693 A practicum-based course in equine parturition for undergraduate students. P. L. Ryan*, D. L. Christiansen, R. M. Hopper, S. T. Willard, S. D. Bowers, T. W. Dickerson, and G. L. Olsen, *Mississippi State University, Mississippi State*.

The objective of this exercise was to develop a practicum-based pilot course to instruct undergraduate students interested in equine reproduction with specific emphasis on the pregnant mare, parturition and postnatal foal. The course was offered as a Special Topics in Animal Science, but open to students from across campus with an interest in the equine species. Forty three students enrolled (4 freshman, 10 sophomore, 8 junior and 21 senior) representing six majors. The course offered a weekly lecture and six nights of foal-watch duty for a total of two credit hours. Students worked in pairs, assisted with the birth process and performed the post-partum treatments of the foal. Students were required to maintain detailed records in the foal-watch log book of activities related to mare behavior, udder development, time of delivery, time from delivery to foal standing and suckling, and whether there were complications (i.e., dystocia). For credit, students had to complete six nights of duty, attend the weekly lecture and write a report on their experiences while on foal-watch duty. At the conclusion of the course, a course evaluation was conducted to assess student perceptions of the course as a whole. Evaluations were conducted on the basis of a 1 to 5 scale (1 = strongly disagree and 5 = strongly agree) and were analyzed to ascertain the value of lectures and the hands-on experience during foal-watch. Thirty six of the forty three students enrolled responded (83.7%). The course evaluation revealed that the students felt that the course was relevant to equine sciences (4.83±0.07), that lectures complimented the practicum exercises (foal-watch; 4.50±0.12), that they learned a lot from the course (4.17±0.17), and that what they learned would have useful application later in life (4.64±0.11). The students agreed that having more than one instructor team-teaching the course was good (4.28±0.14) and students disagreed that the different teaching styles were distracting (2.11±0.17). There was agreement (4.80±0.12) that the pilot course should be recommended to the university curriculum committee for development as a practicum-based course in the equine sciences.

Key Words: Undergraduate, Teaching, Equine Practicum

694 Withdrawn by author. , .

695 Dairy management symposium training: Instructive partnership between academia and industry. A. Ahmadzadeh* and M. A. McGuire, *University of Idaho, Moscow*.

The traditional educational mechanism cannot provide adequate interaction with industry professionals for up-to the-minute knowledge about dynamic changes within the dairy industry. The goal of the described educational activity was to provide complementary instruction in a senior level dairy management course to 1) enhance student knowledge and professional competencies for the progressive and challenging dairy industry and 2) to share knowledge and experience of institutional partners, producers, and allied industry experts. Through the semester, the team-taught course provided a foundation in dairy management. To achieve the goals, a mini-symposium occurred at the end of the semester. Experts in the field of dairy management provided intensive seminars pertinent to topics discussed throughout the semester. The symposium incorporated main aspects of dairy management in an interactive, educational, and enjoyable format. Presentations were based on **real case scenarios**. These mini-symposium was designed to apply not only to baccalaureate students in the course, but also to graduate students, veterinary students, and other interested faculty. However, participation in the symposium was mandatory for students taking the course. Students also had to provide a short report addressing three take home messages for each speaker. This complementary instructional program provides a dynamic collaborative environment with the latest in knowledge and technology practiced in the dairy industry wherein students can act, use tools and devices, collect and interpret information, and interact with others to create a functional linkage between present inputs and prior knowledge. This networking creates a **unique interactive learning environment** in which universities gain the opportunity to create a benchmark for improving their programs to suit the current dairy industry and consumer needs. A critical facet of this activity is the **cooperative partnership** and efforts toward defining the knowledge and experience necessary for effective dairy management.

Key Words: Interactive Learning, Cooperative Partnership, Allied Industry

696 Development of a distance education based food safety microbiology course in poultry science. R. S Hardin*, E. M Hirschler, M. M Kundinger, A. R Sams, and S. C Ricke, *Texas A&M University, College Station*.

With the increasing demand for food safety the responsibilities of food industry personnel has increased. More responsibility requires advanced training, which may not be readily available onsite. Distance education courses have become popular due to the increased number of commuter students as well as people already in the workforce who need more background on foodborne disease. In many cases the ability to physically attend a class at a university that offers such courses and academic expertise can be limited. Therefore a graduate level web based course entitled Special Topics-Poultry Food Safety Microbiology was developed from an existing senior undergraduate advanced food microbiology course in the Poultry Science Department at Texas A&M. Even though the use of the Internet as a teaching tool is becoming more prevalent, converting this course into a distance education course provides some unique challenges, to maintain comparable course content in an asynchronous manner. The overall objective for this course was to examine all aspects of foodborne bacterial activities including ecology in food, animals, raw and processed meat, eggs, and human pathogenesis. To create a graduate level learning experience for the students a research paper assignment was developed in order to provide a more in-depth learning opportunity of microbial pathogens. The writing process was completed through electronic submission of an outline, rough draft, and finally completing a fifteen-page scientific paper related to a food microbiology topic of interest. This instructional approach imparts an effective means for distance education students to extend an understanding of food microbiology.

Key Words: Food Safety, Distance Education, Poultry Science

Contemporary and Emerging Issues: Current and Future Prospects for Animal Nutrition Management for Environmental Impact Reduction

697 Use of mass balance techniques for nutrient excretion modeling. T. J. Applegate*[1] and R. Angel[2], [1]*Department of Animal Sciences, Purdue University,* [2]*Department of Animal and Avian Sciences, University of Maryland, College Park*.

In the absence of comprehensive biological data on total excreted nutrients, development of models is needed to predict these values for livestock species. Models are usually constructed based on relationships that have been determined biologically and allow for estimation of undetermined values. Estimation of nutrient excretion has become necessary due to the recent emphasis on environmental management and regulation of animal feeding operations. Because of the impact that new environmental regulations will have on animal production it is important to determine if model estimates are accurately predicting biological nutrient excretion rates. The majority of current models for estimation of nutrient excretion have largely been derived from a process-based modeling approach, an approach that utilizes known analyses of components (feed analyses, tissue deposition and/or growth, product nutrient composition, average apparent retention, etc.). This mass-balance modeling approach has inherent errors, including: extrapolation of data to other ages, lack of input data for different feeding programs, and unknown referenced inputs for up-to-date industry feeding practices and productivity. Nevertheless, the mass balance approach has been critical in identifying gaps in the existing literature. Models utilizing multivariate least-squares regression may be developed in the future, but knowledge

of the effects of independent variables is relatively unknown at this time for most livestock specie.

Key Words: Nutrient Management, Excretion Models, Mass Balance

698 Interactions between indigenous gut microbiota and animal waste production. J. A. Patterson* and A. L. Sutton, *Purdue University, West Lafayette, IN.*

The importance of the ruminal microbiota in altering the form of feed nutrients during ruminal digestion is well known, however, there has been increased interest in the interactions between the hindgut microbiota and diet in altering animal waste emissions. The primary waste emissions include methane, ammonia, phosphorous and odors. The fundamental microbial processes are similar between the rumen and hindgut, yet the microbial populations and their activities are dictated by differences between the two ecosystems. Examples of the influence of diet on animal waste emissions include reduction of methane emissions in ruminants by feeding monensin or high grain diets and reduction of urea/ammonia excretion in nonruminant animals by lowering dietary crude protein and supplementing with synthetic amino acids. Nutrient digestion has been increased by inclusion of enzymes and phosphorus excretion has specifically been reduced by inclusion of various sources of phytase. Composition and emission of odorous compounds are also affected by diet and microbial activities. Alteration of the intestinal microbiota and their activities will be an important method of reducing animal waste emissions in the future. One may also be able to manipulate the intestinal microbiota to enhance useful products derived from animal waste.

Key Words: Intestinal, Microbiota, Animal Waste

699 Historical and current perspectives of nutritional formulation in swine and poultry to reduce environmental impact. G. Allee*, *University of Missouri, Columbia.*

In past years diets for pigs and poultry were formulated on the basis of crude protein, total phosphorus, with a margin of safety added to ensure a nutrient was not limiting. Little, if any, attention was given to excretion of nutrients. In todays formulations, diets are formulated on an available amino acids, available phosphorus basis at the requirement level for the various nutrients with tremendous emphasis being placed on the excretion of nutrients into the environment. Historically pigs were fed a starter, grower, and finisher diet sequence. Today it is a normal practice to change diets frequently (3 or 4 starter diets, two grower diets and three finisher diets) in order to minimize the feeding of excess nutrients. It is well established that dietary manipulation is a very effective method to reduce the environmental impact of poultry and swine production. By using crystalline amino acids and the concept of ideal protein reduced crude protein corn-soybean diets greatly reduces nitrogen excretion. By using these concepts in formulation nitrogen excretion can often be reduced 20 to 30% without influencing growth performance, carcass value or cost of production. In typical corn-soybean meal diets, two-thirds of the phosphorus is bound as phytic acid, making it unavailable to pigs and poultry and consequently excreted. By using a phytase enzyme or low-phytate corn and formulating diets on an available phosphorus basis phosphorus excretion can be reduced 20 to 30%. The use of both low-phytate cereals and phytate enzyme can reduce phosphorus excretion 40 to 50%. Other examples will be given to demonstrate that dietary manipulation is a very effective method to reduce the environmental impact of pig and poultry production.

Key Words: Swine, Poultry, Phosphorus

700 Reducing environmental impact of cattle through precision feeding. D. G. Fox*[1], T. P. Tylutki[1], L. O. Tedeschi[1], and P. E. Cerosaletti[2], [1]*Cornell University, Ithaca, NY,* [2]*Cornell Cooperative Extension, Hamden, NY.*

Excess dietary N is volatilized or leached into ground and surface water and excess dietary P is lost through runoff or accumulated in the soil over time where it is subject to loss in watercourses. The risk of air and water pollution increases when nutrient imports greatly exceed nutrients exported as meat or milk (positive mass balance). Our studies on dairy and beef farms indicated over two thirds of the N and P imported as feed were not exported as feed or products (meat and milk). Precision feeding involves using mathematical models to implement research-based knowledge to formulate diets and feed management programs that optimize production while minimizing nutrients in manure. Precision feeding also requires using management practices that ensure the diets consumed are as close as possible to those formulated. In our case studies on dairy farms, precision feeding with the Cornell Net Carbohydrate and Protein System (CNCPS) reduced N and P excretion by an average of 33% while reducing annual feed costs by $50 to 130/lactating cow. Precision feeding reduced N and P mass balance on a case study farm by 17 and 28%, respectively. In another study in the basin of a P restricted reservoir, reducing P excretion by 33% with precision feeding reduced dairy farm mass P balance by 50%. The CNCPS model was used to evaluate the impact of advances in research-based knowledge on precision feeding. The bias in predicting feed energy values, which are used to predict diet allowable milk and growth and dietary N and P requirements, was reduced from -11.4 to 0.4 % and the variation accounted for was increased from 61 to 80% by using the CNCPS mechanistic rumen model rather than tabular values. The use of bST was predicted to produce the same amount of milk with fewer cows and 8% less N and 12% less P in the manure. We estimated that ionophores have reduced N excretion by 9.8 Gg/yr in feedlot cattle and would reduce N excretion by 67 Gg/yr if fed to lactating dairy cattle in the US.

Key Words: Environment, Nutrient Management, Modeling

701 Environmentally friendly feeds: manipulations of diets and feeding to reduce environmental impact from intensive aquaculture. G. Fornshell*, *University of Idaho, Moscow.*

The potential negative environmental impact of aquaculture effluents has received considerable attention from regulatory agencies and non-governmental organizations over the past decade. Aquaculture production systems such as net-pens and raceways where the culture water is readily exchanged with or continuously discharged into the surrounding environment have received the most attention. Feed is effectively the only major source of aquaculture-derived nutrients, such as nitrogen and phosphorus, and solids from these systems that can lead to eutrophication and sedimentation. To reduce the environmental impact of aquaculture effluents several dietary manipulations have been developed to minimize metabolic waste production, maintain product quality and maximize growth efficiency of the fish. This talk reviews the approaches taken including diet formulations, ingredient processing, genetic selection of fish and plants, manufacturing processes, and feeding strategies that have lead to considerable reductions in metabolic wastes and solids. Feed represents the largest single variable cost of production. As such, the efficient use of high-quality feeds is essential for productivity, economic efficiency, and protection of the environment.

Key Words: Environment, Feeds, Aquaculture

702 The history and current perspectives of dietary formulation in the horse. L. Lawrence*, *University of Kentucky, Lexington.*

When the most recent NRC recommendations for nutrient intakes of horses were published in 1989, the values represented minimum nutrient amounts for normal activity and health. In many cases, the nutrient amounts recommended by the 1989 NRC are much lower than amounts fed to horses in practical environments. The natural characteristics of some common feeds can result in nutrient excesses. Grass and legume hays are staples in most horse diets but because of their high potassium content, they result in potassium intakes far above the needs of most horses. The advantages of high forage diets (behavior and gastrointestinal health) outweigh any physiological disadvantages of feeding excess potassium. In addition, because it is difficult to measure optimal performance in horses, diets for horses are often formulated to provide nutrient intakes above the NRC (1989) recommendations. Most of the concentrates fed to horses in the U.S. are formulated for use with hay or pasture. Because forages can vary, commercial concentrates may be formulated to provide adequate nutrition even when low quality forages are used. Excess nutrient intakes can occur when these feeds are used with high quality forages. One approach to reducing nutrient excretion by horses would be to use feed ingredients with high nutrient availability or to include feed additives that enhance nutrient availability. Unfortunately, there have been few studies in this area and more research will be necessary to evaluate feeds and feed additives. Another approach to

minimizing nutrient excretion by horses is the use of commercially manufactured feeds that complement specific forages. For example, when alfalfa hay is used, the amounts of protein and calcium included in the concentrate can be significantly reduced. However, horse owners often have difficulty distinguishing among forages, making the successful application of this approach difficult. The approach with the most potential to reduce nutrient excretion by horses would be enhanced education of horse owners to improve their understanding of how to effectively match feed characteristics with the nutrient requirements of horses.

Key Words: Equine, Waste Management, Nutrient

703 Development of on-farm treatment of animal waste. J. B. Carey*, *Texas A&M University, College Station.*

Development of new and alternative on-farm systems to manage waste must address several obstacles or issues in order to have significant potential for adoption by producers. A primary obstacle is time. The new or alternative method must involve a reduction in the amount of time needed for waste management or at least no increase in time required to address waste management duties. Another issue to address is cost. Obviously, any method that actually reduces costs would be considered favorably. However, it is essential that all costs be considered including any potential costs of marketing final products. Additionally, new or alternative methods must prove effective and reliable under field conditions. If extensive training, monitoring, or non-traditional skills are needed for success then the applicability to commercial settings will diminish. Reliability also includes the assurance of consistent performance and accomplishment of the waste management tasks under all field conditions utilizing the skill sets available among producers and farm workers. It is also important that the new or alternative method produce an advantage or benefit, economic or otherwise to the producer. This can range from reduced pressure on existing methods to financial returns. If producers are expected to adopt new technology or change practices, they must perceive a benefit. While this list of issues and obstacles is not exhaustive, it provides a basis for consideration of new and alternative waste management technologies. Methods such as on-farm composting and marketing of manure or litter require full consideration of these issues. Mortality management alternatives such as acid or alkaline preservation, in-vessel composting and similar technologies require broad cooperation among a wide range of scientific and professional disciplines in order to adopt a research concept to a workable on-farm solution to waste management issues.

704 Alternative uses and value added processing of animal waste products. C. M. Williams*, *North Carolina State University, Raleigh.*

Traditional animal waste treatment generally involves on-farm land application of manure as a source of plant nutrients. Although cost effective, such practices may not be sustainable in some regions that produce large quantities of meat, eggs and milk. Technologies that provide economically feasible alternative strategies for processing large quantities of manure and generating marketable value-added products are needed. Some processes identified as potentially effective include centralized processing of manure to generate bio-based energy (methane), diesel fuel, and ash for a granular fertilizer product. Examples of work in progress to accomplish these objectives include high solids anaerobic digestion (HSAD), bio-methanol production, and fluidized bed combustion. The HSAD produced approximately 12 decatherms of methane per ton of feedstock and post-processed material met Class A biosolids requirement for fecal coliform bacteria. The bio-methanol plant capacity is approximately 7,500 gallons of methanol daily from a manure feedstock from 12 farms containing 12,000 finishing pigs each. The methanol is railed to a refinery for biodiesel fuel blending. A combustion study processing approximately 90 tons of combined swine biosolids and turkey litter showed that the fluidized bed technology at combustion temperatures above 1,600° F resulted in efficient combustion and low emissions of carbon monoxide, and minimal emissions of criteria pollutants. Collectively, these technologies demonstrate potential new and off-farm alternatives for processing animal waste products.

Food Safety: Alternatives to Antibiotic Use

705 Control of *Salmonella* in poultry production, the European experience - can it be adapted to the US? J. S. Bailey*[1] and T. Roberts[2], [1]*Agricultural Research Service, USDA, Athens, GA,* [2]*Economic Research Service, USDA, Washington, DC.*

Sweden and Denmark have instituted programs which have significantly controlled *Salmonella* in broiler chicken production. Swedens program was initiated about 15 years ago and Denmark s program was started about 10 years ago. In both programs, extensive testing programs are in place, no *Salmonella* positive feed is allowed, and all breeder birds that test positive for *Salmonella* are eradicated. In Sweden the program is continued for final grow-out and no *Salmonella* positive birds are allowed to be sold to the consumer and any *Salmonella* positive flocks are killed and disposed of. In Denmark, *Salmonella* positive grow-out broilers are processed separately, but can be sold to the consumer. Initially the costs of implementing the programs in both Sweden and Denmark were paid for by the government. Sweden has moved to a program that is self insured through industry check-offs. Denmark is attempting to implement a similar insurance program. Final economic analysis for a similar program in the U.S. is ongoing, but it will likely not be economically feasible to implement this same program in the U.S. However, alternative methods of achieving similar results may be possible. The use of live and killed cell vaccines in breeders, competitive exclusion treatments in breeders and broilers, and extensive biosecurity in breeder and broiler operations should yield similar results without the extensive costs of eradication programs. Intuition would suggest and the European experience has confirmed that the best way to control pathogens like *Salmonella*in food systems is to control the pathogens on the farm and to prevent them from ever entering the processing plant.

Key Words: Broiler, Salmonella, Control

706 Use of competitive exclusion to control enterotoxigenic strains of E. coli. R. B. Harvey*, R. C. Anderson, K. J. Genovese, T. R. Callaway, and D. J. Nisbet, *Food and Feed Safety Research Unit, ARS-USDA, College Station, TX.*

Foodborne diseases, morbidity, and mortality in food-producing animals, associated with pathogenic strains of *Escherichia coli*, are of public health and economic significance. Increasingly, *E. coli* have become resistant to most antibiotics and alternative control measures are sought. Our laboratory developed a defined culture of commensal bacteria of porcine GI tract origin, maintained it in continuous-flow culture, and designated it as RPCF. When administered to neonatal gnotobiotic pigs, immunoglobulin levels were increased 20- to 100-fold. *In vitro* laboratory studies have shown that RPCF prevented colonization of O157:H7 and F-18 strains of *E. coli*. Other laboratory studies demonstrated that RPCF-treated pigs had decreased mortality and bacterial shedding compared to controls when challenged with enterotoxigenic strains of *E. coli*. In field trials involving five geographically separated nursery farms with a history of high mortality from F-18 strain of *E. coli*, piglets were orally administered 10^8 CFU of RPCF within 24 h of birth, were monitored throughout the nursery period, and the performance of RPCF-treated pigs were compared to a similar number of untreated pigs on the same farms. A total of 34,676 pigs were included in these trials. We observed decreased medication costs and a 3.53% decrease in nursery barn mortality in RPCF-treated pigs compared to controls. There was an annual cost benefit of $22,196 per farm due to improved livability and reduced medication. Results from the present studies indicate that under laboratory and field conditions, RPCF was effective in controlling disease induced by enterotoxigenic *E. coli* and may be a viable alternative to the use of antibiotics.

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Key Words: Pathogenic E. Coli, Alternative to Antibiotics, Mortality