elimination of others.

4. Evaluate each major by considering what courses students need as opposed to what courses you currently teach.

The departmental majors are currently required to take most, and in the case of Range Science, all of the courses offered under that major. The faculty should seriously evaluate which courses are truly necessary for all majors and which should be offered as electives. Part of this process should include an overall evaluation of the necessity of each course currently offered and a determination of whether or not courses not currently available are needed.

5. Incorporate more Animal Science courses in the Range Science curriculum and more Range Science courses in the Animal Science curriculum.

It is evident in both the Animal Science and Range Science curricula that the department is missing a great opportunity to take full advantage of the expertise available in both areas. Much more use of Animal Science courses could be made in the Range Science curriculum, and Range Science courses in the Animal Science curriculum, to the great advantage of the students. Identify courses needed by all students in the Animal and Range Sciences Department and ensure that the core in each major adequately prepares students for common upper division courses.

6. Reduce number of required courses.

This will provide greater flexibility for students to choose electives both related and unrelated to their major.

7. Identify courses in which labs are necessary. Consider ways to improve labs in those courses and eliminate labs in courses where they are not essential.

   Students can benefit greatly from hands-on experience, however, not all courses require laboratory sections. Limited resources for teaching might be better spent on fewer, higher quality labs.

8. Open the departmental computer facility during evening and weekend hours.

   Students need to be able to access computers at times other than the typical 8 to 5 office hours. The department could direct some graduate student time or hourly labor to the computer lab so that extended hours were available.

9. The departmental faculty should develop criteria and procedures for evaluating teaching performance within the department.

   The present student evaluation form is perhaps more useful to the individual instructor but may not be appropriate for an overall assessment of a faculty member's teaching. In order for teaching to be a major factor in faculty evaluations (annual and for promotion and tenure), a means of evaluating the effectiveness of teaching is essential.

10. Consider offering a one-to-two week Meats field trip course for students in the Animal Science area.

    One area of the Animal Science curriculum that is seriously deficient is meats. This was identified as a major concern by the Animal Science students. A meats course is very important for Animal Science students who will be directly involved in the production of livestock after graduation. Since the department does not have the faculty or facilities to offer a meats course on campus, a field trip course that exposes students to important aspects of the meats industry could be very beneficial and require a minimum investment of time and funds. Students could visit meats laboratories of other universities in the region and tour meat packing facilities.

GRADUATE EDUCATION

The review team is extremely impressed with the graduate degree program in the Department of Animal and Range Sciences. It has earned regional, national, and in some programs international recognition, and has attracted good students from across the country. The students that we were privileged to meet were very supportive of the faculty and positive about their educational experience. We commend the department's integration of graduate students into the teaching program. This provides valuable experience and training for the graduate students.

Our collective experience indicates that graduates from this department are highly sought after in the job market. Also, those students that continue their education at the Ph.D. level at other institutions are well trained and very successful in their academic pursuits. We believe the department should be proud of the graduate education and training that it is providing students.

We encourage you to continue to strive for excellence throughout your graduate program. The following recommendations are offered to help achieve even higher levels of excellence:

1. The review team recommends against the establishment of a Ph.D. program within the Department of Animal and Range Sciences.

   The Department of Animal and Range Sciences has an excellent M.S. program and fills a unique and important role in providing a broad based education for M.S. level students. Your faculty appear to have higher expectations and requirements of M.S. students than commonly found among peer institutions that offer both M.S. and Ph.D. degrees. The result is well trained graduates that are highly marketable. The review team has serious reservations about the success of a Ph.D. program in your department because of limited resources (e.g. budgetary constraints and faculty time to teach a new compliment of courses) to support such an effort.

2. Every effort needs to be made to increase graduate student stipends.

   A worthy goal would be to increase stipends to at least match the average for the College of Agriculture. This increase should help attract even higher quality students and will be needed to allow students attending MSU to better cope with the increasing costs associated with living in Bozeman. We encourage faculty to supplement their graduate student stipends with contract and grant funding, scholarships and fellowships, and matching funds from departmental support.

3. Some flexibility should be provided in the Animal Science major by allowing students to make substitutions among the list of required courses or by reducing the number of required courses.

   The requirement for all Animal Science graduate students to take the same set of core courses, which totals 17 semester hours, may restrict the ability of some students to pursue more narrowly focused career tracts.

4. Establish some formal method to monitor the potential impact of teaching graduate courses on an every other year basis and the ability of students to complete their degrees in a timely fashion.

   The review team sees a potential problem developing with courses in the Animal and Range Sciences Department and other departments in the college being offered on an

every other year basis. Time will tell whether a problem exists and the significance of the problem. We recommend that the situation be monitored to provide information for future decisions.

5. Guard against the potential problem of inbreeding among your graduate students by accepting too many students with undergraduate training from this department.

   The review team is not suggesting that inbreeding is an existing problem, but simply recommending that the department guard against this potential problem. There will be increased potential for this to become a problem due to the fact that out-of-state students will have a more difficult time attending MSU because of increasing tuition rates and projected living expenses in the Bozeman area.

6. Efforts should be made to increase the total number of graduate students in the department.

   A 20% increase over the next five years would be a reasonable goal. This increase in graduate student numbers would strengthen your overall program and allow faculty to pursue future research objectives that have been identified during the review. However, the department should not sacrifice quality for increased numbers. The graduate program is excellent and should continue to attract high quality students.

7. Publish a departmental graduate student handbook.

   This handbook should be given to each graduate student to provide important information concerning university and department policy and requirements, important dates and deadlines, student rights and privileges, grievance procedures, etc. The information provided in the university bulletin is not detailed enough to meet student needs.

RESEARCH PROGRAM

RANGE SCIENCE

Montana has a diverse array of ecosystems, uses, opportunities and conflicts. Each of these can provide opportunities for research by the Range Science faculty. The faculty is relatively small, however the areas of expertise included in the group are appropriate for the resource in which they work. **It** is impossible for this faculty to address all of the research topics available in the state, so choices must be made. Topics need to be prioritized and efforts concentrated on those within the capability of the group that are determined to be of the greatest importance. It is important for the faculty to consider the future direction of range research in Montana, and then proceed to develop a range research program as a group. Two general options exist: 1) try to address many questions relatively superficially or, 2) select a limited number of research areas and cover them thoroughly. The combination of Animal Science and Range Science in one department offers more opportunities than disadvantages. Opportunities to utilize Animal Science expertise available in the department should be pursued in order to extend the effectiveness of the Range faculty. Greater research relationships need to be developed between faculty from both areas. A critical need in the Range research area is the development of suitable facilities. Adequate facilities are vital to the success of the range research program and will improve the faculty's ability to attract funding.

Specific recommendations for the Range Research Program include:

1. Establish a well-equipped laboratory facility to support Range Science research.

   Adequate laboratory facilities are vital to the success of the range research program, and it will improve the ability of faculty to obtain grant funding. This needs to be a high priority. A strategy should be developed by the range science faculty, department head and dean, to establish this laboratory at the earliest possible opportunity.

2. The Range Science faculty, as a group, should develop a comprehensive range research plan.

   It will be important for the Range Science faculty to seriously consider the directions that they wish range research to take in the next 5 to 10 years, and to consider the roles each faculty member can play in that plan. Priorities should be set considering the areas of expertise of the faculty as well as the needs of the state. One question that would be useful to ask is, "What do we want to be famous for?" Opportunities to include Animal Science and other faculty in the plan will enable

the Range Science faculty to expand the breadth of their overall research program.

3. Develop stronger research relationships with Animal Science faculty.

   Productive relationships between Animal and Range Science faculty have not been adequately developed. Most of the Range Science faculty have interests and research programs that can be greatly complemented by collaboration with Animal Science faculty. Such relationships will enable Range Science faculty to concentrate on their areas of strength.

4. Aggressively pursue extramural funding, especially from competitive grant programs.

   Extramural funding success was relatively poor in 1993 and 1994. The grants prior to that were a mix of competitive funds and funds from special interest groups. Some of the decline in funding in recent years may be attributable to changes in faculty, but efforts to resume good soft dollar support of range research needs to be stressed.

5. Increase the number of peer reviewed manuscripts published in high quality, nationally recognized journals.

RECLAMATION SCIENCE

The reclamation program has a long history relative to the discipline of reclamation science. It is well recognized regionally and nationally as a center for applied reclamation research with specific orientation towards the remediation of chemical limitations associated with reclamation success. We commend the faculty for establishing and maintaining an excellent relationship with both private industry and regulatory agencies, especially within a climate where there is little trust among these stakeholder groups. The research that these faculty are pursuing is current and highly relevant to the needs of the mineral extraction industry throughout the western U.S. The program serves a vital role in addressing key reclamation related research questions that have tremendous economic and environmental implications. Previous work in the coal industry provided important information that helped advance the state of the art of reclamation science.

The graduate students trained in this program are highly desired as employees among regulatory agencies, the mining industry, and environmental consulting companies. The fact that this department offers the only formalized graduate degree in reclamation allows it to fill a very unique nitch among academic institutions along with meeting the needs of cliental groups.

The following recommendations are made to further enhance the Reclamation Science research program:

1. Increase the number and amount of graduate student assistantships.

   A program that has as much potential to generate contract and grant support as reclamation science should be able to provide financial support to a higher percentage of graduate students. Furthermore, the stipend amounts should be increased to reflect the average for the College of Agriculture.

2. The Reclamation Science faculty should publish more of their research results in the open literature.

   A great percentage of the publication effort among these faculty has been devoted to non-refereed publications. Although these publications may serve an important function, they do not take the place of publishing in scientific journals. The research being conducted is of a quality that can and should be published in refereed journals to increase the accessibility of research results and to lend greater creditability to the science being pursued.

3. The Dean of the College of Agriculture should appoint a planning committee (with equal representation from each academic unit of interest) to re-think and formulate a plan for expanding the M.S. degree to other departments outside the Department of Animal and Range Sciences.

   We support the idea of expanding the M.S. degree in Reclamation Science to other departments, and believe that this will strengthen the degree program if properly planned, executed, and managed. Part of this planning must include long-term faculty commitment to ensure the stability of the program. We believe that the decision to enhance this program, although justified, may not have occurred under ideal conditions and decisions made about the program may not reflect the best interests of the graduate degree.

   It is essential for an interdisciplinary program such as Reclamation Science to require a core set of courses that all students complete. This will ensure that specific training in basic sciences is obtained by all students to guarantee their success in working in this multidisciplinary field of study. We believe that the program is unlikely to succeed without these core courses. At the same time however, students in different departments must be given the flexibility to obtain training in more specific areas of specialization within the field of reclamation science, such as mined land reclamation, wetlands restoration, or reclamation interests that are more oriented towards engineering, just to name a few. The core courses should include a number of courses in the fields of ecology, watershed management and hydrology, soil science, and reclamation methods.

ANIMAL SCIENCE

The major focus of the research program in Animal Science is range-livestock research that is

conducted under western range conditions. Research projects under investigation are mostly applied in nature and are addressing the short- and long-term needs of the Montana livestock industries. The Animal Science research program can be grouped into the following three major areas: nutrition, physiology and genetics/systems analysis.

Research in nutrition has two major areas of emphasis: (1) supplementation program for cattle and sheep grazing range pasture, and (2) utilization of barley and other Montana feedstuffs by cattle sheep, and swine. Significant progress has been made in both areas over recent years. The work on supplementation for grazing livestock is obviously important in improving the biological responses of the animal and profitability to the livestock producer. The work on barley varieties will certainly increase the effective use of this important commodity for the production of livestock.

The reproductive physiology program has three areas of emphasis: (1) evaluate developmental changes in the reproductive tract that are involved with altering fertility of young female ruminants; (2) evaluate social and endocrine factors associated with resumption of cycling activity in postpartum cattle; and (3) determine specific physiological processes that are altered by genetic selection for prolificacy in male and female sheep. The overall goal is to increase the reproductive efficiency of cattle and sheep, and at the same time to gain fundamental knowledge regarding the biological basis for reproduction.

The overall goals of the genetics and systems analysis program are to: (1) make genetic improvement in overall production efficiency, and (2) utilizing a systems approach to evaluate overall production efficiency of different biological types of beef cattle under range conditions. This is the strongest area of research in Animal Science. The pending addition of Dr. Hoeschele will complement the existing faculty very well and should allow an even greater contribution from this program area. The use of systems analysis to study overall production efficiency should receive continued emphasis.

The future directions of all three areas of research as stated in the review book provided no major changes of current research goals and emphases. These programs will continue to focus on the needs of the livestock industry in the state.

The following recommendations are made for possible improvement in the future:

1. Faculty members should increase their productivity by publishing their research results in appropriate journals.

   In the last *5* years, Animal Science faculty published 17 articles in refereed journals per year, which averages out to be slightly over one article per faculty each year. This could be improved even with the same amount of research activity.

2. Faculty should increase efforts in seeking extramural funding to support their research programs.

Continued decreases in state and federal formula funds is a reality. Any productive research program must rely heavily on extramural support. Over the last 5 years, the Animal Science faculty has averaged $155,000 per year in grant support. This averages out to be about $13,000/faculty member, which is well below the national average for animal scientists. **It** should be noted that there was a significant increase in extramural funding in 1994.

3. More collaboration between faculty among different disciplines and different species should be encouraged.

   This is especially important for the systems area where a team approach involving scientists with genetics, nutrition, and physiology expertise is essential. In addition, expertise from range faculty should be an integral part of any systems modeling research in range livestock production systems.

4. There should be increased collaboration between Animal Science faculty at MSU and research scientists at USDA Fort Keogh Livestock and Range Research Laboratory.

   We recognize that there is a significant interaction in the areas of genetics and physiology research. However, we believe there is considerable opportunity for increased collaboration. The College and Department should work with the research leader at the USDA Laboratory to develop a plan for increased graduate student training at Miles City.

S. The College and Department are encouraged to develop a plan to reduce the department's dependence on sales income.

   The purpose is to maintain budget stability on one hand and also provide incentives for generating higher sales income as a result of higher productivity of farm and ranch operations.

FACILITIES

The department has facilities located in Linfield Hall, Towne Farm, Fort Ellis, and Red Bluff Ranch, with additional locations at Bandy Ranch and Northern Agricultural Research Center. With the exception of a needed range research lab, these facilities provide adequate laboratory and animal resources to support the department's research and teaching activities.

Based on the Review Teams understanding of the situation from the information provided, the following recommendations are made:

1. Sell the Towne Farm property and use revenues to build new replacement facilities and upgrade other Animal Science facilities.

This parcel of land of approximately 500 acres is surrounded by development in the city. **It** is our belief that sooner or later, the University will be forced to sell the property due to problems associated with intensive livestock operation. We strongly recommend the College sell the entire parcel, or a major portion, and use the proceeds to build a new state-of-the-art animal teaching and research facility not too distant from Bozeman, and to make significant capital improvement at all other animal science teaching and research locations. If the College decides to keep a small portion of the land, the activities on the remaining land should be restricted to teaching purposes only. We further recommend that a task force with members including representatives from the Dean's office, the Department, and the livestock organizations, be appointed by the Dean to develop a comprehensive plan for relocation.

2. Cease further development of the Bandy Ranch.

We believe that the current land and animal resources, excluding those at the Bandy Ranch, are adequate to support the teaching and research activities of the department. With ever decreasing operation budgets, the Department should not divert their limited resources for another ranch operation. We recommend the College begin negotiations with the University of Montana for the sale of this property. In the event that the University of Montana insists on keeping the ranch, an agreement should be reached that they should be solely responsible for the operation of the ranch.

EXTENSION PROGRAM

Montana is a large state with the University located in the southwest comer. This physical location poses challenges for travel and time required by state specialists to meet needs of clientele located great distances from the campus. The location of the state itself tends to isolate producers from other segments of the industry such as finishing, slaughter and processing.. Cattle are the predominate segment of the livestock industry in the state, providing about 85% of income from livestock. However, commercial cattle production is almost entirely limited to cow/calf production with most calves shipped out of the state for finishing in feedlots. Montana is a national leader in the production of purebred breeding cattle. Compared with other cow/calf states, many cattle operations are large and extensive and many of the managers are well educated.

Current staffing patterns do not reflect the relative economic contributions of beef, sheep and swine in the state nor do they adequately address the level of educational programming demanded by some clientele. While county extension staff can meet needs of many of the smaller operations, greater expertise is required to provide cutting edge education to managers of larger operations and to their allied industries. Mostly, this must be provided by State Specialists or other faculty.

All segments of the Montana livestock industry face financial challenges during the next few years as the cattle cycle runs its course, as the state's small-scale swine producers face stiff competition from large integrated corporations developing in other parts of the country, and as wool incentive payments are eliminated. This situation increases the need for an effective extension program and provides an opportunity for the extension program of the Animal and Range Sciences Department to demonstrate its value to the state. Tight budgets mean that timely, innovative programs must be developed and delivered, and that specialists work smarter, not just harder.

The extension faculty are a highly professional and dedicated group. They are to be commended for their efforts in acquiring external funding to support many of their activities. Swine and sheep specialists have developed excellent cooperation with their commodity organization and are using them effectively to promote their programs. Furthermore, extension faculty are contributing to the entire department by participating in classrooms and by being active players in the research program. The recent addition of a wildlife specialist is very positive and should help build coalitions among groups that until now have neither trusted nor understood each other. The addition of a specialist to assist land owners with sustainable and integrated resource management is timely and appropriate.

Some recommendations to further enhance and strengthen the Extension Program are:

1. Proceed to hire the best available person to fill the range management extension position.

   The need for this position has been strongly justified.

2. Use every opportunity to increase visibility of the department's extension programs.

   It is critical that people in the state recognize the contributions of the department's research and extension programs. Display the department name and University logo prominently on publications, slides and visual aids, conference programs, and mailings. This should also include publications, mailings and programs shared with other organizations.

3. Increase the use of radio and television as a means of efficiently reaching large numbers of people with timely information.

4. Expand cooperative programs with livestock organization and allied industries.

   Coopting programs makes tight extension dollars go much farther. **It** increases visibility of MSU Extension and adds credibility to the individual organization's programs as well as to the department.

5. Additional faculty are needed to balance extension programming in the beef cattle area to this industry's importance to agriculture in the state.

   The following are recommended, not in any order of importance:

   A veterinary medicine specialist to work with veterinarians and producers.
   An additional specialist in nutrition and management.
   A specialist in the area of animal breeding.

   Commodity groups and the state's veterinarians have identified the need for an extension veterinarian and they should be very supportive. Nutrition is the most frequent concern of ranchers. **It** is unrealistic to expect one specialist to cover the nutrition and management programming needs of a state this size, especially if programming is also provided in the area of retained ownership and added value. A purebred industry the size of Montana's badly needs an extension animal breeding program. The number, experience and name recognition of the present animal breeding teaching and research faculty offers great potential for utilizing one or more in partial extension roles. In addition to programming on new technologies such as EPD's

and gene mapping, these faculty could bring badly needed expertise in the use of computers for modeling and budgeting and the development of software for use by producers and agents.

6. Publish an annual Research Report.

There is a considerable cost but benefits to the department outweigh the costs. Most Animal Science Departments have developed annual reports as vehicles to ensure rapid delivery of research to clientele. These reports bring valuable visibility to the department and address clientele concerns about accountability.

AGENDA
CSREES REVIEW OF THE DEPARTMENT OF ANIMAL & RANGE SCIENCES MONTANA STATE UNIVERSITY

Monday, June 5th

	Check in at the Holiday Inn, Phone Number (406) 587-4561
6:30 pm	Dinner at the Overland for Review Team, Hosted by John Paterson

Tuesday, June 6th

7:00-8:00	Breakfast at Holiday Inn, Hosted by Chairs' of Teaching Curriculum Committees (Thomas, Tess)
8:30-9:45	Meet with Dean Thomas McCoy and Vice Provost Pagenkopf
10:00-10:45	Meet with Animal & Range Science Faculty; Coffee and Donuts
11:00-12:00	Overview of the Department; Expectations, Faculty, Programs, and Facilities, John Paterson
12:00-1:00	Lunch in SUB with John Paterson
1:15-2:30	Overview of Undergraduate Teaching, Verl Thomas, Bret Olson, Frank Munshower and Paul Hook
2:30-3:00	Meet with undergraduate students
3:15-4:00	Overview of Graduate Student Programs, Mike Tess, Paul Hook and Doug Dollhopf
4:00-6:00	Tour of ARNR Research Facilities (Linfield Hall, Ft. Ellis, Towne Farm)
6:30	Picnic Dinner Red Bluff Ranch (at Cottonwood, Gene Surber, Roger Brownson, Sandy Gagnon, Jim Knight and F'ete Olind)

Wednesday, June 7th

7:00-8:00	Breakfast at Western Cafe, Hosted by Rodney Kott, and Don Kress
8:30-10:00	Extension Programs Beef, Sheep, Swine, Wildlife and Natural Resources
10:15-12:00	Overview of Research Program; Dennis Neuman
12:00- 1:00	Lunch; SUB 273 with College of Agriculture Department Heads
1:30- 3:30	Overview of Animal Science Research, Don Kress
3:30- 3:45	Break
3:45- 5:15	Continue Animal Science Research
6:30-	Dinner hosted by Dean McCoy

Thursday, June 8th

7:00- 8:00	Breakfast at Holiday Inn hosted by Carl Wambolt and Clay Marlow
8:30- 10:45	Overview of Range Research Programs, Carl Wambolt
10:45-11:15	Meet with graduate students
11:15-12:00	Meet with Faculty
1:30 pm-	Review panel begins report writing

Friday, June 9th

8:00-9:00	Exit meeting with Dean McCoy and Vice Provost Pagenkopf
9:00- 10:30	Exit meeting with faculty
12:00	Review team dismissed

Final Report
Animal and Range Science Review Committee
May 21, 2000

The Department of Animal and Range Science has several natural advantages. Montana is a wonderful state with abundant natural resources, resources that blend well with animal agriculture. It was also readily apparent to the review team that producers are very supportive of the department. We were especially pleased to have two excellent producers join us on the review team.

Agriculture is the largest contributor to the state's economy. Within agriculture, animal agriculture provides more than 48% of gross receipts with over 88% of the animal receipts derived from cow-calf operations. As a consequence of the natural resources in the state and the abundance of range land, the major animal agricultural enterprise is beef cattle production, primarily cow-calf with the end result a focus on beef.

The review team found the combination of animal science and range science to be very positive. This was apparent from the faculty and stakeholders as well. One faculty member aptly put this in perspective as "our national niche."

Recommendation-Maintain animal and range science together as a single department.

The Department of Animal and Range Science has a good mix of extension and research programs. Almost all programs are applied in nature that contributes to the strength of the extension and applied research programs. The department, with strong industry involvement, has been successful in securing federal funding for several key programs. This should be continued.

Upon reviewing the departmental facilities and staffing plan, it became clear that several tough decisions were made in the past. For example, the swine and dairy facilities were closed. More recently, a hire was made in meat science and the abattoir renovated. These types of tough decisions, especially with regard to what one will do and not do, need to be continued.

Several challenges became apparent during the review. Turnover in leadership at the department and college level has contributed significantly to what we believe is failure to focus the long-term vision of the department. We believe the opportunities and personnel are present but the collective vision needs to be cultivated and developed.

Overall, additional FTE are needed to cover the current responsibilities. Several faculty with heavy teaching loads could be conducting additional research. Equally important, several faculty with extension and research appointments are spread very thin. All three functions would be enhanced by the addition of new faculty.

The departmental laboratories and other facilities on campus are m dire need of replacement. Laboratories for existing faculty are not adequate. Moreover, additional space will also be needed for new faculty hires.

Although resources and facilities have been limiting, the committee suggests that deliverables of good programs, i.e., productivity should be enhanced. The faculty is strongly encouraged to enhance output of peer-reviewed publications and seek greater outside funding. Fundamental to enhancing programs and attracting new faculty is the establishment of a Ph.D. program. The committee was pleased with the reception of this idea at the summary meeting. It was encouraging to hear many faculty speak of interest in the new food and agriculture initiative. Coupling this interest in grantsmanship with new FTE, namely folks interested in basic research, will have long-term effects on the department and the clientele.

Collectively, the lack of sufficient resources (faculty, facilities and funds) has resulted in a poor moral and entrepreneurial spirit. An influx of resources will be helpful; however, faculty will have to decide to change attitudes as well. The entire department should engage in strategic planning that includes a strong vision for the future.

Recommendations:

- Engage strategic planning
- Solidify leadership- all levels including that of the faculty
- Replace retiring faculty and hire new faculty
- **New building- sharing with Veterinary Molecular Biology makes 'strategic sense'**
- Basic research- more details provided later in the report
- Enhance publications -scholarly publications includes teaching, extension and research
- Seek extramural funding
- Establish a PhD program

During the course of the review, the review team became very excited about the potential for the department. We believe this department can become the flagship animal and range science department in the region. Moreover, we challenge the department to become the flagship department in the college. The excitement and vision shown by the new Dean of the college encouraged the team. We also found this to be true with the stakeholder group, they were all very excited about the department and the college. The department should capitalize on this attention and work with the Dean to see that all recommendations are implemented.

As the department engages the strategic planning process, we would encourage you to set lofty goals. We spent several minutes talking about what the department could achieve in the very near future.

The potential for realizing an outstanding development program is great. This additional funding could be used to fund an endowed chair, judging program, and undergraduate and graduate programs.

We believe it is very important to have focused programs. **It** seems clear that a major focus in the department is the production of high quality calves on high quality land that lead to excellent end product (beef). Range science, nutrition, beef cow reproduction and quantitative genetics are key areas if this focus is to be achieved. Specifically, this should be translated through a planning process into identification of key faculty hires. We suggest that some of these may include – nutritional biochemistry, rumen microbiology, animal breeding (new technologies), beef cow reproduction (basic mechanisms), landscape ecology and grazing management. *This* is a topic worthy of additional discussion; however, we do believe it is imp01iant that basic science IS emphasized in at least three or four of these hires.

Recommendations:

- Establish clear areas of focus
- Examples include:
  - **Nutrition, range emphasis**
    - Cow-calf
    - Backgrounding
    - Meats as related to product produced
  - **Beef cow reproduction**
    - Range of basic to applied
    - Must be in synchrony with producer needs
  - **Genetics**
    - Application of new technologies into breeding programs
    - **Statistical, reproductive and molecular**
- **Create opportunities for competitive funding**
- **Form synergistic research teams**
- **Maintain applied research programs**

The review team was pleased to consult with current graduate students. The students viewed the combination of animal science and range science as very positive. They know each other well and speak highly of the departmental seminar. Additional discipline seminars are needed to enhance student development.

Basic components of the undergraduate programs in animal science appear to be present. Some stakeholders and students expressed concern with 'weed-out' courses and "core curricular" courses. Students were complimentary of the faculty but desire more

interaction social contact. They were especially supportive of 'real-life' experiences presented by faculty.

Stakeholders strongly encouraged the department to provide judging team activities for the students. The committee agrees with this assessment. We encourage the department to challenge the industry to increase involvement by funding judging teams. They have shown a willingness and ability to assist in support for extension and research programs. Moreover, they are very supportive of providing a new building for the department. The clear message is that *"Industry is receptive to specific requests"!*

Recommendations:

- **Enhance graduate student stipends**
- Improve computing support- especially printing for graduate students
- Increase faculty involvement with students
- **Enhance TA experiences- some are purely labor and not stimulating**
- **Encourage courses from other departments**
- **Consider naming a coordinator of graduate programs**
- **Maintain 'gate-to-plate' mentality not just cow-calf in programs**
- Internships should be required
- Make better use of 4H and FFA emphasis in the state
- Allow more time for hands on experiences – 2 vs. 4 h labs
- Establish judging teams
  - Maintain academic quadrathlon
  - Livestock judging team
  - Plant identification team
  - URME team
- Enhance industry involvement with development, judging teams and facility support

Although the committee was asked to focus on research and teaching, we felt it important to comment on the extension structure within the university. First, we found that the extension specialists within the department were more than willing to work together. In addition, we detected a positive attitude and enhanced coordination. However, we found that the structure resulted in multiple lines of reporting with inadequate discussions being held with regard to budgets and staffing.

The committee also received feedback from heads of other departments and stakeholders. Department heads generally believed that coordination could be enhanced. More importantly, stakeholders had the strong perception that extension, teaching and research are under separate structures so management is not coordinated very well.

Recommendations: Administration considers moving agricultural extension under the College of Agriculture. Adding an Associate Dean for Extension would facilitate this. This will enhance coordination of research and extension, and extension and teaching.

Review of Range Science

This review is to synthesize comments reflecting our view of what the Range Science aspect of the Department could be like in five years. **It** is based on the input received from the faculty, knowledge of the reviewers, and an understanding of the future role of Range Science in animal agriculture. The comments are not intended to suggest particular insufficiencies in the current programs but more to suggest what a comprehensive program suited to Montana may be like.

Range Science Research

Basic Research

The Department should have a program of basic ecological research. This is the fundamental science underpinning the applications of management to desired outcomes. From this research it is possible to predict the potential for landscape conditions under the normal vagaries of weather and in response to inevitable catastrophic events. This knowledge is necessary to develop responsible goals for outcome-based management. This research could include areas such as:

- Plant and animal community structure and competition among species. **It** would include specific work on invasive species.
- Water quality potentials in natural systems in terms of sediment, temperature, pH, and other aspects that are particularly important to cold-water fish.
- Wildlife habitat with some emphasis on species of plants and animals that are or may be listed as endangered or threatened.

The area of landscape ecology should be developed in the Department. This is a newly developing highly computer dependent discipline that is most likely going to be the foundation for large scale land use decisions in the future. Within this discipline the possibilities for economical monitoring of land use impacts on a practical scale are important.

Applied Research

This aspect of the research program should be focused on development of new approaches to management of land and livestock, particularly in the context of issues of concern (like environmental problems), or opportunities for increased economic returns from management (like new forages). **It** would need to involve extensive partnerships with other faculty in the Department, College and other scientists in a wide variety of areas. There is great opportunity to bring new knowledge from external research programs into new applied research. For example, applied research programs including some existing efforts could focus on issues such as:

- Livestock grazing impacts with respect to-
  - Wildlife habitat
  - Weeds
- Environmental quality (especially water but other amenities as well)
- Forage quality (including new varieties as well as manipulation of quality by specific grazing practices)
- Land restoration or rehabilitation

- Developing forage bases on depleted lands
- Restoration of native plants, particularly with respect to weed control projects
- Developing practical methods to rehabilitate rangelands
- Monitoring
- Development of new techniques that are accurate
- Landscape scale (probably GIS/GPS based)
- Economical techniques (current techniques are too expensive)
- Developing techniques that can be used to assess compliance with regulations

Range Science Teaching

The teaching program is a strong, traditional Range Science program. It has served students well in their careers following graduation. The program should be considered for Accreditation by the Society for Range Management. We believe it is very close to meeting accreditation requirements. Success in this would establish MSU as the excellent educational program that it is. In addition to current courses the faculty should consider integration of some courses into the program to be sure students are fully up to date with modern skills when they graduate. These suggestions are:

- Watershed
- GIS/GPS courses
- New minors for the new job market
- Consulting (include emphasis on water/water quality, GIS, measurements)
- Agency changes (water, endangered species)

The faculty and College should consider implementation of a Natural Resources degree. Based on current interests of urban students it is very likely that there will be a significant demand for such a broad-based degree. This appeals to urban students and can be an avenue to train students for new niches in job markets. Not only will it capture new students for the Department and College it will put the curriculum in the hands of a faculty that will ensure a practical orientation. I suspect MSU will have such a degree in the near future. If so, it is probably best that it be in Animal and Range Sciences.

Range Science Extension

The current Range Science program is excellent and well received by the clientele. This needs to be maintained. The workload and travel demands are very high for existing contributors to the Extension program. It may be possible to reduce some of the load by hiring one or two extension "aides" to do some of the basic work. This could be an individual with an MS in Range Science that would be of significant help to the specialists.

Conclusions

The review team would like to express its appreciation for the wonderful hospitality provided during the review. We all enjoyed the wonderful Montana scenery and weather!

The committee was greatly excited about the future of the department. We believe it is important that you first and foremost engage in strategic planning. Strong leadership and vision will be required to take you to the next level. You can achieve your goal of

becoming the flagship department in the college and the flagship animal and range department in the region.

We encourage each faculty, staff and student that reads this report to first think of ways of enhancing one's own program and attitude. Please have a "can do" attitude that is contagious. Second, it is equally important that new facilities, support and faculty positions be secured. Planning and a consensus of where the department is headed must precede this. Establishment of a PhD program is fundamentally important for success.

The sky is the limit- please reach high!

Appendix B

Faculty Curriculum Vitae

Dr. James G. Berardinelli

Professor, Animal Science
307 Animal Bioscience Building
Montana State University
Bozeman, MT 59717
Phone: (406) 994-5574
Fax: (406) 994-5589
Email: jgb@montana.edu

Education

B.A. University of Connecticut, Biology, 1973
M.S. West Virginia University, Reproductive Physiology, 1976
Ph.D. West Virginia University, Reproductive Physiology, 1979

Classes

ANSC 321 Physiology of Animal Reproduction
ANSC 321 - Physiology of Animal Reproduction webpage - Fall 2012
ANSC 421 Assisted Reproductive Techniques
ANSC 421 - Assisted Reproductive Techniques webpage - Fall 2012
ARNR 523 Advanced Physiology of Reproduction

Research Interests

Beef Cattle, Sheep, and Wild Ungulates
Biostimulatory Effects of Male Ruminants
Pheromones

Graduate Students (since 2000)

2002
Amy Jacobs
MS Degree: Animal Science

Pramod Shrinivas Joshi
MS Degree: Animal Science

2005
Shaun Tauck
MS Degree: Animal Science

2008
Shaun Tauck
PhD: Animal Science

2009
Jesse Olsen

MS Degree: Animal Science

Jarrod Wilkinson
MS Degree: Animal Science

2010
Michael Borgreen
MS Degree: Animal Science

2011
Richard McCosh
MS Degree: Animal Science

Publications (since 2000)

2000
Forde, J.J., J.G. Berardinelli, R.K. Christenson, L.L. Anderson. 2000. Luteinizing hormone secretion as affected by hypophyseal stalk transection and estradiol-17β in ovariectomized gilts. Anim. Reprod. Sci. 63:255-274.
Lewis, A.W., and J.G. Berardinelli. 2000. Gross anatomical and histomorphometric characteristics of the oviduct and uterus during the pubertal transition in the sheep. J. Anim. Sci. 78:167-175.

2001
Lewis, A.W., and J.G. Berardinelli. 2001. Gross anatomical and histomorphometric characteristics of the oviduct and uterus during the pubertal transition in the sheep. J. Anim. Sci. 79:167-175.
Berardinelli, J.G., J. Weng, P.J. Burfening, and R. Adair. 2001. Effect of excess degradable intake protein on early embryonic development, ovarian steroids, and blood urea nitrogen on Days 2, 3, 4, and 5 of the estrous cycle in mature ewes. J. Anim. Sci. 79:193-199.

2002
Stellflug, J.N. and J.G. Berardinelli. 2002. Ram mating behavior is influenced by long-term selection for number of lambs born. J. Anim. Sci. 80:2588-2593.

2005
Berardinelli, J.G., P.S. Joshi and S.A. Tauck. 2005. Postpartum resumption of ovarian cycling activity in first-calf suckled beef cows exposed to familiar or unfamiliar bulls. Anim. Reprod. Sci. 90:201-209.
Berardinelli, J.G. and P.S. Joshi. 2005. Resumption of postpartum ovarian cycling activity in primiparous restricted suckled beef cows exposed to a bull or excretory products of bulls or cows. J. Anim. Sci. 83:2495-2500.
Berardinelli, J.G. and P.S. Joshi. 2005. Introduction of bulls at different days postpartum on resumption of ovarian cycling activity in first-calf beef cows. J. Anim. Sci. 83:2106-2110.
White, D., Jr., J.G. Berardinelli and K.E. Aune. 2005. Seasonal changes in spermatogenesis and serum testosterone concentrations in the male grizzly bear. Ursus. 16(2):198-207.

White, D., Jr., J.G. Berardinelli and K.E. Aune. 2005. Age variation in gross and histological characteristics of the testis and epididymis in male grizzly bears. Ursus. 16(2):190-197.

2006
Tauck, S.A., J.G. Berardinelli, T.W. Geary, and N.J. Johnson. 2006. Resumption of postpartum luteal function of primiparous, suckled beef cows exposed continuously to bull urine. J. Anim. Sci. 84:2708-2713.

2007
Berardinelli, J.G. and S.A. Tauck. 2007. Intensity of the biostimulatory effect of bulls on resumption of ovulatory activity in primiparous, suckled beef cows. Anim. Repro. Sci. 99:24-33.
Berardinelli, J.G. and S.A. Tauck. 2007. Conception rates to artificial insemination in primiparous, suckled beef cows exposed to the biostimulatory effect of bulls before and during a gonadotropin-releasing hormone-based estrus synchronization protocol. J. Anim. Sci. 85:848-852.
Tauck, S.A., J.R. Olsen and J.G. Berardinelli. 2007. Adrenal involvement in the biostimulatory effect of bulls. Reprod. Biol. And Endocrinol. 5:33-39.
Tauck, S.A., J.R.C. Wilkinson, J.R. Olsen, J.N. Janitell, and J.G. Berardinelli. 2007. Comparison of controlled internal drug release device and melengesterol acetate as progestin sources in an estrous synchronization protocol for beef heifers. Theriogenology. 68:162-167.
Tauck, S.A. and J.G. Berardinelli. 2007. Putative urinary pheromone of bulls involved with breeding performance of primiparous beef cows in a progestin-based estrous synchronization protocol. J. Anim. Sci. 85:1669-1674.

2008
Bailey, J.D., J.G. Berardinelli, T.E. Rocke and R.A. Bessen. 2008. Prominent pancreatic endcrinopthy and altered control of food intake disrupt energy homeostasis in prion diseases. J. Endocrinology 197:251-263.
J.W. Dafoe, R.W. Kott, B.F. Sowell, J.G. Berardinelli, K.C. Davis and P.G. Hatfield. 2008. Effects of supplemental safflower and vitamin E during late gestation on lamb growth, serum metabolites, and thermogenesis. J. Anim. Sci. 86(11):3194-3202.

2009
Tauck, S. A., J.R. Olsen, J.R.C. Wilkinson, and J.G. Berardinelli. 2009. Duration of daily bull exposure on resumption of ovulatory activity in postpartum, primiparous, suckled, beef cows. Anim. Repro. Sci. Epub doi:10.1016/j.anireprosci.2009.06.010. (2010 Mar;118(1):13-8).

2010
Tauck, S. A., J.R. Olsen, J.R.C. Wilkinson, and J.G. Berardinelli. 2010. Duration of daily bull exposure on resumption of ovulatory activity in postpartum, primiparous, suckled, beef cows. Anim. Repro. Sci. 118:13-8.
Tauck, S. A., J. R. Olsen, J. R. C. Wilkinson, K. Davis, R. Wedlake, and J. G. Berardinelli. 2010. Characteristics of temporal patterns of cortisol and luteinizing hormone in primiparous, postpartum, suckled, beef cows exposed acutely to bulls. Reprod. Biol. and Endocrinol. 8:89.
Tauck, S. A., J. R. Olsen, J. R. C. Wilkinson, K. M. Phillips, and J. G. Berardinelli. 2011. Characteristics of cortisol concentration patterns associated with resumption of ovulatory activity

in postpartum, anovulatory, suckled, beef cows exposed to bulls. Dom. Anim. Endocrinol. (Submitted, 2010).
Berardinelli, J. G., S. Tauck, J. Wilkinson, J. Olsen, T. Gibbs, K. C. Davis, J. Dafoe, and D. Boss. 2010. Reproductive performance of beef heifers exposed to bulls during an estrus synchronization protocol that included a 14-d CIDR, PGF2α, and, timed AI and GnRH. J. Anim. Sci.

2011
Tauck, S. A., J. R. Olsen, J. R. C. Wilkinson, K. M. Phillips, and J. G. Berardinelli. 2011. Characteristics of cortisol concentration patterns associated with resumption of ovulatory activity in postpartum, anovulatory, suckled, beef cows exposed to bulls. Dom. Anim. Endocrinol. (Submitted Oct. 2010).
Peterson, J. L., S. J. Moreaux, J.G.P. Bowman, P. G. Hatfield, J. G. Berardinelli, and J. Olsen. 2011. Psyllium lowers blood glucose and insulin in Quarter Horses. J. Equine Vet. Sci.

Dr. Jane Ann Boles

Associate Professor, Meat Science
207 Animal Bioscience Building
Montana State University
Bozeman, MT 59717
Phone: (406) 994-7352
Fax: (406) 995-5589
Email: jboles@montana.edu

Education

B.S. University of Missouri, Animal Science
M.S. Iowa State University, Meat Science
Ph.D. Iowa State University, Meat Science

Classes

ANSC 100 Introduction to Animal Science
ANSC 205 Introduction to Meat Evaluation
ANSC 308 Introduction to Livestock Evaluation
ANSC 316 Meat Science
ANSC 416R Meat Processing
ARNR 525 Muscle and Growth Biology

Research Interests

Current research interests include the improvement of meat tenderness and consistency, effect of rearing regimes on meat quality and increased utilization of underutilized cuts from the beef chuck and round.

Accomplishments and Interests

USDA/FSIS approved HACCP training as part of the Montana HACCP training Group
HACCP Contact for Montana Meat Processes
Worked at the Meat Industry Research Institute of New Zealand in the Processed Meat Section.
Coordinated the Value-Added Beef Program in Canada.

Graduate Students (since 2000)

2007
Kathleen Neary
MS Degree: Animal Science

2012
Kate Perz
MS Degree: Animal Science
Thesis: "The effect of growth rate of cattle on tenderness"

Present
Katelyn Kohlbeck
MS Candidate

Publications (since 2000)

2000
Boles, J.A., B.M. Rathegeber, and P.J. Shand. 2000. Recovery of proteins from beef bone and the functionality of these proteins in sausage batters. Meat Sci. 55: 223-231.

2001
Boles, J.A. and P.J. Shand. 2001. Meat cut and injection level affects the tenderness and cook yield of processed roast beef. Meat Sci. 59:259-265.

2002
Boles, J.A. and P.J. Shand. 2002. Tumbling regime effects on the processing characteristics and tenderness of cooked roast beef. J. of Muscle Foods. 13(1):25-35.
Boles, J.A. and J.E. Swan. 2002. Processing and sensory characteristics of beef roasts: effect of breed, age, gender and storage conditions. Meat Sci. 62:107-112.
Boles, J.A. and J.E. Swan. 2002. Meat and storage effects on processing characteristics of beef roasts. Meat Sci. 62:121-127.
Boles, J.A. and J.E. Swan. 2002. Processing characteristics of beef insides cooked at different rates to different final internal temperatures. Meat Sci. 62:409-427.
Swan, J.E. and J.A. Boles. 2002. Processing characteristics of beef roasts made from high and normal pH bull insides. Meat Sci. 62:399-403.

2003
Kott, R.W., P.G. Hatfield, J.W. Bergman, C.R. Flynn, H. VanWagoner, and J.A. Boles. 2003. Feedlot performance, carcass composition, and muscle and fat CLA concentration of lambs fed diets supplemented with safflower seeds. Small Rum. Res. 49:11-17.
2004

Boles, J.A., J.G.P. Bowman, L.M.M. Surber, D.L. Boss. 2004. Effects of barley variety fed to steers on the carcass characteristics and color of meat. J. Anim. Sci. 82(7):2087-2091.

2005

Boles, J.A., R.W. Kott, P.G. Hatfield, J.W. Bergman, and C.R. Flynn. 2005. Supplemental safflower oil affects initial color and fatty acid profile of lamb. J. Anim. Sci. 83:2175-2181.
Boles, J.A., J.G.P. Bowman, D.L. Boss, and L.M.M. Surber. 2005. Meat color stability affected by barley variety fed in finishing diet fed to beef steers. Meat Sci. 70(4):633-638.

2006

Swan, J.E. and J.A. Boles. 2006. Functionality of cow beef in coarse and fine ground model systems. Meat Sci. 72(1):25-33.

2007

Groenlund, K., J.A. Boles, and J.E. Swan. 2007. Cooked turkey roasts have different processing characteristics than cooked beef roasts. Fleischwirtschaft International. 4:70-73.

2008

Boles, J.A. and P.J. Shand. 2008. Effect of muscle location, fiber direction, and slice thickness on the processing characteristics and tenderness of beef stir-fry from the round and chuck. Meat Science 78(4):369-374.

2009

Boles, J.A., D. L. Boss, K. I. Neary, K.C. Davis and M.W. Tess. 2009. Growth implants reduced tenderness of steaks from steers and heifers with different genetic potentials for growth and marbling. J. Anim. Sci. 87:269-274.
X.L. Yu, X.B. Li, X.L. Xu, G.H. Zhou and J.A. Boles. 2009. Definition of the optimum freezing time postmortem for manufacturing pork meat. J Muscle Foods 20 (2):186-200.

2010

Redden, R. R., R. W. Kott, J. A. Boles, A. W. Layton, J. M. Martin, D. M. Hallford, and P. G. Hatfield. 2010. Effects of ewe late gestation supplementation of rumen undegradable protein, vitamin E, zinc, and chlortetracycline on indices of immune transfer and ewe productivity. J. Anim. Sci. 88: 1125-1134.
Redden, R. R., R. W. Kott, L.M.M. Surber, J. A. Boles, A. W. Layton, J. M. Martin, and P. G. Hatfield.. 2010. Post-weaning management of lambs alters subsequent feedlot performance and tissue deposition. Sheep and Goat Research Journal 24: 26-31
Sindelar, J. J., Terns, M.J., Meyn, E, Boles, J.A. 2010. Development of a Method to Manufacture Uncured, No-Nitrate/Nitrite Added Whole Muscle Jerky. Meat Science 86:298-301

2011

Boles, J.A. 2011. Use of cold-set binders in meat systems. Chapter 11 In Processed Meats: improving safety, nutrition and quality. Edited by J. P. Kerry and J. F. Kerry, Woodhead Publishing Limited, Cambridge, UK, pp 270-298

Dr. Janice G. P. Bowman

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Montana State University
Bozeman, MT 59717
Phone: (406) 994-5563
Fax: (406) 994-5589
Email: jbowman@montana.edu

Education

B.S. University of Missouri, Animal Science, 1977
M.S. University of Missouri, Animal Science, 1979
Ph.D. University of Missouri, Ruminant Nutrition, 1986

Classes

ANSC 320 Animal Nutrition
ANSC 320 - Animal Nutrition webpage - Fall 2012
ANSC 320 - Animal Nutrition Facebook page - Fall 2012
ANSC 418 Topics in Beef Cattle Nutrition
ANSC 418 - Topics in Beef Nutrition Facebook page - Spring 2012
EQUS 423 Equine Nutrition
EQUS 423 - Equine Nutrition webpage - Spring 2013
ARNR 520 Nutrient Metabolism of Domestic Animals

Research Interests

Factors affecting intake and utilization of grazed and harvested forages by beef cattle - including effects of forage species and maturity, harvesting and/or processing methods, supplementation with high fiber or by-product concentrates, and forage combinations on digestive kinetics, nutrient flow, microbial colonization and fermentation, particle size reduction, intake and animal performance.
Nutritive value of barley varieties in diets for feedlot cattle.
Development of nutritional programs for wintering beef cows.

Accomplishments and Interests

Identified QTLs for ruminal digestibility and particle size on barley chromosomes 3 & 4.
Determined heritability of digestibility in barley to be 50%.
Demonstrated legume supplementation of low-quality forage diets increases rate of large particle size reduction and passage from rumen, allowing increased intake by cattle.
Demonstrated ruminal carboxymehthylcellulase activity can be used to compare relative colonization and activity by cellulolytic bacteria.
Demonstrated differences in rate and pattern of ruminal bacterial colonization of cool-season grasses, warm-season grasses and legumes, and relationship to fiber digestion.

Established that a barley variety with extremely rapid ruminal digestion could support superior feedlot performance, indicating rapid ruminal digestion is not strictly a negative influence on animal performance.

Graduate Students (since 2000)

2000
Travis C. Blackhurst
MS Degree: Animal Science

Timothy J. Milner
MS Degree: Animal Science

2001
Nancy Taylor
MS Degree: Animal Science

2004
Janna Kincheloe
MS Degree: Animal Science

Michael McDonnell
MS Degree: Animal Science

2006
Lisa Surber
PhD: Animal Science

2009
Wade Black
MS Degree: Animal Science

2012
Devon Powell Ragen
MS Degree: Animal Science

Publications (since 2000)

2000
Daniels, J.T., P.G. Hatfield, D.E. Burgess, R.W. Kott, and J.G.P. Bowman. 2000. Evaluation of ewe and lamb immune response when ewes were supplemented with vitamin E. J. Anim. Sci. 78:1731-2736.
Daniels, T.K., J.G.P. Bowman, B.F. Sowell, M.E. Branine, and M.E. Hubbert. 2000. Effects of metaphylactic antibiotics on behavior of feedlot calves. Prof. Anim. Scientist. 16:278-285.
Sowell, B.F., J.C. Mosley, and J.G.P. Bowman. 2000. Social behavior of grazing beef cattle: Implications for management. J. Anim. Sci. Available at: http://www.asas.org/jas/symposia/proceedings/0923.pdf.

2001
Bowman, J.G.P., T.K. Blake, L.M.M. Surber, D. Habernicht, and H. Bockelman. 2001. Feed quality variation in the barley core collection of the USDA national small grains collection. Crop Sci. 41:863-870.
Quimby, W.F., B.F. Sowell, J.G.P. Bowman, M.E. Branine, M.E. Hubbert, and H.W. Sherwood. 2001. Application of cumulative sums to predict morbidity of newly received calves in a commercial feedlot. Can. J. Anim. Sci 81:315-320.

2002
Beecher, B., J.G.P. Bowman, J. Martin, A. Bettge, C.F. Morris, T.K. Blake, and M.J. Giroux. 2002. *Hordoindolines* are associated with a major endosperm texture QTL in barley (*Hordeum vulgare* L.). Genome. 45:584-591.
Blake, T.K., J.G.P. Bowman, P. Hensleigh, G. Kushnak, G. Carlson, L. Welty, J. Eckhoff, K. Kephart and D. Wichman. 2002. Registration of 'H3860224' barley. Crop Sci. 42:1747-1748.
Blake, T.K., J.G.P. Bowman, P. Hensleigh, G. Kushnak, G. Carlson, L. Welty, J. Eckhoff, K. Kephart, D. Wichman and P.M. Hayes. 2002. Registration of 'Valier' barley. Crop Sci. 42:1748-1749.
Taylor, N., P.G. Hatfield, B.F. Sowell, J.G.P. Bowman, J.S. Drouillard, and D.V. Dhuyvetter. 2002. Pellet and block supplements for grazing ewes. Anim. Feed Sci. Technol. 96:193-201.

2003
Bowman, J.G.P. and B.F. Sowell. 2003. Technology to complement forage-based beef production systems in the West. J. Anim. Sci. 81(E. Suppl. 1):E18-E26.
Sowell, B.F., J.G.P. Bowman, E.E. Grings, and M.D. MacNeil. 2003. Liquid supplement and forage intake by range beef cows. J. Anim. Sci. 81:294-303.

2004
Boles, J.A., J.G.P. Bowman, L.M.M. Surber, D.L. Boss. 2004. Effects of barley variety fed to steers on the carcass characteristics and color of meat. J. Anim. Sci. 82(7):2087-2091.
Bowman, J.G.P., B.F. Sowell, L.M.M. Surber and T.K. Daniels. 2004. Nonstructural carbohydrate supplementation of yearling heifers and range beef cows. J. Anim. Sci. 82.2724-2733.
Kaiser, C.R., J.G.P. Bowman, L.M.M. Surber, T.K. Blake, and J.J. Borkowski. 2004. Variation in apparent component digestibility of barley in the rat from the core collection of the USDA National Small Grains Collection. Anim. Feed Sci. Technol. 113:97-112.

2005
Boles, J.A., J.G.P. Bowman, D.L. Boss, and L.M.M. Surber. 2005. Meat color stability affected by barley variety fed in finishing diet fed to beef steers. Meat Sci. 70(4):633-638.

2006
Swan, C.G., J.G.P. Bowman, J.M. Martin and M.J. Giroux. 2006. Increased puroindoline levels slow ruminal digestion of wheat (*Triticum aestivum* L.) starch by cattle. J. Anim. Sci. 84:641-650.

2007

Fox, G.P., B. Osborne, J.G.P. Bowman, A. Kelly, M. Cakir, D. Poulsen, A. Inkerman, and R.J. Henry. 2007. Measurement of genetic and environmental variation in barley (Hordeum vulgare) grain hardness. J. Cereal Sci. 46:82-92.

Fox, G.P., L. Nguyen, J.G.P. Bowman, D. Poulsen, A. Inkerman, and R.J. Henry. 2007. Relationship between hardness genes and quality in barley (Hordeum bulgare). J. Institute Brewing. 113:87-95.

2008

Bhatti, S.A., J.G.P. Bowman, J.L. Firkins, A.V. Grove, and C.W. Hunt. 2008. Effect of intake level and alfalfa substitution for grass hay on ruminal kinetics of fiber digestion and particle passage in beef cattle. J. Anim. Sci. 86:134-145.

Fox, G.P., J. Bowman, A. Kelly, A. Inkerman, D. Poulsen, and R. Henry. 2008. Assessing for genetic and environmental effects on ruminant feed quality in barley(Hordeum vulgare). Euphytica 163:249-257.

Turuspekov, Y., B. Beecher, Y. Darlington, J. Bowman, T.K. Blake and M.J. Giroux. 2008. Hardness locus sequence variation and endosperm texture in spring barley. Crop Sci. 48:1007-1019.

Turuspekov, Y., J.M. Martin, J.G.P. Bowman, B.S. Beecher and M.J. Giroux. 2008. Associations between Vrs1 alleles and grain quality traits in spring barley Hordeum vulgare L. Cereal Chem. 85:817-823.

2009

Bowman, Jan, and Bok Sowell. 2009. Feeding the Beef Cow Herd. In: Richard O. Kellems and D. C. Church, eds. Livestock Feeds and Feeding. Sixth Edition. Prentice Hall, Boston.

Peterson, J. L., S. J. Moreaux, J.G.P. Bowman, P. G. Hatfield, J. G. Berardinelli, and J. Olsen. 2009. Metabolic and physical effects of psyllium supplementation on Quarter Horses. Proc. West. Sec. Am. Soc. Anim. Sci. 60:176-179.

Blake, T., V.C. Blake, J.G.P. Bowman, and H. Abdel-Haleem. 2009. Barley Feed Uses and Quality Improvement. In: S. E. Ullrich, ed. Barley: Production, Improvements, and Use. Wiley-Blackwell, Ames, IA.

Peterson, J. L., S. J. Moreaux, J.G.P. Bowman, P. G. Hatfield, J. Olsen, and J. Berardinelli. 2009. Effects of psyllium supplementation on blood glucose, blood insulin and physical characteristics in Quarter Horses. J. Equine Vet. Sci. 29:357. (Abstr.)

2011

Blake, T., V. C. Blake, J.G.P. Bowman, and H. Abdel-Haleem. 2011. Barley feed uses and quality improvement. Page 522 in Barley: Production, Improvement, and Uses. Steven E. Ullrich, ed. Blackwell Publishing Ltd., West Sussex, UK.

Blake, T., V. C. Blake, J.G.P. Bowman, and H. Abdel-Haleem. 2011. Barley feed uses and quality improvement. Page 522 in Barley: Production, Improvement, and Uses. Steven E. Ullrich, ed. Blackwell Publishing Ltd., West Sussex, UK.

Dr. Craig Carr

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Bozeman, MT 59717-2900
Phone: (406) 994-3282
Fax: (406) 994-5589
Email: craig.carr@montana.edu

Education

Ph.D. Oregon State University, Rangeland Ecology & Management, 2007
M.S. Oregon State University, Rangeland Resources, 2003
B.Sc. University of Alberta, Animal Science, 1994

Classes

NRSM 235 Range and Pasture Monitoring
NRSM 350 Vegetation of Western Rangelands
NRSM 351 Biomes of Western Rangelands

Research Interests

Conifer encroachment
Rangeland hydrology & watershed management
Wild horse habitat use and landscape distribution
Non-equilibrium ecology and state-and-transition models
Restoration ecology
Grazing management

Graduate Students

Present
Tulganyam (Sam) Samdanjigmed
MS Candidate

Publications

2012

Carr, Craig A., and William C. Krueger. 2012. The Role of the Seed Bank in Recovery of Understory Species in an Eastern Oregon Ponderosa Pine Forest. Northwest Science 86(3):168-178

Lossing, Samuel S., Tamzen K. Stringham, Craig A. Carr, Keirith A. Snyder, Mark A. Weltz, and Bennett J. Stringham. Quantifying and modeling rainfall interception and redistribution by singleleaf pinon and utah juniper.

Dr. Glenn Duff

Professor, Animal Science
107 Animal Bioscience Building
Montana State University
Bozeman, MT 59717
Phone: (406) 994-4850
Fax: (406) 994-5589
Email: glenn.duff@montana.edu

Education

B.S. Northwest Missouri State University, 1986
M.S. University of Arkansas, Animal & Poultry Science, 1988
Ph.D. New Mexico State University, Animal & Poultry Science, 1991

Classes

ANSC 434R Beef Management

ANSC 215 Calving Management

ANSC 234 Livestock Management – Beef

Research Interests

Research will concentrate on health of neo-natal calves in relation to nutritional requirements and environmental changes

Accomplishments and Interests

Research has focused on health and performance of newly-received beef calves and finishing performance of beef and dairy breeds. Research accomplishments were recognized by writing one of the first BOARD-INVITED reviews for the Journal of Animal Science and two invited reviews on feeding cattle for the Veterinary Clinics of North America
The most significant teaching accomplishments included development of several courses at the University of Arizona including Principles of Nutrition, Advanced Nutrition/Management – Feedlot, and Experimental Analysis of Biological Data. For undergraduate students at Montana State University, courses taught include hands-on aspects.

Graduate Students

Present
Dr. Bob Sager DVM
Ph.D. Candidate

Omalola Betiku
Ph.D. Candidate

Brian Ham
MS Candidate

Kaitlyn Spence
MS Candidate

Amanda Vogstad
Ph.D. Candidate

Completed Graduate Student

Kate Sharon
MS Degree, Spring 2013

Publications (since 2000)

2000

Frank, G. H., and G. C. Duff. 2000. Effects of tilmicosin phosphate, administered prior to transport or at time of arrival, and feeding of chlortetracycline, after arrival in a feedlot, on *Mannheimia haemolytica* in nasal secretions of transported calves. Am. J. Vet. Res. 61:1479-1483.

Malcolm-Callis, K. J., G. C. Duff, S. A. Gunter, E. B. Kegley, and D.A. Vermeire. 2000. Effects of zinc levels and source on performance, carcass characteristics, and serum parameters in finishing beef steers. J. Anim. Sci. 78: 2801-2808.

Brown, M. S., C. R. Krehbiel, G. C. Duff, M. L. Galyean, D. M. Hallford, D.A. Walker. 2000. Effect of degree of corn processing on urinary nitrogen composition, serum metabolite and insulin profiles, and performance by finishing steers. J. Anim. Sci. 78:2464-2474.

Soto-Navarro, S. A., C. R. Krehbiel, G. C. Duff, M. L. Galyean, M. S. Brown, and R. L. Steiner. 2000. Influence of feed intake fluctuation and frequency of feeding on nutrient digestion, digesta kinetics, and ruminal fermentation profiles in limit-fed steers. J. Anim. Sci. 78:2215-2222.

Soto-Navarro, S. A., G. C. Duff, C. R. Krehbiel, M. L. Galyean, and K. J. Malcolm-Callis. 2000. Influence of feed intake fluctuation, feeding frequency, time of feeding, and rate of gain on performance by limit-fed steers. Prof. Anim. Sci. 16:13-20.

Duff, G. C., K. J. Malcolm-Callis, D. A. Walker, M. W. Wiseman, M. L. Galyean, and L. J. Perino. 2000. Effects of intranasal versus intramuscular modified live vaccines and vaccine timing on health and performance by newly received beef cattle. Bovine Practitioner 34(1):66-71.

Duff, G. C., K. J. Malcolm-Callis, D. A. Walker, M. W. Wiseman, and D. M. Hallford. 2000. Effects of pre-shipping versus arrival medication with tilmicosin phosphate and feeding chlortetracycline on health and performance of newly-received beef cattle. J. Anim. Sci. 78:267-274.

Ralphs, M. H., J. D. Graham, G. Duff, B. L. Stegelmeier, and L. F. James. 2000. Impact of locoweed poisoning on grazing steer weight gain. J. Range Manage. 53:86-90.

2001

Gunter, S. A., K. J. Malcolm-Callis, G. C. Duff, and E. B. Kegley. 2001. Performance of growing steers supplemented with zinc pre- and post-shipping to the feedlot. Prof. Anim. Sci. 17:280-286.

Mikus, J. H., G. C. Duff, C. R. Krehbiel, D. M. Hallford, D. A. Walker, J. D. Graham, and M. H. Ralphs. 2001. Effects of an estradiol implant on locoweed consumption, toxicity, and recovery in growing beef steers. Prof. Anim. Sci. 17:109-114.

Ralphs, M. H., F. D. Provenza, J. A. Pfister,. D. Graham, G. C. Duff, and G. Greathouse. 2001. Conditioned food aversions: From theory to practice. Rangelands 23:14-18.

2002

Fent, G. M., R. W. Fulton, J. T. Saliki, S. L. Caseltine, H. D. Lehmkuhl, A. W. Confer, C. W. Purdy, R. E. Briggs, R. W. Loan, and G. C. Duff. 2002. Bovine adenovirus-7 infections in post weaning calves. Am. J. Vet. Res. 63:976-978.

Duff, G. C., M. H. Ralphs, D. A. Walker, J. D. Graham, J. D. Rivera, and L. F. James. 2002. Grazing behavior of Hereford, Charolais, or Brangus steers on locoweed-infested pastures. Prof. Anim. Sci. 18:33-37.

Rivera, J. D., § G. C. Duff, M. L. Galyean, D. A. Walker, and G. A. Nunnery. 2002. Effects of supplemental vitamin E on performance, health, and humoral immune response of beef cattle. J. Anim. Sci. 80:933-941.

Frank, G. H., R. E. Briggs, G. C. Duff, R. W. Loan, and C. W. Purdy. 2002. Effects of pretransit vaccination and arrival medication with florfenicol on the health of transported steers and the presence of *Mannheimia haemolytica* organisms in nasal secretions. Am. J. Vet. Res. 63:251-256.

Beck, P. A., S. A. Gunter, G. C. Duff, K. J. Malcolm-Callis, D. A. Walker, and E. B. Kegley. 2002. Performance of steers supplemented with copper pre- and(or) post-shipping to the feedlot. Can. J. Anim. Sci. 82:87-93.

Fulton, R. W., J. F. Ridpath, J.T. Saliki, R. E. Briggs, A. W. Confer, L. J. Burge, C. W. Purdy, R. W. Loan, G. C. Duff, and M. E. Payton. 2002. Bovine viral diarrhea virus (BVDV) 1b: Predominant BVDV subtype in calves with respiratory disease. Can. J. Vet. Res. 66:181-190.

Choat, W. T., C. R. Krehbiel, M. S. Brown, G. C. Duff, D. A. Walker, and D. R. Gill. 2002. Effects of restricted versus conventional dietary adaptation on feedlot performance, carcass characteristics, site and extent of digestion, digesta kinetics and ruminal metabolism. J. Anim. Sci. 80:2726-2739.

Duff, G. C., M. L. Galyean, and K. J. Malcolm-Callis. 2002. Effects of proportions of steam-flaked corn and grain sorghum and switching grain sources during the finishing period on performance and carcass characteristics of beef steers. Prof. Anim. Sci. 18:387-394.

2003

Duff, G. C., B. D. Hunsaker, A. C. Anderson, J. D. Roder, and D. A. Walker. 2003. Florfenicol concentration in serum of beef cattle fed 0, 3, or 6% added dietary fat in a 70% concentrate diet. J. Anim. Vet. Advan. 2:44-48.

Frank G. H., R. E. Briggs, G. C. Duff, and H. S. Hurd. 2003. Effect of intranasal exposure to leukotoxin-deficient Mannheimia haemolytica at the time of arrival at the feedyard on the subsequent isolation of Mannheimia haemolytica from nasal secretions of calves. Am. J. Vet. Res. 64:580-585.
Rivera, J. D., G. C. Duff, M. L. Galyean, D. M. Hallford, and T. T. Ross. 2003. Effects of graded levels of vitamin E on inflammatory response and evaluation of methods of supplementing vitamin E on performance and health of beef steers. Prof. Anim. Sci. 19:171-177.
Duff, G. C., K. J. Malcolm-Callis, M. L. Galyean, and D. A. Walker. 2003. Effects of dietary urea concentration on performance and health of receiving cattle and performance and carcass characteristics of finishing cattle. Can. J. Anim. Sci. 83:569-575.

2004
Fulton, R. W., R. E. Briggs, M. E. Payton, A. W. Confer, J. T. Saliki, J. F. Ridpath, L. J. Burge, and G. C. Duff. 2004. Maternally derived humoral immunity to bovine viral diarrhea virus (BVDV)1a, BVDV1b, BVDV2, bovine herpesvirus-1, parainfluenza-3 virus, bovine respiratory syncytial virus, Mannheimia haemolytica and Pasteurella multocida in beef calves, antibody decline by half-life studies and effect on response to vaccination. Vaccine 22:644-650.
Capitan, B. M., C. R. Krehbiel, R. E. Kirksey, L. M. Lauriault, G. C. Duff, and G. B. Donart. 2004. Effect of winter and summer forage type on pasture and feedlot performance and carcass characteristics by beef steer. Prof. Anim. Sci. 20:225-236.
Gleghorn, J. F., N. A. Elam, M. L. Galyean, G. C. Duff, N. A. Cole, and J. D. Rivera. 2004. Effects of crude protein concentration and degradability on performance, carcass characteristics, and serum urea nitrogen concentrations in finishing beef steers. J. Anim. Sci. 82: 2705-2717.
Bailey, C. R., G. C. Duff, R. C. Cheatham, S. R. Sanders, T. W. Whitney, O. B. Mendivil, and J. L. Treichel. 2004. Dietary urea concentration and acid-base balance in feedlot steers fed a high concentrate steam-flaked corn-based diet. Can. J. Anim. Sci. 84:741-743.

2005
Fulton, R. W., R. E. Briggs, J. F. Ridpath, J. T. Saliki, A. W. Confer, M. E. Payton, G. C. Duff, D. L. Step and D. L. Walker. 2005. Transmission of Bovine Viral Diarrhea Virus 1b to Susceptible and Vaccinated Calves by Exposure to Persistently Infected Calves. Can. J. Vet. Res. 69:161-169.

2006
Whitney, T. W., G. C. Duff, J. K. Collins, D. W. Schafer, and D. M. Hallford. 2006. Effects of diet for early-weaned crossbred beef steers on metabolic profiles and febrile response to an infectious bovine herpes virus-1 challenge. Live. Sci 101:1-9.
Whitney, Travis, Glenn Duff, Peder Cuneo, David Henderson, David Schafer, Dennis Hallford, Robert Collier, and Paula Gentry. 2006. Effects of weaning programs on serum metabolites and hepatic IGF-1 mRNA of first calf heifers or mature cows. J Food Agric. Envir. 4(2):49-53.
Ibrahim, R. M., J. A. Marchello, and G. C. Duff. 2006. Effect of zeranol implantation on fatty acid composition of subcutaneous and intramuscular fat in beef steers. Prof. Anim. Sci. 22:301-306.

Cole, N. A., P. F.Defoor, M. L. Galyean, G. C. Duff, and J. Gleghorn. 2006. Effects of phase feeding of crude protein on performance, carcass characteristics, serum urea nitrogen concentrations and manure nitrogen of finishing beef steers. J. Anim. Sci. 84:3421-3432.
Thomas, C. T., A. E. Hoet, S. Sreevatsan, T. E. Wittum, R. Briggs, G. C. Duff, and L J. Saif. 2006. Field transmission of bovine coronavirus and herd immunity against associated respiratory disease in feedlot cattle. Am. J. Vet. Res. 68:1412-1420.

2007

Duff, G. C., and M. L Galyean. 2007. BOARD SPONSORED REVIEW: Recent advances in management of highly stressed, newly received feedlot cattle. J. Anim. Sci. 85:823-840.
Duff, G. C. 2007. Integrating lifetime nutrition From cow/calf to stocker to feedlot. L. Hollis and K. C. Olson, eds. Elsevier, Philadelphia, PA. Vet. Clinics of North America: Food Animal Practice 23:177-191.
Duff, G. C., and C. P. McMurphy. 2007. Feeding Holstein steers from start to finish. L. Hollis and K. C. Olson, eds. Elsevier, Philadelphia, PA. Vet. Clinics of North America: Food Animal Practice 23:281-297.

2008

Bailey, C. R., G. C. Duff, S. R. Sanders, J. L. Treichel, L. H. Baumgard, J. A. Marchello, D. W. Schafer, and C. P. McMurphy. 2008. Effects of increasing crude protein concentrations on performance and carcass characteristics of growing and finishing steers and heifers. Anim. Feed Sci. Technol. 142:111-120..
Ibrahim, R. M., J. A. Marchello, G. C. Duff, E. V. Marchello, and D. W. Schafer. 2008. Effect of two breeds and two dietary concentrate levels on feedlot performance, carcass composition and fatty acid profiles. J. Anim. Sci. 86:1426-1433.
Jones, B., R. D. Fish, A. Martin, G. C. Duff, and R. L. Ax. 2008. Effects of supplemental linoleic and linolenic acids on reproduction in Holstein cows. Prof. Anim. Sci 24:500-505.
Cheatham, R. C., §G. C. Duff, C. R. Bailey, S. R. Sanders, R. J. Collier, J. A. Marchello, and L. H. Baumgard. 2008. Effects of implant programs on live performance, carcass characteristics, serum metabolites, fatty acid profiles and lipogenic gene expression of adipose tissue in Holstein steers. S. African J. Anim. Sci. 38:238-246.
Bailey, C. R., G. C. Duff, S. R. Sanders, S. P. Cuneo, C. P. McMurphy, S. W. Limesand, J. A. Marchello, D. W. Schafer, M. L. Rhoads, and D. M. Hallford. 2008. Effects of ovarietomy and anabolic steroid implantation on the somatotropic axis in feedlot heifers. S. African J. Anim. Sci. 38:207-216.
Zerai, D. B., K. M. Fitzsimmons, R. J. Collier, and G. C. Duff. 2008. Evaluation of Brewers Waste as partial replacement of fish meal protein in Nile-Tilapia (Oreochromic niloticus) diets. J. World Aquaculture Soc. 39:556-564.

2009

Vogel, G. J., G. C. Duff, J. Lehmkuhler, J. L. Beckett, J. S. Drouillard, A. L. Schroeder, W. J. Platter, M. T. Van Koevering, and S. B. Laudert. 2009. Effect of ractopamine hydrochloride on growth performance and carcass traits in calf-fed and yearling Holstein steers fed to slaughter. Prof. Anim. Sci. 25:26-32.
McMurphy, C. P., G. C. Duff, M. A. Harris, S. R. Sanders, N. K. Chirase, C. R. Bailey, and R. M. Ibrahim. 2009. Effect of humic/fulvic acid in beef cattle finishing diets on animal

performance, ruminal ammonia, and serum urea nitrogen concentration. J. Appl. Anim. Res. 35:97-100.
Beckett, J. L., R. Delmore, G. C. Duff, D. A. Yates, D. M. Allen, and N. Elam. 2009. Effects of zilpaterol hydrochloride on growth rates, feed conversion and carcass traits in calf-fed Holstein steer. J. Anim. Sci. 87:4092-4100.

2010
O'Brien, M. D., R. P. Rhoads, S. R. Sanders, G. C. Duff, and L. H. Baumgard. 2010. Metabolic adaptations to heat stress in growing cattle. Dom. Anim. Endocrin. 38:86-94.
McDaniel, M. D., J. K. Collins, G. C. Duff, S. P. Cuneo, R. D. Glock, and J. W. Campbell. 2010. A survey of southern Arizona calves for persistent infection with bovine viral diarrhea virus. The Bovine Practitioner 44:88-92.

2011
McMurphy, C. P, G. C. Duff, S. R. Sanders, C. P. Cuneo, and N. K. Chirase. 2011. Effects of supplementing humates on rumen fermentation of Holstein steers. S African J. Anim. Sci. 41:134-140.

2012
Bernal-Rigoli, J. C., G. C. Duff, J. A. Marchello, S. P. Cuneo, S. R. Garcia, G. Xie, L. W. Hall, J. D. Allen, and C. D. Burrows. 2012. Effects of housing and feeding systems on performance of neo-natal Holstein bull calves. J. Anim. Sci. 90:2818–2825.
Allen, J. D., L. W. Hall, J. E. English, and G. C. Duff. 2012. Effect of bird depredation on nutrient composition of cattle diets fed at two southwestern cattle facilities. Prof. Anim. Sci. 28:573-577.

2013
Dick, K. J., G. C. Duff, S. W. Limesand, S. P. Cuneo, D. K. Knudson, C. P. McMurphy, L. W. Hall, J. C. Bernal-Rigoli, and J. A. Marchello. 2013. Effects of *Lactobacillus acidophilus* and *Propionibacterium freudenreichii* on digestive tract morphology of neo-natal/transition Holstein bull calves and performance by calf-fed Holstein steers. Prof. Anim. Sci. 29:107-115.
Sharon, K. P., G. C. Duff, J. A. Paterson, J. W. Dailey, J. A. Carroll, and E. A. Marceau. 2013. Case Study: Effects of timing of a modified-live respiratory viral vaccination on performance, feed intake, antibody titer response, and febrile response of beef heifers. Prof. Anim. Sci. 29:307-312.
Xie, G., G. C. Duff, L. W. Hall, J. D. Allen, C. D. Burrows, J. C.Bernal-Rigoli, S. E. Dowd, V. Guerriero, and C. J. Yeoman. 2013. Alteration of digestive tract microbiome in neo-natal Holstein bull calves by bacitracin methylene diasalicylate treatment and scours. J. Anim. Sci. (Accepted).
Muumba, J., J. D. Allen, J. A. Marchello, D. W. Shafer, G. C. Duff, and R. J. Collier. 2013. Association of single nucleotide polymorlphisms in the β2 adrenergic receptor gene with performance and carcass characteristics in beef steers and heifers. J. Anim. Sci. (submitted).

Dr. Rachel Endecott

Associate Professor, Animal Science
Extension Beef Cattle Specialist
219 Animal Bioscience Building
Montana State University
Bozeman, MT 59717
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Fax: (406) 994-5589
Email: rachel.endecott@montana.edu

Education

B.S. Montana State University, Animal Science, 2001
M.S. New Mexico State University, Ruminant Nutrition, 2003
Ph.D. University of Missouri, Ruminant Nutrition, 2006

Classes

ANSC 434 Beef Cattle Management

Research Interests

Develop Bozeman-based applied research-program to answer producer questions
Continue to collaborate with USDA-ARS colleagues where appropriate
Develop alternative methods of Extension program delivery (distance education, adapt new technology, etc.)
Continue to write monthly e-newsletter, Cow Sense Chronicle
Develop Beef Cattle Management class from foundation built during Fall 2012

Accomplishments and Interests

Applied research projects answer producer's questions about turning lot-developed cattle out on grass and how post-weaning development impacts feedlot performance and carcass characteristics
Collaborative research efforts with MSU and USDA-ARS personnel
Provide unbiased, research-based beef cattle information to producers, youth, and other stakeholders
Provide in-service training to county agents on beef cattle management topics
Re-wrote 4-H Livestock Quality Assurance curriculum
Advise Collegiate Stockgrowers at MSU and re-invigorated the Academic Quadrathlon program

Graduate Students

2010
Lindsey Voigt
MS Degree: Animal Science

Publications

2012

Endecott, R. L., S. H. Cox, C. M. Rubio, C. A. Löest, D. E. Hawkins, and M. K. Petersen. 2012. Effects of supplements with increasing glucogenic precursor content on reproduction and nutrient utilization in young postpartum range cows. Livest. Sci. 145:109-118.
Endecott, R. L., R. N. Funston, J. T. Mulliniks, and A. J. Roberts. 2012. Implications of beef heifer development systems and lifetime productivity. J. Anim. Sci. .2012-5704; published ahead of print October 24, 2012, doi:10.2527/jas.2012-5704.
Mulliniks, J. T., S. H. Cox, M. E. Kemp, R. L. Endecott, R. C. Waterman, D. M. VanLeeuwen, and M. K. Petersen. 2012. Relationship between body condition score at calving and reproductive performance in young postpartm cows grazing native range. J. Anim. Sci. 90:2811-2817.

Dr. Patrick Hatfield

Professor, Animal Science
113 Animal Bioscience Building
Montana State University
Bozeman, MT 59717
Phone: (406) 994-7952
Fax: (406) 994-5589
Email: hatfield@montana.edu

Education

B.S. Montana State University, Range Science, 1983
M.S. New Mexico State University, Range Science, 1985
Ph.D. University of Nebraska-Lincoln, Ruminant Nutrition, 1988

Classes

ANSC 222 Livestock in Sustainable Systems ‹ Syllabus
ANSC 232 Livestock Management - Sheep ‹ Syllabus
ANSC 432 Sheep Management ‹ Syllabus
ARNR 521 Advanced Ruminant Nutrition ‹ Syllabus

Research Interests

Incorporating sheep into sustainable crop production systems for insect and weed pest control, and residue management.
Nutritional and management factors that improve sheep production efficiency.

Accomplishments and Interests

Investigate alternatives to traditional crop residue and fallow management using sheep to control weed and insect pests and enhance soil nutrient cycling.
Develop strategic nutritional intervention strategies for the late gestating ewe to minimize neonatal losses by improving lamb immune function and/or fetal and neonate energetic status.
Determine profitable management options that enhance quality and expand the availability of market ready lean lamb beyond current seasonal limits.

Develop and maintain online programs to aid students and producers in making sound nutrition and management decisions.
68 peer reviewed publications, 1 book chapter, 31 invited papers, 100 proceedings, abstract, and research reports, 33 popular press articles.
$8.3 million in competitive research, teaching, and USDA special grants.
2011 MSU meritorious award
2012 MSU meritorious award
MSU Sheep Ration Program
Ewe Cost and Sheep Grazing Crop Residue Partial Budgeting Programs

Graduate Students (since 2000)

2003
Theresa Spezzano
MS Degree: Animal Science

2006
Julia Dafoe
MS Degree: Animal Science

2009
Reid Redden
PhD: Animal Science

2010
Hayes Goosey
PhD: Animal Science

Jennifer Keithly
MS Degree: Animal Science

2012
Erin Snyder Nix
MS Degree: Animal Science

Present
Molly Butler
MS Candidate

Publications (since 2000)

2000
Daniels, J.T., P.G. Hatfield, D.E. Burgess, R.W. Kott, and J.G.P. Bowman. 2000. Evaluation of ewe and lamb immune response when ewes were supplemented with vitamin E. J. Anim. Sci. 78:1731-2736.
Daniels, J.T., D.E. Burgess, P.G. Hatfield, and R.W. Kott. 2000. An ELISA method for determining sheep serum lgG concentration. Sheep and Goat Res. J. 16:33.

Hamadeh, S.K., P.G. Hatfield, B.L. Robinson, N.J. Roth, and R.W. Kott. 2000. Alpha acid glycoprotein (AGP) as an early indicator of stress in new born lambs. Sheep and Goat Res. J. 16:72.
Hamadeh, S.K., P.G. Hatfield, R.W. Kott, B.L. Robinson, and B.F. Sowell. 2000. Effects of breed, sex, birth type and colostrum intake on body temperature of new born lambs subjected to cold stress. Sheep and Goat Res. J. 16:46.
Hatfield, P.G., J.T. Daniels, R.W. Kott, D.E. Burgess, and T.J. Evans. 2000. Role of supplemental vitamin E in lamb survival and production: A Review. Proc. Am. Soc. Anim. Sci. at: http://www/asas/prg/jas/symposia/proceedings/0932.pdf.
Hatfield, P.G., R. A. Field, J.A. Hopkins, and R.W. Kott. 2000. Palatability of wethers fed an 80% barley diet processed at different ages and of yearling wethers grazed on native range. J. Anim. Sci. 78:1779-1785.
Hatfield, P.G., W.S. Ramsey, and J.A. Fitzgerald. 2000. Effect of naloxone on intake, growth hormone, and luteinizing hormone concentrations in lactating and non-lactating ewes. Small Rum. 35:21.
Roeder, R.L., V.M. Thomas, R.W. Kott, P.G. Hatfield, and D. Burgess. 2000. Effect of short term prepartum feeding of levels and type of protein on ewe performance and colostrum accumulation. Sheep and Goat Res. J. 16:1.

2001
Griffith, D., P.G. Hatfield, and R.W. Kott. 2001. Enterprise budgeting for ewe flock operations. Sheep and Goat Res. J. 17:29.
Hatfield, P.G., C.K. Swenson, R.W. Kott, R.P. Ansotegui, N.J. Roth, and B.L. Robinson. 2001. Zinc and copper status in ewes supplemented with sulfate- and amino acid-complexed forms of zinc and copper. J. Anim. Sci. 79:261-266.
Hatfield, P.G., J.T. Daniels, R.W. Kott and D.E. Burgess. 2001. Survival and serum lgG levels in twin born lambs supplemented with vitamin E early in life. Sheep and Goat Res. J. 17:24.
Shanks, B.C., P.G. Hatfield, R.A. Field, and J.A. Hopkins. 2000. Influence of winter backgrounding systems on subsequent lamb finishing performance, body composition, carcass traits, and palatability. Sheep and Goat Res. J. 16:88. (note: journal not published until March, 2001).
Stellflug, J.N., P.G. Hatfield, M.C. Wulster-Radcliffe, and J. Walker. 2001. Reproductive performance of ewe lambs from ewes from different selection practices with or without induced estrus. Anim. Repro. Sci. 66:185.

2002
Hatfield, P.G., B.L. Robinson, D. Minikheim, R.W. Kott, N.J. Roth, J.T. Daniels, and C.K. Swenson. 2002. Serum α-tocopherol and immune function in yearling ewes supplemented with zinc and vitamin E. J. Anim. Sci. 80:1329.
Taylor, N., P.G. Hatfield, B.F. Sowell, and G.S. Lewis. 2002. Influence of supplement form on ewe performance and reproduction. Sheep and Goat Res. J. 17:52.
Taylor, N., P.G. Hatfield, B.F. Sowell, J.G.P. Bowman, J.S. Drouillard, and D.V. Dhuyvetter. 2002. Pellet and block supplements for grazing ewes. Anim. Feed Sci. Technol. 96:193-201.

2003

Kott, R.W., P.G. Hatfield, J.W. Bergman, C.R. Flynn, H. VanWagoner, and J.A. Boles. 2003. Feedlot performance, carcass composition, and muscle and fat CLA concentration of lambs fed diets supplemented with safflower seeds. Small Rum. Res. 49:11-17.

2004
Goosey, H.B., P.G. Hatfield, S.L. Blodgett and S.D. Cash. 2004. Evaluation of alfalfa weevil (*Coleoptera: circulionidae*) densities and regrowth characteristics of alfalfa grazed by sheep in winter and spring. J. Entomol. Sci. 39:598-619.

2005
Boles, J.A., R.W. Kott, P.G. Hatfield, J.W. Bergman, and C.R. Flynn. 2005. Supplemental safflower oil affects initial color and fatty acid profile of lamb. J. Anim. Sci. 83:2175-2181.
Goosey, H.B., P.G. Hatfield, A.W. Lenssen, S.L. Blodgett and R.W. Kott. 2005. The potential role of sheep in dryland grain production systems. Agric. Ecosystems Environ. 111:349-353.

2006
Surber, L.M.M., B. Roeder, P.G. Hatfield and R.W. Kott. 2006. Feedlot performance and carcass characteristics of spring-born wethers finished on an 80% barley diet either in the fall or spring and slaughtered at seven to eight, or fourteen to fifteen months of age, respectively. Small Rum. Res. 66:102-107.

2007
Hatfield, P.G., S.L. Blodgett, T.M. Spezzano, H.B. Goosey, A.W. Lenssen, R.W. Kott, and C.B. Marlow. 2007. Incorporating sheep into dryland grain production systems: I. Impact on over-wintering larva populations of Wheat stem sawfly, *Cephus cintus* Norton, (Hymenoptera: Cephidae). Small Rum. Res. 67:209-215.
Hatfield, P.G., S.L. Blodgett, T.M. Spezzano, H.B. Goosey, A.W. Lenssen, R.W. Kott, and C.B. Marlow. 2007. Incorporating sheep into dryland grain production systems: II. Impact on changes in biomass and weed frequency. Small Rum. Res. 67:216-221.
Hatfield, P.G., S.L. Blodgett, T.M. Spezzano, H.B. Goosey, A.W. Lenssen, R.W. Kott, and C.B. Marlow. 2007. Incorporating sheep into dryland grain production systems: III. Impact on changes in soil bulk density and soil nutrient profiles. Small Rum. Res. 67:222-231.

2008
Dafoe, J.M., R.W. Kott, B.F. Sowell, J.G. Berardinelli, K.C. Davis and P.G. Hatfield. 2008. Effects of supplemental safflower and vitamin E during late gestation on lamb growth, serum metabolites and thermogenesis. J. Anim. Sci. 86:3194-3202.

2009
Redden R. R., R. W. Kott, J. A. Boles, A. W. Layton, and P. G. Hatfield. 2009. Effects of late gestation supplementation of rumen undegradable protein, vitamin E, zinc, and chlortetracycline to ewes on indices of immune transfer and productivity. J. Anim. Sci. Accepted for Publication on November 23, 2009.
Redden R. R., R. W. Kott, L.M.M. Surber, J. A. Boles, A. W. Layton, and P. G. Hatfield. 2009. Post-weaning management of lambs alters subsequent feedlot performance and tissue deposition. Sheep & Goat Res. J. Accepted for Publication on October 2, 2009.

J. I. Keithly, R. W. Kott, J. G. Berardinelli, S. Moreaux, and P. G. Hatfield. Submitted. Thermogenesis, blood metabolites and hormones, and growth of lambs born to ewes supplemented with docosahexaenoic acid. J. Anim. Sci.

2010

Kott, R. W., L. M. M. Surber, A. V. Grove, P. G. Hatfield, J.A. Boles, C. R Flynn and J. W. Bergman. 2010. Feedlot performance, carcass characteristics, and muscle CLA concentration of lambs fed diets supplemented with safflower seeds and vitamin E. Sheep and Goat Res. J. 25: 16-22.

Sainju, U. M., A. W. Lenssen, H. B. Goosey, E. Snyder, and P. G. Hatfield. 2010. Dryland soil carbon and nitrogen influenced by sheep grazing in the wheat-fallow system. Agronomy J. 102: 1153-1561.

Redden, R. R., R. W. Kott, L.M.M. Surber, J. A. Boles, A. W. Layton, and P. G. Hatfield. 2010. Post-weaning Management of Lambs Alters Subsequent Feedlot Performance and Tissue Deposition. . Sheep and Goat Res. J. 24: 26-31

Redden, R. R., R. W. Kott, J. A. Boles, A. W. Layton, and P. G. Hatfield. 2010. Effects of late gestation supplementation of rumen undegradable protein, vitamin E, zinc, and chlortetracycline to ewes on indices of immune transfer and productivity. J. Anim Sci. 88: 1125-1134.

2011

Sainju, U. M., A. W. Lenssen, H. B. Goosey, E. Snyder, and P. G. Hatfield. 2011 Sheep grazing in the wheat-fallow system affects dryland soil properties and grain yield. 2011. Soil. Sci. Soc. Am. J. 75:1789-1798.

Keithly, J. I., R. W. Kott, J. G. Berardinelli, S. Moreaux, and P. G. Hatfield. 2011. Thermogenesis, blood metabolites and hormones, and growth of lambs born to ewes supplemented with docosahexaenoic acid. J. Anim. Sci. 89:4305-4313.

Moreaux, J. J., J. L, Nichols, J.G. P. Bowman, and P. G. Hatfield. 2011. Psyllium Lowers Blood Glucose and Insulin Concentrations in Horses. J. Equine Vet. Sci 31: 160-165

Lenssen, A. W., S. D. Cash, P. G. Hatfield, U. M. Sainju, W. R. Grey, S. L. Blodgett, H. B. Goosey, D. A. Griffith, and G. D. Johnson. 2011. Yield, quality, and water and nitrogen use of Durum and annual forages in two-year rotations. Agronomy J. 102: 1261- 1268.

2013

Goosey, H. P., J. P. Hatfield, M. G. Rolston, G. D. Johnson, and P. G. Hatfield. 2013. Hymenoptera parasitoid response to sheep grazing tillage, and herbicides in wheat-fallow rotations. Journal of the Kansas Entomological Society.

INVITED PAPERS and PRESENTATIONS

Hatfield, P. G., T. Spezzano, H. B. Goosey, S. Blodgett, A. W. Lenssen, and R. W. Kott. 2012. Integrated crop livestock production systems using grazing sheep to control wheat stem sawfly: Impact on over-wintering larval populations. 5th Intl. Wheat Stem Sawfly Conf. Bozeman, MT. http://www.entomology.montana.edu/sawfly

Hatfield, P. G., H. B. Goosey, A. W. Lenssen, and S. Blodgett. 2011. Sheep grazing to manage crop residues and control insects and weeds in northern plains grain and alfalfa production. SARE Learning Center, Agricultural Innovations. sare.org/Learning-Center/Fact-Sheets

Dr. Greg Johnson

Professor Veterinary Entomology
Dept. of Animal and Range Sciences
Marsh Lab Rm. 70 MSU-Bozeman
PO Box 172900
Bozeman, MT 59717
Phone: (406) 994-3875
Fax: (406) 994-5589 Email: gdj@montana.edu

Education

Ph.D. University of Wyoming, 1978
M.S. University of Wyoming, 1975
B.S. Eastern Mennonite University, 1970

Classes

ANSC 410 Veterinary Entomology

Research Interests

Research in my laboratory focuses on the biology, ecology and management of arthropod pests that attack livestock and wildlife. Field and laboratory studies have been conducted on West Nile virus determining vector distribution in the state, identifying enzootic and epizootic zones of virus transmission and studying the impact of WNV on sage grouse and American white pelicans. Research has also been conducted on biting midges (*Culicoides*) and bluetongue virus focusing on vector competency and midge distribution in the state. I also conduct studies on insecticide management of different livestock pests that cause direct losses and affect livestock production. Included in this group are cattle grubs, horn flies, sheep keds and the African blue louse.

Completed Graduate Students

Hale, K. M. 2011. Proximate causation of stable fly (Stomoxys calcitrans (L.)) host use: the influence of phenology and host blood suitability. Ph.D. Dissertation. 113p.
Hale, K. M. 2007. Investigations of the West Nile Transmission Cycle at Medicine Lake National Wildlife Refuge, Montana 2005-2006. Montana State University. MS Thesis. 74p.
Doherty, M. K. 2007. Mosquito Populations in the Powder River Basin, Wyoming: A Comparison of Natural, Agricultural and Effluent Coal Be Natural Gas Aquatic Habitats. Montana State University. MS Thesis. 95p.

Extension Programs

Extension efforts focus on disseminating timely information about applied research results and vector surveillance activities through educational meetings, popular press articles and news releases.

Graduate Students (since 2000)

2007
Kristina Hale
MS Degree: Etomology

Melissa Kuckler Doherty
MS Degree: Entomology

2011
Kristina Hale
PhD: Animal Science

Publications (since 2000)

2000

Tharp, C. I., **G. D. Johnson**, and J. Onsager. 2000. Laboratory and field evaluations of imidacloprid against the migratory grasshopper, *Melanoplus sanguniipes,* on small grains. J. Econ. Entomol. 93:293-300.

Tharp, C. I., S. L. Blodgett, and **G. D. Johnson**. 2000. Susceptibility of the cereal leaf beetle to imidacloprid under greenhouse and field conditions in barley. J. Econ. Entomol. 93:38-42.

Blodgett, S., **G. Johnson**, W. Lanier, and J. Wargo. 2000. Pale western and army cutworms in Montana. MontGuide. MT 200005.

2001

Morrill, W. L., D. K. Weaver and **G. D. Johnson**. 2001. Trap strip and field border modification for wheat stem sawfly management. J. Entomol. Sci. 35: 478-482.

Blodgett, S. L. and **G. D. Johnson**. 2001. Canola and mustard insects. *In* High Plains Integrated Pest Management Guide for Colorado, Western Nebraska, Montana & Wyoming. Bull No. 564A. XVI: 5-9.

Hein, G.L. and **G. D. Johnson**. 2001 Insect Management Production. University of Nebraska Coop. Ext. 156. p. 81-116.

2002

Ni, X., **G. D. Johnson**, and S. S. Quisenberry. 2002. Comparison of hindwing hamuli from five species of cereal aphids (Hemiptera: Aphididae). Annals Ent. Soc. America. 95 (1): 109-114.

Rolston, M.G., M. A. Ivie and **G. D. Johnson.** 2002. *Tychius meliloti* Stephens, newlydiscovered in the United States (Coleopetra: Curculionidae). Coleopterists Bulletin: 220.

Olfert, O., **G. D. Johnson**, S. A. Brandt, and A. G. Thomas. 2002. Diversity and abundance of arthropods as a function of cropping systems in the northern Great Plains. J. Agronomy. 94: 210-216.

2004

Naugle, D. E., C. L. Aldridge, B. L. Walker, T. E. Cornish, B. J. Moynahan, M. J. Holleran, K. Brown**, G. D. Johnson**, E. T. Schmidtmann, R. T. Mayer, C. Y. Kato, M. R. Matchett, T. J. Christiansen, W. E. Cook, T. Creekmore, R. D. Falise, E. T. Rinkes, and M. S. Boyce. 2004. West Nile virus: pending crisis for greater sage-grouse. Ecol. Letters. 7: 704-713.

2005

Chen, C., G. Jackson, K. Neill, D. Wichman, **G. Johnson**, D. Johnson. 2005. Determining the feasibility of early seeding canola in the northern Great Plains. Agron. J. 97: 1252 – 1262.

2007

Lenssen, A.W., **G.D. Johnson**, S.L. Blodgett, and H.B. Goosey. 2007. Influence of tillage system, oilseed species, and seed treatment on flea beetle, *Phyllotreta cruciferae* (Coleoptera: Chrysomelidae) damage, oilseed production, and postharvest residue cover. Journal of Entomological Science 42:1-11.

Lenssen, A.W., **G.D. Johnson**, and G.R. Carlson. 2007. Cropping sequence and tillage system influences annual crop production and water use in semiarid Montana, USA. Field Crops Research 100:32-43.

Goosey, H., A. Lenssen, **G. Johnson**, S. Blodgett, G. Carlson, and K. Kephart. 2007. Evaluation of durum spring wheat susceptibility to wheat stem sawfly, *Cephus cinctus*. J. Entomol. Sci. 133 - 138.

Lenssen, A.W., **G.D. Johnson**, G.R. Carlson. 2007. Cropping sequence and tillage system influences annual crop production and water use in semiarid Montana, USA. Field Crops Res. 100: 32-43.

Johnson, G. D. 2007. Cutworms. *In* Handbook of Small Grain Insects. G.D. Buntin, K. S. Pike, M. J. Weiss and J.A. Webster eds. APS Press. P 53-55.

Lloyd, J. E., **G. D. Johnson**, R. W. Kott, H. B. Goosey and D. E. Legg. 2007. Clean-up Pour-on insecticide with IGR to control sheep ked. Arthropod Management Test . Article # K1.

Schreder, P. G. Pirelli and **G. Johnson**. 2007. Beef Cattle Pests. PNW Insect Management Handbook. 198 - 201.

2010

Johnson, G. N. Panella, K. Hale and N. Komar. 2010. Detection of West Nile Virus in Stable Flies (Diptera: Muscidae) Parasitizing Juvenile American White Pelicans. J. Medical Entomology. 16: 1205 – 1211.

Johnson, G., N. Nemeth, K. Hale, N. Lindsey, N. Panella and N. Komar. 2010. Surveillance for West Nile Virus in American White Pelicans, Montana, USA, 2006 – 2007. Emerg. Infect. Dis. 16: 406 – 411.

Reeves, W., J. Lloyd, R. Stobart, C. Stith, M. Miller, K. Bennett and **G. Johnson**. 2010. Control of *Culicoides sonorensis* (Diptera: Ceratopogonidae) Blood Feeding on Sheep with Long-lasting Repellent Pesticides. J. Am. Mosq. Contr. Assoc. 26: 302 – 305.

Miller, M., J. Brown, T. Cornish, **G. Johnson**, J. Mecham, W. Reeves and W. Wilson. 2010. Investigation of an Epizootic of Bluetongue Virus Serotype 17 in Sheep in Wyoming. JAVMA. 237: 955 – 959.

Lenssen, A.W., U.M. Sainju, D.C. Cash, P.G. Hatfield, W.R. Grey, S.L. Blodgett, H.B. Goosey, D.R. Griffith, and **G.D. Johnson**. 2010. Yield, quality, water use, and nitrogen uptake of durum and annual forages in two-year rotations. Agronomy Journal 102:1261-1268.

Johnson, G. 2010. Management of Lice on Livestock. MSU Extension Service. MT201002AG.

Johnson, G. 2010. Ticks of Veterinary and Public Health Importance in Montana. MSU Extension Service. EB0198.

Johnson, G. 2010. Horn Flies on Cattle: Biology and Management. MSU Extension Service. MT200912AG.

2012

Friesen K. M. and **G. D. Johnson.** 2012. Reproductive potential of stable flies (Diptera:Muscidae) fed cattle, chicken, or horse blood. J. Medical Entomology. 49:461-466.

Rolston, M and **G. Johnson**. 2012. Biology and impact of mosquitoes in Montana. MSU Extension Service MT 201204AG. 4 p.

Rolston, M and **G. Johnson**. 2012. Biology and impact of biting midges in Montana. MSU Extension Service MT 201205AG. 4 p.

2013

Friesen, KM and **GD Johnson**. 2013. Mosquito and West Nile virus surveillance in northeast Montana, 2005-2006. Med Vet Entomol. 27: 1 – 9.

Friesen, KM and **GD Johnson**. 2013. Evaluation of methods for collecting blood engorged mosquitoes (Diptera: Culicidae) from habitats within a wildlife refuge in northeast Montana. J. American Mosq. Control Assoc. 29: 102 – 107.

Friesen, KM and **GD Johnson**. 2013. Stable fly (Diptera: Muscidae) phenology in a mixed agricultural-wildlife ecosystem in northeast Montana. Environ. Entomol. 42: 49 – 57.

Johnson, G. D., H. B. Goosey, M. G. Rolston, W. L. Miller, D. G. Hokit, R. R. Redden, and R. J. Kott. 2013. Evaluation of Mosquito Responses to Pyrethroid Insecticides Topically Applied to Sheep. 29:146 – 153.

Goosey, H. B., J. P Hatfield, M. G. Rolston, **G. D. Johnson,** and P. G. Hatfield. 2013. Hymenopteran parasitoid response to sheep grazing, tillage, and herbicides in wheat- fallow rotations. Accepted: J. Kansas Entomol. Soc.

Rolston, M. and G. Johnson. 2013. Ticks on companion animals. MSU Extension. MT201303AG.

Dr. James Knight

Extension Wildlife Specialist
215 Animal Bioscience Building
Bozeman, MT 59717
Montana State University
Bozeman, MT 59717
Phone: (406) 994-5579
Fax: (406) 994-5589
Email: jknight@montana.edu

Education

Ph.D. University of Michigan, Natural Resource Management, 1980
M.S. Michigan State University, Wildlife Biology, 1975
B.S. Michigan State University, Wildlife Management, 1973

Research Interests

Continue development of wildlife damage control training programs and resource materials for traditional and organic farmers.
Develop web materials and online resources to enable county agents to address wildlife damage control issues after my retirement.

Accomplishments and Interests

Development and publication of a book, Manage Your Land for Wildlife, to serve as a reference and guide for ranchers and other landowners seeking to manage wildlife habitat and populations on their land.
Development of numerous methods and techniques for wildlife damage control that are now used and referenced across the country.
Development and publication of the national curriculum for 4-H Shooting Sports Hunting
Development and publication of information related to benefits of ranching and livestock grazing for wildlife.

Graduate Students (since 2000)

2000
Jeffrey J. Short
MS Degree: Range Science

2006
Randy Fenster
MS Degree: Range Science

Publications (since 2000)

2000
Gross, J.A. and J.E. Knight. 2000. Elk presence inside various-sized cattle exclosures. J. Range Manage. Vol. 53 No. 3.

2001
Swensson, E.J. and J.E. Knight. 2001. Hunter management strategies used by Montana ranchers. Wildlife Soc. Bull. 29(1):306-310.

2002
Tortenson, W.L., M.W. Tess and J.E. Knight. 2002. Effects of elk management strategies on the profitability of beef cattle enterprises. J. Range Manage. 55(2).

2003
Short, J.J. and J.E. Knight. 2003. Fall grazing affects big game forage on rough fescue grasslands. J. Range Manage. 56:213-217.

2004
Taylor, N., J.E. Knight and J.J. Short. 2004. Fall cattle grazing versus mowing to increase big-game forage. Wildlife Soc. Bull. 32(2):449-456.

2005
Johnson-Nistler, C.M., J.E. Knight and S.D. Cash. 2005. Considerations related to Richardson's ground squirrel (*Spermophilus richardsonii*) control in Montana. Agron. J. 97:1460-1464.

2006
Torstenson, W.L. F., J.C. Mosley, T.K. Brewer, M.W. Tess, and J.E. Knight. 2006. Elk, mule deer, and cattle foraging relationships on foothill and mountain rangeland. Range. Ecol. Manage. 59:80-87.

Dr. Rodney W. Kott

Extension Sheep Specialist
Wool Lab, MSU-Bozeman
Bozeman, MT 59717
Phone (406) 994-5602
Fax (406) 994-5589
rkott@montana.edu

Education

BS Texas A&M University, Agricultural Education 1974
MS Texas A&M University, Animal Science 1976
PhD New Mexico State University, Animal Science 1980

Classes

ARNR 230 Range Livestock Production
ARNR 232 Applied Techniques in Livestock Management - Sheep
ARNR 432 Sheep Management
ARNR 521 Ruminant Nutrition

Research Interests

Sheep Management

Community of Practice for Sheep (Sheep CoP) within eXtension

Although sheep inventories have declined, the sheep industry is a still a substantial component of the US livestock industry. There is a need to connect current sheep research outcomes and the extension and industry communities. The purpose of the Sheep CoP is to transfer knowledge regarding sheep production and products to producers, stakeholders, and consumers. The Sheep CoP covers a wide variety of sheep topics of interest, including (among others):
Sheep Management Practices
Sheep Breeds
Sheep Purpose (wool vs. meat vs. dual-purpose)
Markets
History
International Perspectives (how the industry differs in other countries)

Use the following form to *Ask An Expert*

Showmanship
Wool
Meat Products (available products, how to prepare, etc.)
Producer Profiles
Feed Efficiency
Genetic Selection
Prolificacy
Seasonality
Shearing
Feeding/Nutrition
Feedlot
Grazing/Pasture
Organic Sheep Production
Natural Sheep Production
Health
Veterinary Care

Accomplishments and Interests

Conducts 20 to 30 sheep production workshops yearly throughout Montana on sheep genetics, reproduction, nutrition, health, management & marketing.
Coordinates the Montana Central Ram Test and the Montana On-Farm Ram Testing Program.
Conducts enhanced wool preparation and marketing workshops which are designed to add value to wool produced in Montana.
Evaluates the effects of improved wool preparation methods on wool value.

Evaluates the potential benefits of utilizing Australian Merino sheep on crossbreeding programs with domestic breeds of sheep (cooperative study with U.S. Sheep Station, DuBois; Texas A&M; & University of California).

Graduate Students (since 2000)

2008
Stacee Henderson
MS Degree: Range Science

Brenda Robinson
MS Degree: Animal Science

2010
Mark Rude
MS Degree: Animal Science

Publications (since 2000)

2000
Daniels, J.T., P.G. Hatfield, D.E. Burgess, R.W. Kott, and J.G.P. Bowman. 2000. Evaluation of ewe and lamb immune response when ewes were supplemented with vitamin E. J. Anim. Sci. 78:1731-2736.
Daniels, J.T., D.E. Burgess, P.G. Hatfield, and R.W. Kott. 2000. An ELISA method for determining sheep serum lgG concentration. Sheep and Goat Res. J. 16:33.
Hamadeh, S.K., P.G. Hatfield, B.L. Robinson, N.J. Roth, and R.W. Kott. 2000. Alpha acid glycoprotein (AGP) as an early indicator of stress in new born lambs. Sheep and Goat Res. J. 16:72.
Hamadeh, S.K., P.G. Hatfield, R.W. Kott, B.L. Robinson, and B.F. Sowell. 2000. Effects of breed, sex, birth type and colostrum intake on body temperature of new born lambs subjected to cold stress. Sheep and Goat Res. J. 16:46.
Hatfield, P.G., R. A. Field, J.A. Hopkins, and R.W. Kott. 2000. Palatability of wethers fed an 80% barley diet processed at different ages and of yearling wethers grazed on native range. J. Anim. Sci. 78:1779-1785.
Hatfield, P.G., J.T. Daniels, R.W. Kott, D.E. Burgess, and T.J. Evans. 2000. Role of supplemental vitamin E in lamb survival and production: A Review. Proc. Am. Soc. Anim. Sci. at: http://www/asas/prg/jas/symposia/proceedings/0932.pdf.
Roeder, R.L., V.M. Thomas, R.W. Kott, P.G. Hatfield, and D. Burgess. 2000. Effect of short term prepartum feeding of levels and type of protein on ewe performance and colostrum accumulation. Sheep and Goat Res. J. 16:1.

2001
Griffith, D., P.G. Hatfield, and R.W. Kott. 2001. Enterprise budgeting for ewe flock operations. Sheep and Goat Res. J. 17:29.
Hatfield, P.G., C.K. Swenson, R.W. Kott, R.P. Ansotegui, N.J. Roth, and B.L. Robinson. 2001. Zinc and copper status in ewes supplemented with sulfate- and amino acid-complexed forms of zinc and copper. J. Anim. Sci. 79:261-266.

Hatfield, P.G., J.T. Daniels, R.W. Kott and D.E. Burgess. 2001. Survival and serum lgG levels in twin born lambs supplemented with vitamin E early in life. Sheep and Goat Res. J. 17:24.

2002
Hatfield, P.G., B.L. Robinson, D. Minikheim, R.W. Kott, N.J. Roth, J.T. Daniels, and C.K. Swenson. 2002. Serum α-tocopherol and immune function in yearling ewes supplemented with zinc and vitamin E. J. Anim. Sci. 80:1329.

2003
Kott, R.W., P.G. Hatfield, J.W. Bergman, C.R. Flynn, H. VanWagoner, and J.A. Boles. 2003. Feedlot performance, carcass composition, and muscle and fat CLA concentration of lambs fed diets supplemented with safflower seeds. Small Rum. Res. 49:11-17.

2005
Boles, J.A., R.W. Kott, P.G. Hatfield, J.W. Bergman, and C.R. Flynn. 2005. Supplemental safflower oil affects initial color and fatty acid profile of lamb. J. Anim. Sci. 83:2175-2181.
Goosey, H.B., P.G. Hatfield, A.W. Lenssen, S.L. Blodgett and R.W. Kott. 2005. The potential role of sheep in dryland grain production systems. Agric. Ecosystems Environ. 111:349-353.

2006
Surber, L.M.M., B. Roeder, P.G. Hatfield and R.W. Kott. 2006. Feedlot performance and carcass characteristics of spring-born wethers finished on an 80% barley diet either in the fall or spring and slaughtered at seven to eight, or fourteen to fifteen months of age, respectively. Small Rum. Res. 66:102-107.

2007
Borg, R.C., D.R. Notter, L.A. Kuehn, and R.W. Kott. 2007. Breeding objectives for Targhee sheep. J. Anim. Sci. 2006-064v1.
Hatfield, P.G., S.L. Blodgett, T.M. Spezzano, H.B. Goosey, A.W. Lenssen, R.W. Kott, and C.B. Marlow. 2007. Incorporating sheep into dryland grain production systems: I. Impact on over-wintering larva populations of Wheat stem sawfly, *Cephus cintus* Norton, (Hymenoptera: Cephidae). Small Rum. Res. 67:209-215.
Hatfield, P.G., S.L. Blodgett, T.M. Spezzano, H.B. Goosey, A.W. Lenssen, R.W. Kott, and C.B. Marlow. 2007. Incorporating sheep into dryland grain production systems: II. Impact on changes in biomass and weed frequency. Small Rum. Res. 67:216-221.
Hatfield, P.G., S.L. Blodgett, T.M. Spezzano, H.B. Goosey, A.W. Lenssen, R.W. Kott, and C.B. Marlow. 2007. Incorporating sheep into dryland grain production systems: III. Impact on changes in soil bulk density and soil nutrient profiles. Small Rum. Res. 67:222-231.
Kott, R.W. 2007. Book Review – Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids and New World Camelids (Animal Nutrition Series). JAVMA 231:881-882.
Lloyd, J.E., G.D. Johnson, R.W. Jott, H.B. Goosey, and D.E. Legg. 2007. Clean-Up™ Pour-On Insecticide with Igr to Control Sheep Ked. Antropod Management Tests 32:k1.
Notter, D.R., L.A. Kuehn and R.W. Kott. Genetic analysis of fibre characteristics in adult Targhee ewes and their relationship to breeding value estimates derived from yearling fleeces. Small Rum. Res. 67:164-172.

2008
Dafoe, J.M., R.W. Kott, B.F. Sowell, J.G. Berardinelli, K.C. Davis and P.G. Hatfield. 2008. Effects of supplemental safflower and vitamin E during late gestation on lamb growth, serum metabolites and thermogenesis. J. Anim. Sci. 86:3194-3202.
Thrift, B.D., J.C. Mosley, T.K. Brewer, B.L. Roeder, B.E. Olson and R.W. Kott. 2008. Summer diets of sheep grazing spotted knapweed-infested foothill rangeland. Rangeland Ecology & Management. 61:18-25.

2010
Kott, R. W., B. L. Roeder, and L.M.M. Surber. 2010. Sorting lines of wool with the OFDA2000. International J. of Sheep and Wool Science. 58:50-60.
Kott, R.W., L.M.M. Surber, A. V. Grove, P.G. Hatfield, and C. R Flynn and J.W. Bergman. 2010 . Feedlot performance, carcass characteristics, and muscle CLA concentration of lambs fed diets supplemented with safflower seeds and vitamin E. Sheep and Goat Res. J. 25:16-22. [On-line] 25: http://www.sheepusa.org/Sheep_and_Goat_Research_Journal
Redden, R. R., R. W. Kott, J. A. Boles, A. W. Layton, and P. G. Hatfield. 2010. Effects of late gestation supplementation of rumen undegradable protein, vitamin E, zinc, and chlortetracycline to ewes on indices of immune transfer and productivity. J Anim Sci, 88:1125-1134

2011
Redden, R.R, L. M. M. Surber, B. L. Roeder, B. M. Nichols, J. A. Paterson, and R. W. Kott. 2011. Residual feed efficiency established in a post-weaning growth test may not result in more efficient ewes on the range. Small Ruminant Research doi10.1016.
Surber, L.M.M., M. E. Rude, B. L. Roeder, T. K Mosley, A. V. Grove, J. W. Walker, and R.W. Kott, 2011. Percent spotted knapweed (Centaurea stoebe) in the diets of grazing sheep. Invasive plant science and management.
Keithly, J. I.,R. W. Kott, J. G. Berardinelli, S. Moreaux and P. G. Hatfield. Thermogenesis, blood metabolites and hormones, and growth of lambs born to ewes supplemented with algae-derived docosahexaenoic acid. J Anim Sci, 89:4305-4313
Surber, L.M.M., M. E. Rude, B. L. Roeder, T. K Mosley, A. V. Grove, J. W. Walker, and R.W. Kott, 2011. Percent spotted knapweed (Centaurea stoebe) in the diets of grazing sheep. Invasive Plant Science and Management.
Redden, R.R, L. M. M. Surber, B. L. Roeder, B. M. Nichols, J. A. Paterson, and R. W. Kott. 2011. Residual feed efficiency established in a post-weaning growth test may not result in more efficient ewes on the range. Small Ruminant Research. (Online publication complete: 20-JAN-2011 DOI information: 10.1016/j.smallrumres.2010.12.007).

2012
Henderson, Stacee L., Tracy K Mosley, Jeffrey C. Mosley and Rodney W. Kott. 2012. Spotted Knapweed utilization by sequential cattle and sheep grazing. Rangeland Ecology & Management 65(3): 286-291.

2013
Johnson, G.D., H. B. Goosey, M. G. Rolston, W. L. Miller, D. G. Hokit, R. R. Redden andR. J. Kott. 2013. Evaluation of Mosquito Responses to Pyrethroid Insecticides Topically Applied to Sheep. J.A. Mosquito Control Assn. 29(2):146-153.

Redden, R.R., L.M.M. Surber, A.V. Grove and R.W. Kott. Accepted, 2013. Growth efficiency of ewe lambs classified into residual feed intake groups and pen fed a restricted amount of feed. Small Ruminant Research, RUMIN 4558.

Dr. Clayton B. Marlow

309 Animal Bioscience Building
MSU-Bozeman
Bozeman, MT 59717-2900
Phone: (406)994-2486
Fax: (406)994-5589
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Education

BS University of Wyoming, Range Management 1974
MS Washington State University, Forest & Range Management 1976
PhD University of Wyoming, Range Management 1978

Classes

ARNR 543 Riparian Process & Function
NRSM 236 Small Pasture Management
NRSM 455 Riparian Ecology & Mgmt
NRSM 490 Undergraduate Research
WILD 355 Wildlife-Livestock Habitat Restoration

Research Interests

Identification and definition of the processes that create and maintain riparian ecosystems.
Linkage between wildfire patterns and riparian processes.
Assessment of grazing management practices for the protection and enhancement of water quality and riparian ecosystems.

Accomplishments and Interests

Established existence of linkage between forest structure and groundwater recharge of riparian areas..
Description of the interaction between stream bank stability and livestock grazing.
Identified the response of certain sedges and willows to grazing.
Identified the relationship between groundwater levels, soil texture and certain sedge, willow and cottonwood community types.
Continued refinement of bison landform and foraging preferences.

Graduate Students (since 2000)

2000
Sonja N. Skovlin
MS Degree: Range Science

2003
Robert Finck
MS Degree: Range Science

2004
Chris Wood
MS Degree: Range Science

2005
Travis Miller
MS Degree: Range Science

2007:
Ronald Tucker, Jr.
MS Degree: Range Science

2008
Daniel Durham
MS Degree: Range Science

2009
Sarah Summerford
MS Degree: Range Science

2011
Kimberly Haile
MS Degree: Range Science

Charles Sloane
MS Degree: Range Science

2012
Glenn Owings
MS Degree: Range Science

Present
Jacob Anderson
MS Candidate

Neto Garcia
MS Candidate

Publications (since 2000)

2000

Law, D.J., C.B. Marlow, J.C. Mosley, S. Custer, P. Hook and B. Leinard. 2000. Water table dynamics and soil texture of three riparian plant communities. Northwest Sci. 74(3):234-241.

2002
Manoukian, M. and C.B. Marlow. 2002. Historical trends in willow cover along streams in a southwestern Montana cattle allotment. Northwest Sci. 76(3):213-220.

2006
Marlow, C.B., R. Finck and H. Sherwood. 2006. Grazed stubble heights as a criterion for controlling sediment production from grazing lands. J. Amer. Water Resources. 42(4):891-900.

2007
Hatfield, P.G., S.L. Blodgett, T.M. Spezzano, H.B. Goosey, A.W. Lenssen, R.W. Kott, and C.B. Marlow. 2007. Incorporating sheep into dryland grain production systems: I. Impact on over-wintering larva populations of Wheat stem sawfly, *Cephus cintus* Norton, (Hymenoptera: Cephidae). Small Rum. Res. 67:209-215.
Hatfield, P.G., S.L. Blodgett, T.M. Spezzano, H.B. Goosey, A.W. Lenssen, R.W. Kott, and C.B. Marlow. 2007. Incorporating sheep into dryland grain production systems: II. Impact on changes in biomass and weed frequency. Small Rum. Res. 67:216-221.
Hatfield, P.G., S.L. Blodgett, T.M. Spezzano, H.B. Goosey, A.W. Lenssen, R.W. Kott, and C.B. Marlow. 2007. Incorporating sheep into dryland grain production systems: III. Impact on changes in soil bulk density and soil nutrient profiles. Small Rum. Res. 67:222-231.

Dr. Shannon John J. Moreaux, DVM

Assistant Professor - Equine Science
109 Animal Bioscience Building; MSU-Bozeman
Bozeman, MT 59717
Phone: (406) 994-7689
Cell Phone: (406) 579-3997
Fax: (406)994-5589
Email: moreaux@montana.edu

Education
Doctor of Veterinary Medicine, Oklahoma State University

Classes
EQUS 100 Introduction to Animal Science (Team Instructor)
EQUS 233 Equine Science and Management
EQUS 327 Equine Lameness
ARNR 337 Diseases of Domestic Livestock
EQUS 347 Equine Form to Function
EQUS 346 Equine Reproduction

Research Interests

Major research is focused on equine nutrition, metabolism and metabolic disease. Other research at this time includes epidemiologic surveillance of regional infectious diseases and equine facilitated therapy.

Other

Advisor: Montana State University Horseman's Club
Director: Youth Horsemanship School
Director: MSU Extension Annual Equine Conference
Board Member: Montana Horse Council
Instructor: American Association of Equine Practitioners Veterinary-Farrier Short Courses

Accomplishments

Invited Speaker
Australasian Equine Science Society Meeting
American Farriers Association
BIVI Equine Industry Leadership Award

Graduate Students

2010
Jyme Peterson
MS Degree: Animal Science

Present
Paula Helmecke
MS Candidate

Jaclyn Rohrs
MS Candidate

Publications

2009
McElwee, M., S. Griffith, J. Mediavilla, B. Krelswirth, J. Voyich, and S. Moreaux. 2009. Characterization of Staphylococcus aureus in horses and horse personnel in Southwest Montana. J. Equine Vet. Sci. 29:490. (Abstr.)
Peterson, J. L., S. J. Moreaux, J.G.P. Bowman, P. G. Hatfield, J. G. Berardinelli, and J. Olsen. 2009. Metabolic and physical effects of psyllium supplementation on Quarter Horses. Proc. West. Sec. Am. Soc. Anim. Sci. 60:176-179.
Peterson, J. L., S. J. Moreaux, J.G.P. Bowman, P. G. Hatfield, J. Olsen, and J. Berardinelli. 2009. Effects of psyllium supplementation on blood glucose, blood insulin and physical characteristics in Quarter Horses. J. Equine Vet. Sci. 29:357. (Abstr.)
Moreaux SJ, Peterson JL. Psyllium Lowers Blood Glucose and Insulin Concentration In Horses. Proc. Australasian Equine Science Symposium

McElwee M, Moreaux S, Voyich J, Griffith S, Mediavilla J, Kreiswirth B, Staphylococcus aureus in Horses and Horse Personnel in Southwest Montana. Submitted: Journal of Equine Veterinary Science.
Moreaux SJ, Peterson JL, Bowman JGP, Hatfield PG. Psyllium Lowers Blood Glucose and Insulin Concentration in Horses. Accepted for publication, Journal of Equine Veterinary Science.

2010
Moreaux SJJ, Nichols JL, Bowman JGP, Hatfield JGP. 2010 Psyllium lowers blood glucose and insulin concentrations in horses. J Equine Vet Sci 2011; 31: 160-165.

2011
J. I. Keithly, R. W. Kott, J. G. Berardinelli, S. Moreaux, and P. G. Hatfield. Thermogenesis, blood metabolites and hormones, and growth of lambs born to ewes supplemented with algae-derived docosahexaenoic acid. J ANIM SCI December 2011 89:4305-4313; doi:10.2527/jas.2010-3391.

Dr. Jeffrey C. Mosley

Professor, Extension Range Management Specialist
Department of Animal & Range Sciences
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Fax: (406) 994-5589
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Education
B.S. in Agriculture-Range Science, Montana State University, 1981
M.S. in Range Resources, University of Idaho, 1983
Ph.D. in Range Science, Texas Tech University, 1987

Research Interests
Livestock Grazing Relationships with Fish and Wildlife
Targeted Livestock Grazing
Invasive Plants
Foraging Behavior of Livestock and Wildlife
Wildlife Habitat Management

Honors and Awards
Past President, Society for Range Management
Fellow Society of Range Management
Western Extension Directors' Association Award of Excellence
State Visionary Leadership Award, Montana State University Extension
Past President, International Mountain Section-Society for Range Management
Past President, Range Science Education Council

Outstanding Undergraduate Teaching Award, Society for Range Management and Range Science Education Council
Top Hand Award (Range Manager of the Year), Idaho Section-Society for Range Management
Outstanding Academic Advisor Award, College of Forestry, Wildlife and Range Sciences, University of Idaho
Teaching Appreciation Award, Natural Resources Student Association, University of Arizona

Graduate Students (since 2000)

2000
B. Ross Macdonald
MS Degree: Range Science

2002
Tracy Brewer
MS Degree: Range Science

2005
Brian Thrift
MS Degree: Range Science

2007
Tanya Thrift
MS Degree: Range Science

2008
Katie Benzel
MS Degree: Range Science

Ashley Beyer
MS Degree: Range Science

Joshua Bilbao
MS Degree: Range Science

Stacee Henderson
MS Degree: Range Science

Publications (since 2000)

2000
Hansen, K.V., and J.C. Mosley. 2000. Effects of roundups on behavior and reproduction of feral horses. J. Range Manage. 53:479-482.
Law, D.J., C.B. Marlow, J.C. Mosley, S. Custer, P. Hook and B. Leinard. 2000. Water table dynamics and soil texture of three riparian plant communities. Northwest Sci. 74(3):234-241.
Sowell, B.F., J.C. Mosley, and J.G.P. Bowman. 2000. Social behavior of grazing beef cattle: Implications for management. J. Anim. Sci. Available at: http://www.asas.org/jas/symposia/proceedings/0923.pdf.

2003
Crawford, J.A., R.A. Olson, N.E. West, J.C. Mosley, M.A. Schroeder, T.D. Whitson, R.F. Miller, M.A. Gregg, C.S. Boyd. 2003. Ecology and management of sage-grouse and sage-grouse habitat. J. Range Manage. 57:2-19

2006
Torstenson, W.L. F., J.C. Mosley, T.K. Brewer, M.W. Tess, and J.E. Knight. 2006. Elk, mule deer, and cattle foraging relationships on foothill and mountain rangeland. Range. Ecol. Manage. 59:80-87.

2007
Brewer, T.K., J.C. Mosley, D.L. Lucas, L.R. Schmidt. 2007. Bluebunch wheatgrass response to spring defoliation on foothill rangeland. Range. Ecol. Manage. 60:498-507.

2010
Durham,D.A. and C.B. Marlow. In Press. Aspen Response to Prescribed Under Managed Cattle Grazing and Low Elk Densities. Northwest Science
Durham, D.A. and C.B. Marlow. 2010. Aspen Response to Prescribed Fire under Managed Cattle Grazing and Low Elk Densities in Southwest Montana. Northwest Science. 84(2):141-151

2011
Sloane, C.E. and C.B. Marlow. 2011. Effects of Sugar Beet Pulp on Cheatgrass (Bromus tectorum) and Bluebunch Wheatgrass (Pseudoroegneria spicata) Growth Under Controlled Conditions. Submitted to Rangeland Ecology and Management

2012
Lesica, P. and C.B. Marlow. 2012. Values and Management of Montana's Green Ash Draws. MontGuide MT201114AG. Montana Cooperative Extension Service.
Marlow, C.B. and D.A. Anderson. 2012. Identification of Interflow Pathways and Potential Wetland Sites in the Kelly Hayfields, Grand Teton National Park. IN:Harlow, H.J. and M. Harlow. 2012. National Park Research Center. 34th Annual Report. University of Wyoming, Laramie, WY.

Dr. Bret E. Olson

Professor of Range Ecology
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Bozeman, MT 59717
Phone: (406) 994-3721
Fax: (406) 994-5589
Email: bolson@montana.edu

Education

B.A. University of California, Berkeley, Botany, 1977

M.S. University of California, Berkeley, Range Management, 1982
Ph.D. Utah State University, Range Ecology, 1987

Classes
NRSM 240 Natural Resource Ecology
NRSM 453 Habitat Inventory and Analysis
ARNR 541 Range Ecophysiology

Research Interests
Determine how livestock use the landscape on winter range.
Develop effective grazing recommendations for controlling noxious weeds

Accomplishments and Interests
Assessed cattle use patterns on winter range to identify how to minimize weight loss
Identified effects of sheep grazing on two noxious weeds in Montana, using several approaches from basic plant biology to animal behavior and nutrition
Conducted a unique, long term study to assess effects of livestock grazing on grasshoppers, and cumulative effects of livestock grazing and grasshopper herbivory on plant communities
Used the stable ^{13}C isotope as a tracer to assess carbon allocation in plants, and used background levels of $^{13}C/^{12}C$ in plant tissues to indicate water use efficiency of leafy spurge and spotted knapweed and native grasses
Using ^{15}N isotope as a tracer to assess N uptake in spotted knapweed and native plants
Conduct studies and develop models that indicate the importance of solar radiation for the thermal balance beef cattle grazing winter rangeland

Graduate Students (since 2000)
2005
Ilai Keren
MS Degree: Range Science

2006
Melany Cheeseman
MS Degree: Range Science

2008
Benjamin Hileman
MS Degree: Range Science

2013
Katie Tierney
MS Candidate

Publications (since 2000)
2000

Olson, B.E., R.T. Wallander and J.A. Paterson. 2000. Do windbreaks minimize stress on cattle grazing foothill winter range? Can. J. Anim. Sci. 80:265-272.
Olson, B.E., R.T. Wallander and J.M. Beaver. 2000. Comparing nondestructive measures of forage structure and phytomass. Can. J. Plant Sci. 80:565-573.

2001
Olson, B.E. and R.T. Wallander. 2001. Sheep grazing of spotted knapweed and Idaho fescue. J. Range Manage. 54:25-30.

2002
Blicker, P.S., B.E. Olson and R. Engel. 2002. Traits of the invasive *Centaurea maculosa* and two nativegrasses: effect of N supply. Plant and Soil. 247:261-269.
Olson, B.E., and R.T. Wallander. 2002. Does ruminal retention time affect leafy spurge seed of varying maturity? J. Range Manage. 55:65-69.
Olson, B.E., and R.T. Wallander. 2002. Effects of invasive forb litter on seed germination, and seedling growth and survival. Basic and Applied Ecology. 3:309-317.

2003
Blicker, P.S., B.E. Olson and J.M. Wraith. 2003. Water use and water use efficiency of spotted knapweed and three native grasses. Plant and Soil 254:371-381.
Olson, B.E., and P.S. Blicker. 2003. Response of the invasive *Centaurea maculosa* and two native grasses to N-pulses. Plant and Soil. 254:457-467.
Olson, B.E., and R.T. Wallander. 2003. Comparing indicators of sheep grazing leafy spurge and perennial grasses. Sheep and Goat Res. J. 18:
O'Neill, K.M., B.E. Olson, M.G. Rolston, R.T. Wallander, D.P. Larson, and C.E. Seibert. 2003. Effects of livestock grazing on rangeland grasshopper (*Orthoptera: Acrididae*) abundance. Agriculture, Ecosystems and Environment. 97:51-64.
Sperber, T.D., J.M. Wraith and B.E. Olson. 2003. Soil physical properties associated with the invasive spotted knapweed and native grasses are similar. Plant and Soil. 252:241-249.

2004
Hook, P.B., B.E. Olson and J.M. Wraith. 2004. Effects of the invasive forb *Centaurea maculosa* on grassland carbon and nitrogen pools in Montana, USA. Ecosystems. 7:686-694.

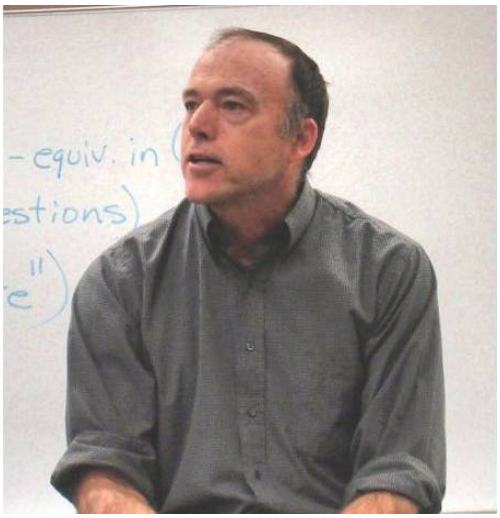
2005
Whitney, T.R., and B.E. Olson. 2005. Conditioning ewes and lambs to increase consumption of spotted knapweed. Appl. Anim. Behav. Sci.

2006
Hill, J.P., M.J. Germino, J.M. Wraith, B.E. Olson, and M.B. Swan. 2006. Advantages in water relations contribute to greater photosynthesis in *Centaurea maculosa* compared with established grasses. Intl. J. Plant Sci. 167:269-277.
Keren, I.N. and B.E. Olson. 2006. Thermal balance of cattle grazing winter range: model development. J. of Thermal Biol. 31:371-377.
Keren, I.N. and B.E. Olson. 2006. Thermal balance of cattle grazing winter range: model application. J. Anim. Sci. 84:1238-1247.

Whitney, T.R., and B.E. Olson. 2006. Conditioning ewes and lambs to increase consumption of spotted knapweed. Appl. Anim. Behav. Sci. 100:193-206.

2007
Keren, E.N. and B.E. Olson. 2007. Applying thermal imaging software to cattle grazing winter range. J. Thermal Biol. 32:204-211.
Whitney, T.R., and B.E. Olson. 2007. Will molasses or conditioning increase consumption of spotted knapweed by sheep? Range Ecol. Manage. 60:533-537.

Dr. Bok Sowell



Professor, Range Science
205 Animal Bioscience Building
Bozeman, MT 59717-2900
Phone: (406) 994-5558
Fax: (406) 994-5589
Email: bok@montana.edu

Education

B.S. New Mexico State University, Wildlife Science, 1978
M.S. Texas Tech University, Range Science, 1981
Ph.D. New Mexico State University, Animal Science, 1989

Classes

NRSM 101 Natural Resource Conservation
NRSM 102 Principles of Range Management Lab
NRSM 353 Grazing Ecology
WILD 325 Wildlife-Livestock Range Nutrition
ARNR 507 Research Methods
ARNR 544 Advanced Grazing Management and Ecology

Research Interest

Wildlife habitat
Ungulate herbivory
Wildlife/Livestock nutrition
Nutritional ecology of ruminants

Teaching Awards

2004 President's Excellence in Teaching Award. Montana State University
2001 Distinguished Teacher Award. Western Section American Society of Animal Science
2001 Award of Excellence. MSU Alumni/Chamber of Commerce
2000 Professor of the Month. Mortar Board. Montana State University
1998 College of Agriculture: Top Ten Instructor Award. Montana State University
1998 Who's Who Among Americas' Teachers
1998 Phi Kappa Phi-Anna Kruser Fridley Teaching Award. Montana State University

Graduate Students (since 2000)

2001
Nancy Taylor
MS Degree: Animal Science

2002
Carolyn Johnson
MS Degree: Range Science

2004
Janel Johnson
MS Degree: Range Science

2005
Vanessa Lane
MS Degree: Range Science

2007
David Kimble
MS Degree: Range Science

Samuel McColley
MS Degree: Range Science

Baigalmaa Purevsuren
MS Degree: Range Science

2008
Krystle Wengreen
MS Degree: Range Science

2010
Karen Kitchen
MS Degree: Range Science

Brittany Mendelsohn
MS Degree: Range Science

2012
Erin Thais Riley
MS Degree: Range Science

2013
Tucker Porter
MS Degree

Molly Runyon
MS Degree

Publications (since 2000)

2000
Daniels, T.K., J.G.P. Bowman, B.F. Sowell, M.E. Branine, and M.E. Hubbert. 2000. Effects of metaphylactic antibiotics on behavior of feedlot calves. Prof. Anim. Scientist. 16:278-285.
Hamadeh, S.K., P.G. Hatfield, R.W. Kott, B.L. Robinson, and B.F. Sowell. 2000. Effects of breed, sex, birth type and colostrum intake on body temperature of new born lambs subjected to cold stress. Sheep and Goat Res. J. 16:46.
Sowell, B.F., J.C. Mosley, and J.G.P. Bowman. 2000. Social behavior of grazing beef cattle: Implications for management. J. Anim. Sci. Available at: http://www.asas.org/jas/symposia/proceedings/0923.pdf.
Winslow, S.R. and B.F. Sowell. 2000. Technical note: a comparison of methods to determine plant successional stages. J. Range Manage. 53:194-198.

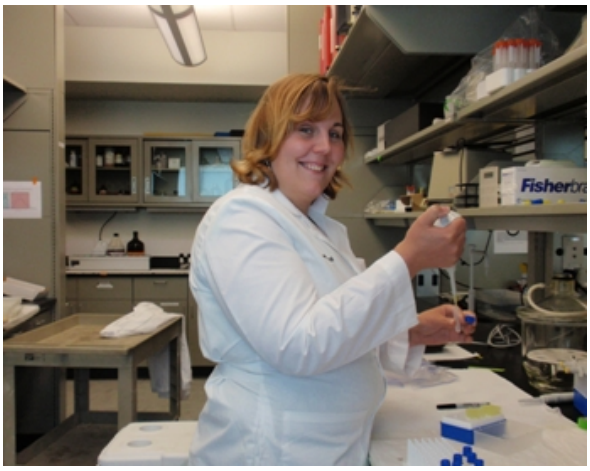
2001
Quimby, W.F., B.F. Sowell, J.G.P. Bowman, M.E. Branine, M.E. Hubbert, and H.W. Sherwood. 2001. Application of cumulative sums to predict morbidity of newly received calves in a commercial feedlot. Can. J. Anim. Sci 81:315-320.
Frisina, M.R., C.L. Wambolt, B.F. Sowell, S.J. Knapp, M. Sullivan, and C. Johnson. 2001. A balancing act: sagebrush-sage grouse-prairie dogs. Rangelands. 23:17-19.

2002
Eneboe, E., B.F. Sowell, R. Heitschmidt, M. Hafercamp, and S. Karl. 2002. Drought and Grazing VI. Effects on blue grama and western wheatgrass tiller dynamics. J. Range Manage. 55:73-79.
Taylor, N., P.G. Hatfield, B.F. Sowell, and G.S. Lewis. 2002. Influence of supplement form on ewe performance and reproduction. Sheep and Goat Res. J. 17:52.
Taylor, N., P.G. Hatfield, B.F. Sowell, J.G.P. Bowman, J.S. Drouillard, and D.V. Dhuyvetter. 2002. Pellet and block supplements for grazing ewes. Anim. Feed Sci. Technol. 96:193-201.

2003
Bowman, J.G.P. and B.F. Sowell. 2003. Technology to complement forage-based beef production systems in the West. J. Anim. Sci. 81(E. Suppl. 1):E18-E26.
Sowell, B.F., J.G.P. Bowman, E.E. Grings, and M.D. MacNeil. 2003. Liquid supplement and forage intake by range beef cows. J. Anim. Sci. 81:294-303.

2004
Bowman, J.G.P., B.F. Sowell, L.M.M. Surber and T.K. Daniels. 2004. Nonstructural carbohydrate supplementation of yearling heifers and range beef cows. J. Anim.Sci. 82.2724-2733.
Gibbs, M.C., J.A. Jenks, C.S. Deperno, B.F. Sowell and K.J. Jenkins. 2004. Cervid forage utilization in noncommercially thinned ponderosa pine forests. J. Range Manage. 57:435-441.
Johnson-Nistler, C.M., B.F. Sowell, H. Sherwood and C.L. Wambolt. 2004. Black tailed prairie dog effects on Montana's mixed grass prairie. J. Range Manage. 57:641-648.
Vermeire, L.T., R.K. Heitschmidt. P.S. Johnson and B.F. Sowell. 2004. The Prairie Dog Story: Do We Have It Right? BioScience 54(7):689-695.

Dr. Jennifer Thomson



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Fax: (406) 994-5589
Email: jennifer.thomson@montana.edu

Education

Postdoctoral training, Livestock Gentec Centre, University of Alberta, 2012
Postdoctoral training, USDA Bovine Functional Genomics Laboratory & University of Maryland, 2008
Ph.D. Washington State University, Animal Science, 2007
M.S. Oregon State University, Animal Science, 2003
B.Sc. Oregon State University, Animal Science, 2001

Classes

ANSC 322 Principles of Animal Breeding & Genetics
ARNR 524 Advanced Animal Breeding
ARNR 507 Research Methods

Research Interests

Nutrigenomics: the interaction between nutrients and gene expression and the contribution of this interaction to variation in economically important traits such as growth, milk production, feed efficiency, and reproduction
Systems biology approach to understanding physiology underlying complex traits in cattle such as feed efficiency, production, immune response, and reproduction
Integration of –omics data with traditional metabolism to improve understanding and to create next generation models of growth and production

Graduate Students

Present
Kate Perz
PhD Candidate

Publications

2012
Sumner-Thomson, J., V. Bowles, J. Choi, U. Basu, P. Stothard, S. Moore. 2012. The Identification of Candidate Genes and Candidate Gene Structural Variation for Bovine Spongiform Encephalopathy. J. Anim. Sci. Vol. 90, Suppl. 3/J. Dairy Sci. Vol. 95, Suppl. 2
Karisa, B. K., J. Thomson, Z. Wang, P. Stothard, S. Moore and G. Plastow. 2013. Candidate genes and polymorphisms associated with variation in Residual Feed Intake in beef cattle. Manuscript in review with J. Anim Sci
Baldwin VI, R. L., R.W. Li, C. Li, J. Sumner-Thomson, B. Bequette. 2012. Characterization of longissimus lumborum transcriptome response to sodium propionate feeding in growing Angus beef steers. Physiological Genomics 44:543-550
Karisa, B. K., J. Thomson, E. Zewoldi. Z. Wang, H. Bruce, G. Plastow, S. Moore. 2013. Candidate genes associated with carcass quality traits in beef cattle and their effects on residual feed intake. Manuscript in review with C. Journal Anim Sci.
Sumner-Thomson, J., V. Bowles, J. Choi, U. Basu, P. Stothard, S. Moore. 2012. The Identification of Candidate Genes and Candidate Gene Structural Variation for Bovine Spongiform Encephalopathy. Prion 1;6(5):461-9
Sumner-Thomson, J U. Basu, Y. Meng, P. Stothard, S. S. Moore. 2012. Generation of mRNA transciptome atlas in the Bovine. . J. Anim. Sci. Vol. 90, Suppl. 3/J. Dairy Sci. Vol. 95, Suppl. 2
J. M. Thomson, P. Stothard, J. P. McNamara. 2012. Comparison of the transcriptome profile of pooled tissue mRNA reveals differences in gene expression between beef and dairy adipose. Submitted and accepted for presentation at 2013 Meeting of International Society of Energy and Protein Metabolism.

Dr. Carl Yeoman

Assistant Professor, Rumen/Gastrointestinal Microbiology
321 Animal Bioscience Building
Montana State University
P.O. Box 172900
Bozeman, MT 59717-2900
Phone: (406) 994-7440
Fax: (406) 994-5589
Email: carl.yeoman@montana.edu

Education

B.S. Massey University, Microbiology and Genetics, 2003
Ph.D. Massey University, Palmerston North, Microbial Genomics, 2009

Classes

ARNR 520 Advanced Ruminant Nutrition
BIOM405 Host-Associated Microbial Ecosystems (Approved for teaching this fall)

Research Interests

My research exploits molecular techniques to examine the microbial ecology associated with animal systems. My specific focus is on the microbial ecosystems of the gut and their role in health, nutrition and performance and those occupying the vaginal tract and their relation to reproductive performance. I believe that microbial ecosystems have an evolved ecology principally governed by their symbioses, as is evident in many systems. Obtaining a system-wide understanding of these relationships is fundamental to improving livestock, their interactions with the environment and the health of producers and consumers.

Graduate Students

Present
Jeffery Swartz; MS Degree
Medora Lachman, MS Degree
Laura Brutscher; Ph.D Degree (Microbiology - current)

Publications

Yeoman CJ, Chia N, Jeraldo N, Sipos M, Goldenfeld ND, White BA. (2012) The microbiome of the chicken gastrointestinal tract. Anim. Health Res. Rev. 13:89-99.

Schachtschneider KM, **Yeoman CJ**, White BA, Schook LB, Pieters M. (2013) Modulation of Systemic Immune Responses Through Commensal Gastrointestinal Microbiota. PLoS One 8(1): e53969.

K.R. Amato, **C.J. Yeoman**, A. Kent, N. Righini, F. Carbonero, A. Estrada, H.R. Gaskins, R.M. Stumpf, S. Yildirim, M. Torralba, M. Gillis, B.A. Wilson, K.E. Nelson, B.A. White, S.R. Leigh. (2013) Habitat degradation impacts black Howler monkey (*Alouatta pigra*) gastrointestinal microbiomes. ISME J. 7(7): 1344-1353.

C.J. Yeoman, S.M. Thomas, M.E. Berg Miller, A.V. Ulanov, M. Torralba, S. Lucas, M. Gillis, M. Cregger, A. Gomez, M. Ho, S. Leigh, R. Stumpf, D.J. Creedon, M.A. Smith, J.S. Weisbaum, K.E. Nelson, B.A. Wilson, B.A. White. (2013) A multi-omic systems-based approach reveals metabolic markers of bacterial vaginosis and insight into the disease. PLoS One. 8(2) e56111

Vodovnik M, Duncan SH, Reid MD, Cantlay L, Turner K, Parkhill J, Lamed R, **Yeoman CJ**, Miller ME, White BA, Bayer EA, Marinšek-Logar R, Flint HJ. (2013) Expression of cellulosome components and type IV pilli within the extracellular proteome of *Ruminococcus flavefaciens* 007. PLoS One 8(6): e65333

Xie, G., G. C. Duff, L. W. Hall, J. D. Allen, C. D. Burrows, J. C.Bernal-Rigoli, S. E. Dowd, V. Guerriero, and **C. J. Yeoman**. 2013. Alteration of digestive tract microbiome in neo-natal Holstein bull calves by bacitracin methylene diasalicylate treatment and scours. J. Anim. Sci. (Accepted).