Production, Management and the Environment Symposium: Environmental footprint of livestock production—Greenhouse gas emissions and climate change

818 Environmental footprint of livestock production: A global perspective. Frank M. Mitloehner*, *University of California, Davis, Davis, CA.*

Global livestock production is projected to double by 2050 and the majority of this growth will be occurring in the developing world. Much of the growth in the global livestock sector will occur in areas that are currently forested (i.e., parts of South America and South East Asia). It has been well established that significant reductions of carbon sequestering forests will have large effects on global climate change. Livestock production in most countries of the developed world (e.g., United States and Europe) has a relatively small greenhouse gas (GHG) contribution within the countries' overall carbon portfolios, dwarfed by large transportation, energy, and other industry sectors. In contrast, livestock production in the developing world can be a dominant contributor to a country's GHG portfolio, due to the developing world's significantly smaller transportation and energy sectors. The fact that land-use changes associated with livestock (i.e., forested land converted to pasture or cropland used for feed production) are a significant source of anthropogenic GHGs in Latin America and other parts of the developing world is apparent. The Food and Agriculture Organization attributes almost half of the climate-change impact associated with livestock to the change of land-use patterns. The United States and most other developed countries have not experienced significant land-use change practices around livestock production within the last few decades, sometimes centuries. Intensification of livestock production provides large opportunities for climate change mitigation and can reduce greenhouse gas emissions from deforestation, thus becoming a long-term solution to a more sustainable livestock production. Overall, growing demands for animal protein could strongly increase GHG emissions from agriculture. However, knowledge exists to improve efficiencies in livestock production, which dramatically reduces GHG per unit of production. What is called for is a sustainable intensification in animal agriculture, coupled with technology transfers from developed to developing countries, to supply a growing demand for animal protein using sustainable and modern production practices.

Key Words: environmental footprint, livestock

819 Environmental impact reduction strategies for pig farms. Richard Ulrich*[1], Greg Thoma[1], Jennie Popp[1], and Mark Hanigan[2], [1]*University of Arkansas, Fayetteville, AR,* [2]*Virginia Tech, Blacksburg, VA.*

The purpose of this project was to determine what design and operational factors have a significant influence with minimal cost on the GHG, water and land usage impacts of a pork production facility. The Pig Production Environmental Footprint Calculator provides a detailed comparison of impacts as a function of animal feed practices, manure treatment strategies, barn heating/cooling settings and additives. The model utilizes the NRC nutrition equations to estimate feed intake and manure production as a function of barn temperature, animal gender, immunocastration, ractopamine use, and crowding. The model's economic code calculates the dollars per kg of avoided equivalent carbon dioxide emissions. The results confirm that feed production and manure management are the leading causes of environmental impacts from pig farms but differential improvements can come from other areas. Decreasing treatment temperatures can lessen GHG emissions from manure systems through managing barn and tank conditions. Digesters can recover energy from produced methane while converting the methane to lower-impact carbon dioxide. Barn temperatures have an impact on animal feed intake and subsequent growth rates. Common feeds are evaluated for their environmental impacts per calorie or gram protein provided.

Key Words: environmental impact, modeling, pig farms

820 Quantifying greenhouse gas fluxes in animal production. Wendy Powers* and Matheus Capelari, *Michigan State University, East Lansing, MI.*

Direct and indirect sources of CO_2, CH_4, and N_2O emissions in animal production systems includes the animals, feed storage areas, manure deposition and storage areas, and feed and forage production fields. These 3 gases comprise the primary greenhouse gas (GHG) emissions from animal feeding operations. Each GHG may be more or less prominent from each emitting source. Similarly, species dictates importance of enteric CH_4 emissions. Measures of GHG flux from animals are often made using respiration chambers for measurement of concentration and flux, head boxes or halters allowing for measures of concentration directly and flux indirectly (tracer gas techniques), or in vitro gas production techniques. Concentration measures are made using gas chromatography, photoacoustic, open path Fourier transform infrared (FTIR) or non-dispersive infrared (NDIR) spectroscopy. The prominent methods for measuring GHG emissions from housing include tracer gas techniques (indirect ventilation measures) or direct ventilation measures, each coupled with concentration measures of gases of interest. Methods for collecting and measuring GHG emissions from manure storage and/or production lots include use of downwind concentration measures combined with modeling techniques, static chambers or flux hood methods. Similar methods can be deployed for determining GHG emissions from fields. Each method identified has its own benefits and challenges to use for the stated application. Considerations for use include intended goal, compatibility with production system, equipment investment and maintenance, frequency and duration of sampling needed to achieve desired representativeness of emissions over time, accuracy and precision of the method, and environmental influences on the method. In the absence of a perfect method for all situations, full knowledge of the advantages and disadvantages of each method is extremely important during the development of the experimental design and interpretation of results. Attributes of the various options for measuring GHG flux from different sources within a farming system will be discussed including methods to measure both concentration of gas and flux from the various emission sources.

Key Words: emissions, flux, greenhouse gas

821 Greenhouse gas emissions and nitrogen cycling from beef production systems: Effects of climate, season, production system, and diet. Galen E. Erickson*, Samodha C. Fernando, Terry J. Klopfenstein, Andrea K. Watson, James C. MacDonald, Anna C.

Pesta, Allison L. Knoell, and Henry Paz, *University of Nebraska-Lincoln, Lincoln, NE.*

Greenhouse gas (GHG) and nitrogen emissions from beef cattle production systems are receiving greater attention. Emissions of methane and nitrous oxide in grazing and confined feedlot systems are microbial-mediated, whether from the rumen (methane) or soil surfaces (methane and nitrous oxide). Additionally, emissions of ammonia are microbial-mediated as well as dependent on ammonium concentration. Factors that increase microbial activity, such as temperature and season, are positively correlated with emissions from soil surfaces, whereas enteric methane emissions are not affected by ambient temperature and therefore not affected by climate or season. Previous research illustrates that diet, season, and type of production system dramatically affect N emissions as ammonia. However, the effect of season, diet, and type of production system on nitrous oxide emissions from cattle production systems and soils are poorly understood. Additionally, methane emissions data from production systems are lacking and needed. Enteric methane emissions have received the greatest attention across a wide array of climates, season, and diets. Forage quality has been shown to have a large impact on methane emissions, with lower quality forage increasing methane per unit of energy intake. Likewise, feeding finishing diets results in less enteric methane per unit of energy intake compared with forages. However, both high quality forages, and finishing diets increase energy intake and thus absolute amount of methane produced per day. Expressing enteric emissions as amount per day will lead to different mitigation strategies compared with decreasing methane emissions per unit of energy intake or per unit of productive function (i.e., gain). Many benefits exist to utilize forages in beef production systems, thus converting existing forage-based systems to intensive (i.e., grain-based) beef production as a mitigation strategy for methane emissions is not logical. However, greater opportunity likely exists to mitigate methane emissions within forage-based production systems as compared with grain-based systems, which will require understanding microbial mediated processes to dramatically decrease enteric methane.

Key Words: emissions, methane, nitrogen

822 Forage utilization to mitigate greenhouse gas emissions by ruminants. Karen A. Beauchemin*, *Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB, Canada.*

Meat and dairy products account for almost half of food-generated greenhouse gases (GHG), and as global consumption of livestock products continues to grow there is pressure on the livestock industry to lower its emissions. Poultry, pig, dairy, and feedlot production rely on the use of grains and oilseeds, increasing the demand for limited resources. With continued expansion of livestock production to meet global demand for protein, ruminant production will need to increase its use of forages. Unlike pigs and poultry, ruminants can utilize cellulosic materials to produce high quality protein for human consumption. Furthermore, perennial forages, forage-cropping rotations, and well-managed grazing lands provide numerous environmental benefits. However, high-fiber diets increase enteric CH_4 emissions from ruminants, so increasing forage use by ruminants may at first seem counterproductive in terms of reducing GHG emissions. However, there is increasing knowledge of mitigation practices that lower CH_4 emissions from cattle. Some strategies are (1) technologies to reduce methanogenesis in the rumen (nitrate, inhibitors), (2) improving fiber digestibility (pre-treatment, genetic selection of forages, harvest management), and (3) targeted supplementation and management of animals to improve productivity. When examining the total GHG emissions from a system, all emissions and removals of CH_4, N_2O, and CO_2 on the farm and from purchased inputs must be considered using a life cycle approach. Forage-based ruminant systems tend to be relatively low input with less fossil fuel CO_2 emissions and fertilizer-based N_2O emissions than grain-based systems. Use of N-fixing legume forages further displaces the use of fertilizers. With grazing systems, the nutrient cycle is relatively closed with excreted nutrients returned directly to the land. Well managed grasslands subject to moderate grazing can augment soil carbon reserves. Such lands also provide many other ecosystem services including conservation of biodiversity, water quality, and wildlife habitat. Thus, continued development and adoption of mitigation strategies will allow ruminant production systems to rely more extensively on forages while lowering GHG emissions and providing enhanced ecosystem services.

Key Words: forage, methane, environmental sustainability