at 140.0 ± 3.55 breaths per minute (bpm) compared with TN at 74.9 ± 3.55 bpm. The HOT group had a greater ($P < 0.05$) TRUM (40.4 ± 0.03°C) than the TN group (39.9 ± 0.04°C). ALP ($P = 0.0003$), GGT ($P = 0.0158$) and IL-1β ($P < 0.05$) were all lower in the HOT sheep. Creatinine concentration ($P = 0.0038$) and CK ($P > 0.05$) were higher in the HOT sheep. LPS concentration was greater ($P < 0.05$) in HOT compared with TN. The remaining parameters were not affected ($P > 0.05$) by treatment. Elevated CK, creatinine and TRUM suggest that the HOT sheep were heat stressed. There is some evidence pointing to impaired immune status. However, the data is equivocal, and in some cases confounding (e.g., greater IL-1β expression in TN, but greater LPS in HOT).

Key Words: sheep, heat stress, blood parameters

1286 Stocking rates and parasite load in yearling steers grazed season long in the Northern Great Plains.

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Intestinal parasitism of grazing ruminants can result in poor performance and compromised systems, especially in younger animals. Twelve pastures (12.9 ± 0.8 ha) were stocked at four stocking rates: light 1.83 ± 0.38 AUM · ha^{-1}, moderate 3.26 ± 0.30 AUM· ha^{-1}, heavy 4.98 ± 0.78 AUM · ha^{-1}, and extreme 6.18 ± 0.68 AUM · ha^{-1}. Yearling steers (317 ± 32 kg) were grazed on the pastures from mid-May to mid-September, 2015. Before turnout, the steers were dewormed with an injectable dewormer, as well as implanted with Revalor GTM to maximize live weight gains. The steers were also supplemented with dry distillers grains with solubles at 0.3% of body weight. Steers were weighed monthly during which time fecal grab samples were collected. Results demonstrated that initially the worming treatment before turnout proved effective in the early part of the grazing season as there was no difference ($P > 0.05$) among treatments in egg counts per gram (epg) in June, with corresponding low epg. However, a significant difference ($P < 0.05$) in epg was detected between the light and extreme treatment groups in July, with low levels in the light treatment, and higher levels in the extreme treatment. Egg counts over 35 epg, which has been proved as a performance threshold in grazing yearling cattle, were noted in individual animals on all treatments except the lightly grazed treatment in August and September. This study demonstrates an association between high stocking rates and increases in detectable parasite load, and supports the conclusion that individual yearling cattle that are susceptible to parasitism may be negatively impacted by season long systems that are stocked from moderate to extreme levels in the northern Great Plains.

Key Words: parasitism, northern Great Plains, yearling cattle, season long grazing

PRODUCTION, MANAGEMENT AND THE ENVIRONMENT SYMPOSIUM: IMPACTS OF LIVESTOCK PRODUCTION ON ENVIRONMENTAL REACTIVE NITROGEN

1287 The world's nitrogen cycle and human impacts.

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Perhaps 40% of the people alive today are sustained from increased grain yields attributed to the use of synthetic nitrogen fertilizer. While the Haber-Bosch process of converting atmospheric nitrogen to ammonia (i.e., fertilizer) has transformed agricultural production, it has also caused an unprecedented shift in the global nitrogen balance. Despite many improvements in nitrogen use efficiency in both crop and livestock systems, a large fraction of agricultural nitrogen inputs are lost to the environment. This "fugitive" nitrogen is causing a host of environmental problems at local and global scales. Excess nitrogen has been shown to alter biogeochemical processes and ecosystem function across the globe. Because nitrogen can be easily transported in water or air through natural processes, or by the transport of grain and livestock; the impacts of agriculture nitrogen are often observed far from where the nitrogen was initially used. A good example of this process is the observed increases in the atmospheric deposition of reactive nitrogen across many areas, including many pristine ecosystems. Nitrogen deposition is often linked to ammonia-derived aerosols, compounds that can travel hundreds of kilometers from the source before being redeposited back to the surface. Because livestock account for over 50% of all ammonia emissions in many regions; beef feedlots, dairies, and swine and poultry operations are often linked to this air quality issue. While there is no question that livestock ammonia emissions are large, quantifying the actual impact of reactive nitrogen on the environment is a complex question. One must consider atmospheric transport at both local and regional scales, chemical reactions with pollutants from other industries, and other non -livestock sources and forms of nitrogen. Perhaps nowhere has this issue been more investigated than along the Front Range of Colorado, where a mature cattle feeding industry is located relatively close to the pristine ecosystems in Rocky Mountain National park. This presentation will begin with the role of livestock in the global and U.S. nitrogen cycle, and then narrow the scope to specific issues facing livestock producers in Colorado regarding atmospheric ammonia. Summary comments will suggest how animal scientists and industry leaders might respond to these growing concerns.

Key Words: Colorado producers, atmospheric ammonia, nitrogen

1288 Reactive N emissions from beef cattle feedlots.

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Large amounts of nitrogen (N) are fed to meet the nutritional needs of beef cattle in feedlots. However, only from 10 to 15% of fed N is retained in animals. Most N is excreted. Chemical and biological processes transform manure N into ammonia (NH_3), nitrous oxide (N_2O) and nitrate (NO_3^-). These reactive forms of N (N_r) are those most readily lost into the environment. Our objectives are to outline the forms and impacts of N_r lost from beef feedlots, present patterns and magnitudes of emissions, and examine ways to mitigate emissions. We will focus on NH_3, the major form of $N_r$emitted from beef feedlots. Fugitive NH_3 is a precursor to particulates in the atmosphere that cause air quality problems or overburden N-sensitive terrestrial ecosystems and initiate species changes and loss of diversity. Reactive N contributes to the eutrophication of surface waters and the creation of hypoxic zones in the Gulf of Mexico. Nitrous oxide is a greenhouse gas with almost 300 times the global warming potential of carbon dioxide (CO_2). Stringent regulations to control runoff have virtually eliminated NO_3^- as a source of N_r from beef feedlots. Direct N_2O emissions from beef cattle production are only about 0.1% of the national greenhouse gas inventory of CO_2–equivalent emissions. However, animal agriculture is the major source of U.S. NH_3 emissions (81%), and beef cattle production contributes about 15% to the total national NH_3 emissions. Research on NH_3 emissions has matured to where we have a good understanding of the pattern and magnitude of emissions. Ammonia volatilization depends on temperature, reflected in the daily and annual patterns of emission, with peak emissions during the warmest time periods. The magnitude of NH_3–N emissions is consistent across the cattle-feeding region from Texas to Nebraska. Reported winter emissions range from 25 to 35% of fed N, while summer emissions range from 50 to 75% of fed N. Research on multiple scales shows that crude protein content of diets is a critical driver of emissions. Diets that meet NRC guidelines for crude protein lose about 50% of fed N as NH_3–N. Diets with byproducts like distillers grains often exceed recommendations, with increases in NH_3 emissions from 25 to 50%. Several technologies offer promises of NH_3 emission mitigation, but most are expensive and hard to apply. Carefully managed cattle diets remain the most effective and practical way to limit the loss of NH_3 from beef feedlots.

Key Words: nitrogen

1289 Reactive nitrogen losses from dairy production systems.

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Reactive nitrogen (N_r) losses from dairy production vary depending on housing type, manure storage system, and manure land application practices. To illustrate on farm N_r losses, we compared 3 systems: a dry-lot in ID with 213 lactating and 137 young cattle, a free-stall operation in NY with 1,261 lactating and 925 young cattle, and a free-stall and grazing operation in the Netherlands (De Marke) with 78 lactating and 57 young cattle. The De Marke farm was designed to reduce N_r losses through an efficient feeding program, barn flooring to reduce ammonia (NH_3) losses, enclosed manure storage, injection of manure on cropland and the use of cover crops. Farms were modeled using the Integrated Farm System Model (IFSM) to estimate N_r losses and evaluate effects of mitigation strategies on the ID and NY dairies. Total estimated Nr losses ranged from 5,727 to 139,455 kg N yr^{-1} and comprised 34%, 46% and 50% of imported N from the ID, NY, and De Marke dairies, respectively. The N_r lost per animal equivalent (AE) was 121, 98, and 65 kg N AE^{-1} for the ID, NY, and De Marke dairies, respectively. The N_r losses differed between production systems with 80% of N_r lost as NH_3 (63% from housing) on the ID dairy, while the NY dairy lost 49% of N_r as NH_3 (52% land application of manures) and 46% due to leaching from crop fields. On the De Marke dairy the majority of N_r loss was due to leaching from crop fields and pasture comprising 52% of total N_r lost. To mitigate N_r losses at the ID dairy, strategies targeted the housing sector by feeding a balanced ration that reduced overall dietary CP, reducing housing emissions by 10 kg AE^{-1}along with a 1 kg AE^{-1}reduction from manure storage. Immediate incorporation of land applied manure decreased N_r losses by 1.7 kg AE^{-1}. These combined practices led to a 12.5% reduction in total N_r lost. A reduction in dietary CP on the NY dairy coupled with covering the lagoon reduced N_r losses from housing and manure management combined by 5.4 kg AE^{-1}, while immediate incorporation of land applied manure reduced field losses by 7.8 kg AE^{-1}. These practices combined reduced total farm N_r loss by 27%. While Nr losses from dairy production can be large, mitigation strategies are available, however they must be targeted to address issues within each production system individually to ensure system-wide reductions.

Key Words: nitrogen, dairy production, environment

1290 Reactive N emissions from crops and pastures.
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1291 Measurement and mitigation of reactive nitrogen species from swine and poultry production facilities. W. Powers* and M. Capelari, *Michigan State University, East Lansing.*

Reactive nitrogen (Nr) species include oxides of nitrogen (nitric oxide, nitrogen dioxide and nitrous oxide [N_2O]), anions (nitrate and nitrite) and amine derivatives (ammonia [NH_3], ammonium salts and urea). Of the different Nr species, air emissions from swine and poultry facilities are dominantly NH_3 followed by N_2O. Excreta emissions are NH_3, ammonium ions, and urea with trace amounts of nitrate and nitrite. Farm systems and practices that handle manure as a wet product without pH modification favor almost exclusive NH_3 production while systems and practices associated with dry manure handling and bedded systems emit more NH_3 and result in greater N_2O production than that produced in wet systems. Results from a turkey grow-out study estimated that just under 1% of consumed nitrogen was emitted as N_2O from housing, compared to just under 11% emitted as NH_3. Despite generally lower N_2O emissions from animal housing compared to crop field emissions, N_2O emissions from housing are greater than often estimated. Lagoon systems emit more N_2O than either slurry or deep pit swine systems. Deep pit swine buildings emit as much as two-thirds less N_2O than deep bedded swine systems and laying hen, broiler chicken and turkey buildings emit over 4 times as much N_2O as swine housing, on an animal unit basis. Critical control points for mitigation center on 1) reducing the amount of nitrogen excreted and therefore excreted nitrogen available for loss to air or water during housing, manure storage or following land application of manures, 2) capturing excreted nitrogen to prevent release of nitrogen-containing compounds to air, water or soil resources or 3) conversion/treatment of nitrogen-containing compounds to non-reactive nitrogen gas.

Key Words: air emissions, poultry, swine

1292 Modeling atmospheric reactive nitrogen.
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Nitrogen is an essential building block of all proteins and thus an essential nutrient for all life. Reactive nitrogen, which is naturally produced via enzymatic reactions, forest fires and lightning, is continually recycled and cascades through air, water, and soil media. Human activity has perturbed this cycle through the combustion of fossil fuels and synthesis of fertilizers. The anthropogenic contribution to this cycle is now larger than natural sources in the United States and globally. Until recently, little progress has been made in modeling of the nitrogen cycle in the environment due to the complexity of and uncertainty in its transport and transformation between soil, water and atmospheric media. The lack of understanding of these multimedia transport processes is due to the typical focus of research on specific media and the difficulty in parameterizing the human dimension of anthropogenically fixed reduced nitrogen and input into the environment, primarily through mineral fertilizer application to crops, the largest source of environmental reactive nitrogen. Here we will focus on modeling of the atmospheric component of the nitrogen cascade, with an emphasis on ammonia, emerging measurement techniques, and the potential for model improvements using emerging measurements, existing networks and modeling. The USEPA's Community Mulitscale Air Quality (CMAQ) model will be evaluated against observational trends in nitrogen deposition and ambient air quality from 2002 to 2012 and the sensitivity of CMAQ to NH_3 emissions will be explored. These findings will be presented with an emphasis on how the sensitivity of the modeling system to animal husbandry emissions and how the representation of these emissions can be improved.

Key Words: nitrogen cycle, emissions, environment

BIG DATA IN ANIMAL SCIENCE: USES FOR MODELS, STATISTICS AND META-APPROACHES

1293 Modeling in animal science: an introduction to quantitative understanding and prediction.
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In animal science, continuous advances in technology, computing, and engineering result in the generation of data at a rapidly increasing rate. Mathematical models enable quantitative analysis and integration of data to study the behavior and complexity of biological systems. This review highlights several aspects of modeling in the context of understanding, predicting and modifying complex processes in farm animal systems, and offers a current perspective for animal scientists without requiring specialized knowledge of mathematics or bioinformatics. A mathematical model is an equation or set of equations which represents the behavior of a system, and can be viewed as an idea, hypothesis or relation expressed in mathematics. In animal science, the system may range from the molecules in cells up to herd or flock level, with any level of the system being composed of subsystems lying at a lower