

# “Waste to Worth: Spreading Science and Solutions” 2013



## Book of Abstracts

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### Important links

Main conference website: <http://www.extension.org/63747>

Online agenda: <http://www.extension.org/67740>

Online version of this book of abstracts: <http://www.extension.org/67805>



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## Predicting Extension Professionals' Climate Change Perceptions

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We know that climate change generates reactions from deep concern to disbelief. Regional outreach programs that develop materials for extension agents must understand two audiences—the extension agent and the ultimate receiver to be effective. Previous research suggests that Americans fall into six categories, or “Six Americas,” with their perspectives on climate change (alarmed to dismissive). Our 2011-2012 study used a 56-item web-based survey to collect data from extension professionals (n=2,758) in eight southeastern states and classify them according to the Six Americas spectrum. Using econometric modeling techniques, we specify predictive models of extension professionals' perceptions on climate change as a function of several factors, including location (e.g., from coastal counties), political leaning (e.g., conservative), major program area (e.g., livestock), and position in extension (e.g., extension agent). We present the results of these models, and briefly discuss potential application of the models and implications of the findings for program development, long term education strategies, and climate change messaging. <http://www.extension.org/67718>

## From waste to energy: life cycle assessment of anaerobic digestion systems

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In recent years, processing agricultural by-products to produce energy has become increasingly attractive due to several reasons: centralized availability of low cost by-products, avoiding the fuel vs. food debate, reduction of some associated environmental impacts, and added value that has the potential to generate additional income for producers. Anaerobic digestion systems are one waste-to-energy technology that has been proven to achieve these objectives. However, investigation on the impacts of anaerobic digestion has focused on defined segments, leaving little known about the impacts that take place across the lifecycle. Current systems within the U.S. are dairy centric with dairy manure as the most widely used substrate and electricity production as the almost sole source for biogas end use. Recently, there is more interest in exploring alternative feedstocks, co-digestion pathways, digestate processing, and biogas end uses. Different operational and design practices raise additional questions about the wide reaching impacts of these decisions in terms of economics, environment, and operational aspects, which cannot be answered with the current state of knowledge.

The goal of this analysis is to understand the environmental and operational trade-offs that happen in anaerobic digestion systems. Global warming potential, energy intensity, land use, and nutrient balances are assessed using lifecycle assessment (LCA) methods. Several scenarios are modeled to assess different biogas uses (electricity, compressed gas for transportation, and upgraded gas for pipeline injection), co-product uses (fertilizer and bedding), and substrates (dairy manure, cheese whey, corn-stover, and switchgrass). In addition, other variables are taken into account such as digester type, land application technique, and separation technology to evaluate their influence in the overall system.

The resulting conclusions will provide information on all processes that take place from cradle-to-farm-gate in order to accomplish a fair comparison of economic and environmental impacts among design and operational decisions involved in anaerobic digestion systems. <http://www.extension.org/67565>

## **New Technologies for Drainage Water Management and Subsurface Irrigation**

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“Drain only the amount of water needed to ensure equipment access and healthy crop production, and not a drop more.” -Dr. Wayne Skaggs

Drainage water management is a practice that has been around for years. When a farmer sees a drain tile running, even though it hasn't rained for a month, he must ask himself, “Why?”. In the past, plugging the tile was an option. This was effective but problems could occur if the plug was not removed after a heavy rainfall.

For over 35 years, Agri Drain Corporation has manufactured and supplied products for water management. These products have evolved, and today, are used for the implementation of drainage water management and subsurface irrigation.

Agri Drain's Water Level Control Structures are well known as a device used to manage the water table without plugging the tile. Agri Drain recently introduced the “Water Gate”, a float activated head pressure valve. The Water Gate is used in conjunction with a Water Level Control Structure, allowing drainage water management to be utilized on ground that may not have been viable in the past.

The benefit of Drainage Water Management is twofold, a potential yield increase and nutrient retention, resulting in improved water quality. We will explain how both these goals can be met, benefiting the farmer and the environment. <http://www.extension.org/67719>

## **Soil Amendments Reduced Herbicides Mobility into Agricultural Runoff**

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Recycling waste such as municipal sewage sludge (SS) and yard waste (YW) for use as low-cost fertilizer resulted in positive effects on the growth and yield of vegetable crops. Eighteen runoff plots were established at Kentucky State University research farm (Franklin County, KY) to study the impact of soil amendments on reducing surface runoff water contamination by residues of dimethazone and trifluralin herbicides arising from agricultural fields. Three soil management practices: municipal sewage sludge (SS), SS mixed with YW, and no-mulch rototilled bare soil were used to monitor the impact of soil amendments on herbicide residues in soil following natural rainfall events. Biobeds (a soil cavity filled with a mixture of wheat straw, peat moss, and top soil) reduced dimethazone and trifluralin by 84 and 82%, respectively in runoff water that would have been transported down the land slope of agricultural fields and contaminate natural water resources. Biobeds installed in SS and SS+YW treatments reduced

dimethazone by 65 and 46% and trifluralin by 52 and 79%, respectively. We concluded that soil amendments could be used to intercept pesticide-contaminated runoff from agricultural fields, creating optimum conditions for sorption and biodegradation such that the amount of pesticides adjacent to water bodies is significantly reduced. This practice might provide a potential solution to pesticide contamination of surface and seepage water from farmlands. <http://www.extension.org/67566>

## **Management Techniques to Reduce Nitrogen Losses from Feedlot Cattle**

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The effects of ractopamine hydrochloride (RAC) and a steroidal implant (IMP), on whole body N metabolism were evaluated in 24 Hereford x Angus steers (BW 554.4 ± 26.8 kg). The experimental design was a completely randomized block design with a 2 x 2 factorial arrangement of treatments. Factors included: 1) RAC (0.0 or 400 mg×steer-1×d-1) and 2) IMP (0.0 or 200 mg trenbolone acetate and 28 mg of estradiol benzoate). Steers were housed in individual pens and allowed ad libitum access to feed and water throughout the experiment. Once cattle had been implanted for 48 d and had received RAC for 21 d, a nutrient balance study was conducted for 6 d. Implanted steers receiving RAC tended to have lower DMI compared to non-IMP steers receiving RAC as well as IMP steers not receiving RAC (IMP x RAC; P = 0.09). N intake (P > 0.11) and fecal N (P > 0.18) were not different due to treatment, yet numerically reflected the trend noted for DMI. Urinary N excretion was decreased by feeding RAC (P < 0.01). There tended (P < 0.08) to be an IMP x RAC interaction for urinary N excretion where implanted steers receiving RAC tended to produce less urinary N than non implanted steers receiving RAC. Similarly, urine urea N excretion was decreased by RAC treatment (P < 0.02) and excretion tended to be decreased in steers that had also received IMP (IMP x RAC interaction; P < 0.07). Overall N retention was not affected by treatment (P > 0.14). These results indicate that urinary N excretion can be reduced by incorporating RAC according to labeled usage during the final phase of the finishing period. However, more studies will be required to elucidate the potential interactions of RAC with implant status and types of implants. <http://www.extension.org/67720>

## **Greenhouse Gas Mitigation Opportunities for Livestock Management in the U.S.**

Shawn Archibeque, Colorado State University

## **Introductory RUSLE2 Workshop**

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This workshop is an introductory level workshop that will provide the participants with introductory knowledge and software orientation about RUSLE2. It will educate participants on the RUSLE2 equation factors, how these factors affect soil erosion under different on-farm conditions and conservation practices, and how these factors are considered into the RUSLE2 software.

The workshop will also introduce participants to the operating parameters for RUSLE2, selection of input values for RUSLE2 factors, and developing and saving management operations for RUSLE2. Different on-farm conservation practices and their application in RUSLE2 will also be discussed and demonstrated. These on-farm conservation practices include contouring, strips and barriers, strip cropping, different terraces, and diversions for reduction in sediment loss from a farm field.

The workshop will focus on RUSLE2 including installing software programs, database management, performing dominant critical area determinations, and operating RUSLE2 with example. RUSLE2 operations will be performed on the simple template using the base database. Plan and Watershed templates will also be introduced. The workshop will also introduce participants to Soil Conditioning Index (SCI) and Soil Tillage Intensity Rating (STIR), both of which can be calculated using RUSLE2. Use of RUSLE2 for both SCI and STIR will also be discussed in this workshop. <http://www.extension.org/67571>

## **Training Manure- and Compost-Spreading Contractors for the Cattle-Feeding Industry in the Texas Panhandle**

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Kevin Heflin, Gary Marek

Manure and compost companies have strived over the years to provide a service to both feedyards and crop producers in the most cost-effective manner possible. Unfortunately, little attention has been given to environmental impacts, by this important segment of the cattle feeding industry. This project, through training and demonstrations, will establish a program to provide for long-term implementation of best management practices (BMP) to be used during the land application of manure or compost. This will give producers a greater assurance that using manure or compost in their nutrient management programs has tremendous benefits and can be applied in a manner that is protective of the environment.

This event was conducted to determine which method of calibration might be appropriate when calibrating a manure spreader in the field. We used several different scales, dump gate configurations, and tarp placements to determine which method was the easiest and most reliable at determining actual tons/acre of manure applied.

The visual and measured observations of the manure spreader show that most of the manure is spread in a 10ft wide swath directly behind the spreader. There is a small amount of manure that extends out to 12-14ft behind the spreader, but the bulk of the manure is applied in 10ft strips. Manure collected from tarp to tarp varied greatly depending upon where it was placed in the 10 ft strip. If the tarps were placed on the edge, then they received 25-50% of the estimated tons per acre that the tarps placed directly in the center of the strip received.

Tarp aspect ratio was changed to accommodate the narrow distance between the back wheels on manure trucks. 28"x112" Tarps = 1/2000th of an acre. One pound on a standard tarp equals one ton of manure per acre.

Overlap measurements should also be considered when raw manure is applied with trucks that have vertical beaters or horizontal spinners that apply manure wider than the truck footprint. Application width and overlap are the primary factors influencing "single" pass estimates.

<http://www.extension.org/67721>

## **Ammonia and Greenhouse Gas Surface Concentration Measurements from Beef Bedded Manure Packs**

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Erin Cortus, South Dakota State University, Mindy Spiehs, USDA-ARS Meat Animal Research Center, Daniel Miller, USDA-ARS University of Nebraska - Lincoln

Bedding material is used in livestock operations to facilitate manure management and provide comfort for the animal. However, the implications of bedding on fertilizer value and gaseous emissions are not fully understood. The objective of this study was to determine differences in ammonia (NH<sub>3</sub>), carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), and methane (CH<sub>4</sub>) concentrations from bedded beef cattle manure related to manure pack age (0 to 3, 3 to 6 and 6 to 9 weeks), bedding material (corn stover (CS) or soybean stubble (SB)), and temperature (10°C or 40°C). Twenty four lab-scale manure packs were monitored in temperature and humidity-controlled chambers (n=2 per treatment). Freshly collected fecal material from an open feedlot, urine, and bedding were added weekly to the bedded packs. Flux chamber measurements from the pack headspace were analyzed for CO<sub>2</sub>, N<sub>2</sub>O, and CH<sub>4</sub> after 0, 24, 46 and 144 h and for NH<sub>3</sub> at 0, 5, 9, 23, 34, 46 and 144 h after material addition. At 40°C, NH<sub>3</sub> concentrations for CS (2353 ppm, CV=0.60) were significantly higher than for SB (1674 ppm, CV=0.58) and both significantly higher than average NH<sub>3</sub> concentrations at 10°C (772 ppm, CV=0.79). Average concentrations for CO<sub>2</sub> (6242 ppm, CV=0.74) and CH<sub>4</sub> (45.3 ppm, CV=1.35) were approximately twice as high at 40°C as for CO<sub>2</sub> (3197 ppm, CV=0.73) and CH<sub>4</sub> (21.9 ppm, CV=1.04) at 10°C. Average N<sub>2</sub>O concentrations at 10°C for SB (0.31 ppm, CV=0.87) were significantly lower than the other average treatment concentrations (0.53 ppm, CV=1.30). Significant differences related to age were only observed for CH<sub>4</sub> at 10°C and 40°C and CO<sub>2</sub> at 10°C. Overall, temperature significantly increased all gas concentrations while bedding only affected NH<sub>3</sub> at 40°C and N<sub>2</sub>O at 10°C by increasing concentrations when CS was used. The gas concentrations are supported by nutrient analyses and microbial enzymes activity potentials. <http://www.extension.org/67570>

## **Anaerobic Digester Operators' Virtual Discussion Group Management**

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The Anaerobic Digester Workforce Development Project is a project funded by the New York State Energy Research and Development Authority, aimed at developing and delivering high quality educational programs targeted to a range of workforces within the dairy farm-based anaerobic digestion (AD) sector of the clean energy field.

A goal of the project was to form a farmer driven discussion group among existing AD owners and operators. Farmers value and learn from the insights of fellow producers because they trust the experience and knowledge of others who are in situations similar to their own. This is especially true when adopting new technology. The purpose of this discussion group was to allow farmers an opportunity to learn from each other by sharing their real world experiences integrating and operating an anaerobic digester system into their farm business. Realizing that frequent, long-distance travel of all involved was a barrier to continued, dedicated involvement, the group opted to pursue a virtually-based discussion group platform. Farmers from across the state were linked via an online meeting site. This is an efficient method to allow farmers to interact with each other in a meaningful way without leaving their farm. The use of high definition video conferencing enhanced the interaction considerably. There have been many lessons learned from this challenging venture, as well as many successful communication strategies to share. <http://www.extension.org/67569>

### **A Review of WV Poultry Litter Analysis from 1994 to 2010 That Demonstrates a Continual Fluctuation in Nutrient Concentrations Resulting from Changes In Poultry Feed Formulations and New Storage Methods**

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The nutrient management planning process requires continual nutrient analysis of generated poultry litter to determine accurate agronomic land application rates. To better understand the challenges that nutrient management planners have faced with these nutrient concentration changes in poultry litter, an analysis was conducted of sample results submitted to the West Virginia Department of Agriculture Nutrient Management Lab, from 1994 to 2010. The number of produced Broilers in WV for 2010 was 87,600,000; the number of turkeys grown in WV during 2010 was 3,100,000 and the number of Layers averaged 1,200,000. NASS did not report pullet numbers. Data was analyzed by bird type including, Broilers, Layers, Pullets and Turkeys. Lab analysis included TKN, Ammonia, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O, Cu, Ca, Mg, WEP (Water Extractable Phosphorus) and Moisture content. Ammonia concentrations increased during the study period for all bird types, broilers and turkeys had ammonia concentrations averaging 15 lbs per ton in 1995 and had doubled to 30 lbs per ton of litter in 2010. This increase of ammonia may be attributed to the adoption by poultry growers of long term in-house litter storage. P<sub>2</sub>O<sub>5</sub> concentrations in broiler litter have consistently declined over the study period likely due to addition of phytase enzyme to feed allowing the reduction of P in the broiler diets. Average P<sub>2</sub>O<sub>5</sub> levels in 1995 were 60 lbs per ton and had dropped to 40 lbs per ton of litter by 2012. This data can also provide estimates of watershed nutrient loading used in the Chesapeake Bay, TMDL process and improve the Bay watershed model. <http://www.extension.org/67723>

## Phosphorus: EPA Perspective

Alfred Basile, US Environmental Protection Agency

And although progress has been made over the past decade, much more is needed. Realizing a need for greater action, In March 2011, EPA issued a memorandum titled “Working in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutrient Reductions.” This memo emphasized that nutrient pollution continues to have the potential to become one of the costliest and most challenging environmental problems that we face and reaffirmed the agencies commitment to partner with states and stakeholders to make greater progress in reducing nutrient loading to our nation’s waters. EPA cannot solve this problem alone – please join us in protecting and restoring our nation’s waters. For more information please visit EPA’s nutrient pollution website at <http://www.epa.gov/nutrientpollution/>

<http://www.extension.org/67798>

## Overview: Manure Management Equipment for Small Farms

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Increased local or regional food marketing opportunities have allowed commercial success in livestock and poultry operations with relatively small herds and flocks. The Census of Agriculture recently reports an increase in the number of small farms, as a proportion of all farms, across much of the U.S. Small animal feeding operations, less than 300 animal units, are a productive component of the animal ag sector. Finally, there continues to an interest in the development of hobby farm and equine related properties. All of these scenarios result in the necessity to manage manure resources, often on small acres, and often in close proximity to a neighbor. Knowledge about, access to, and acquisition of, appropriate manure handling equipment is a requirement to proper manure and nutrient management on all of these types of commercial or hobby farms and ranches. <http://www.extension.org/67568>

## Livestock Mortality Composting in the Semi-Arid West

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Proper management of animal mortalities has important implications for nutrient management, water quality, animal health, and farm/ranch family and public health. To best ensure human health and safety, reduce regulatory risks, and protect environmental resources, livestock producers should become familiar with best management practices (BMPs) for dealing with dead animals. They should also be aware of state laws related to proper disposal or processing of mortalities.

Mortality composting is an increasingly popular and viable alternative when compared to other disposal practices because of cost savings, bio-security benefits, and reduced environmental risks. Static

mortality composting differs from traditional composting in both management intervals and carbon to nitrogen ratios. The objective of this workshop is to provide those who advise livestock producers with the knowledge, tools, and resources to develop a mortality management plan, with specific focus on the static composting option.

The Rocky Mountain based authors conducted demonstrated research, reviewed pertinent literature, studied USDA-NRCS standards, and documented mortality composting systems already in-use by regional producers. Data from these activities provided a basis for the following tools: 1) a decision aid spreadsheet that evaluates the costs of mortality composting against other mortality disposal options, 2) a how-to-manual on mortality composting, 3) a video illustrating on-the-ground mortality composting, and 4) a companion PowerPoint presentation explaining mortality composting principles, methods and resources.

This 90 minute in-service workshop will provide background and step-by-step considerations for mortality composting, with an emphasis on the practice in the semi-arid environments of the western United States. However, fundamentals of the workshop will apply to all climates. Attendees will be provided with a hard copy of the manual and electronic copies of the video, spreadsheet tool and PowerPoint companion for their own use in future programming. The workshop delivery will include video, PPT assisted lecture, visual aids, and Q&A time. <http://www.extension.org/67616>

### **Federal Regulations and Pending Legislation Affecting Nutrient Management**

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The presenters will discuss the Clean Water Act as it pertains to nutrient management. The presentation will describe current and ongoing federal action in several watersheds in the form of a Total Maximum Daily Load or Numeric Nutrient Criteria. Areas discussed will include the Chesapeake Bay, the Oregon Coast, the Illinois River in Arkansas and Oklahoma, marine and freshwater systems in Florida, and the Mississippi River watershed. The presentation will conclude with a discussion on the agriculture community's role in nutrient management issues.

Decisions are being made everyday in Washington, D.C. by federal agencies, Congress, and the courts on how farmers and ranchers must manage their manure and their operations. It is important that producers and experts in the field educate their elected representatives and regulators on the important use of nutrients and our efforts to protect the environment at the same time we attempt to feed an ever-growing world. <http://www.extension.org/67738>

### **Financial Benefits of Composting Stable Waste for the Equine Industry**

Mollie Bogardus, Green Mountain Technologies [mollie@compostingtechnology.com](mailto:mollie@compostingtechnology.com)

Composting is becoming widely accepted as a best management practice for equine facilities. Stable waste is a readily compostable feedstock which generates heat and transforms into a finished compost product in as little as 2 weeks using in-vessel technologies. Composting the stable waste is financially beneficial, turning a liability into an asset, negating disposal fees, offering a decrease in bedding

expenses and creating a saleable product. In-vessel composting allows for compliance with increasing environmental regulations associated with manure management.

The primary topic will be the cost analysis of in-vessel vs. open pile composting of stable waste. The author will also compare the value of the product produced, specifically the value added with weed seed kill, reduction of pathogens, and the uniform quality and dryness of end product. The presenter will provide lab data showing compost stability and pathogen reduction using both shavings and pellet bedding. Value of the end product is seen in bedding re-use and/or soil amendment.

Discussion of cost savings will differ for different venues in the industry. Case studies will be shown for the financial analysis of a private 20 horse stable and the 65 horse stable at the US Army base at Fort Myer/Henderson Hall in Washington DC. <http://www.extension.org/67567>

### **Benefits of Bedding Reuse for the Equine Industry**

Mollie Bogardus, Green Mountain Technologies [Mollie@compostingtechnology.com](mailto:Mollie@compostingtechnology.com)

The primary topic will be the evaluation of composted bedding recycling for the equine industry. Stable waste is a readily compostable feedstock which generates heat and transforms into a finished compost product in as little as 2 weeks using in-vessel technologies.

The presenter will provide lab data showing compost stability, ammonia levels, nutrient content and pathogen reduction at two and three weeks detention time in-vessel. Lab results will be presented for both shavings and pellet bedding and comparisons made for impacts on the compost process.

Bedding recycling is now common practice in the dairy industry and has been demonstrated to reduce mastitis and other diseases in milking parlors. Composting is becoming widely accepted as a best manure management practice for equine facilities. It is also known that horses and stall workers may develop allergies to dust and resins in the raw wood bedding.

The author will compare the performance of three bedding mixes. The control will be new white wood shavings. The second is a 50/50 mix with composted bedding and the third mix is 100% composted bedding. The moisture content of the three mixes will be taken before and after use in the stall. A relative absorbency test will be conducted using weight change from dry to saturated state with free water drained. The dust production will be compared by weighing an air filter on a ventilation fan before and after spreading the bedding mixes in the stall for all three trials. Observations will be made for odor level, ease of cleaning and health impacts on the horse, such as cases of thrush, scratches and other increase or reduction of dermatitis. <http://www.extension.org/67724>

### **Impacts of the Michigan Agriculture Environmental Assurance Program**

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The Michigan Agriculture Environmental Assurance Program (MAEAP) is a holistic approach to environmental protection. It helps farmers evaluate their entire operation, regardless of size or commodity, and make sustainable management decisions balancing society's needs, the environment,

and economics. MAEAP is a partnership effort that aims to protect natural resources and build positive communities by working with farmers on environmentally responsible agricultural production practices. To become MAEAP verified, farmers must complete three comprehensive steps: educational seminars, an on-farm risk assessment, and development and implementation of an action plan addressing potential environmental risks. The Michigan Department of Agriculture and Rural Development (MDARD) conducts an on-farm inspection to verify program requirements related to applicable state and federal environmental regulations, including the Generally Accepted Agricultural and Management Practices (GAAMPs). MAEAP benefits Michigan by helping to protect the Great Lakes by using proven scientific standards to improve air, water, and soil quality. Annual phosphorus reduction through MAEAP is over 340,451 pounds per year which is enough to grow almost 85,104 tons of algae in lakes and streams. Farming is an environmentally intense practice and the MAEAP-verification process ensures farmers are making choices that balance production and environmental demands. The measures aimed at protecting air, soil, water, and other environmental factors mean that MAEAP-verified farmers are committed to utilizing farming practices that protect Michigan's natural resources.

<http://www.extension.org/67639>

## **Environmental Effects of Mortality Disposal**

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With the decline of the rendering industry, disease issues, ban on use of downer cows and rules to halt the sale of horses for slaughter, environmentally safe and sound practices for disposal of livestock mortality are limited. Improper disposal of carcasses containing veterinary drugs has resulted in the death of domestic animals and wildlife. Composting of mortalities has been performed successfully to reduce pathogen levels, nutrient release and biosecurity risks. Properly built mortality compost piles deter scavenging by wildlife and other animals. However, there is concern that drugs used in the livestock industry in feed and for health may not degrade and will persist in compost or leachate, causing threats to the environment, wildlife, domestic animals and humans. Two classes of drugs commonly used in the livestock include barbiturates for euthanasia and non-steroidal anti-inflammatory drugs (NSAID) for pain relief and inflammation. Sodium pentobarbital and phenylbutazone levels in liver, compost, effluent and leachate were analyzed in two separate horse mortality compost piles in two separate years. Horse liver samples were also buried in 3 feet of loose soil in the first year and drug levels were assessed over time. Phenylbutazone levels in the liver of the horse were undetectable (< 10 ppb) by 20 days of composting or burial in loose soil and were undetectable in effluent from the pile at the time of first sampling on day 6. Pentobarbital levels in the liver were undetectable (< 10 ppb) in liver samples retrieved from both the compost pile and loose soil by 83 days of composting. Rate of decay was faster in the soil, than in the compost, but occurred at the same rate of 1% and a half-life between 55 and 67 mesophilic degree days when calculated on the number of mesophilic degree days to which it was exposed. <http://www.extension.org/67572>

## **Manure Management Facilities and Structures on Small Farms**

Jean Bonhotal, Cornell University

## What Practices Increase Infiltration and Reduce Runoff on Slopes Greater Than 30%?

Joe Bragger, Bragger Family Farm

Dennis Frame, Amber Radatz [aradatz@wisc.edu](mailto:aradatz@wisc.edu)

For seven years, the UW - Discovery Farm Program (DFP) and the United States Geological Survey (USGS) conducted a paired research project on a livestock operation in the driftless region of Wisconsin. This farm consisted of about 800 tillable acres where some fields range from 6-30% slope, and every one drains into a waterway or stream which eventually flows into the Mississippi River. Agricultural fields are located on the ridge tops and in the valleys. The very steep side-slopes are kept as woodland or devoted to pasture. The fields are in a corn/soybean/alfalfa rotation and have been farmed using a no till system for the past 18 to 20 years (no tillage, subsoiling, and no manure incorporation). Sediment and nutrient movement into streams, rivers, and lakes in this part of the state has always been an issue, and agriculture has been identified as the largest contributor.

The USGS installed two in-stream monitoring stations in two small headwater streams that divide the farm. The north basin consists of 430 acres with 150 acres cropland, 250 acres woodland, and 30 acres pasture. The south basin consists of 215 acres with 39 acres cropland and pasture, 107 acres woodland, and 69 acres in CRP/CREP. The farming system uses a combination of conservation tools and techniques that have been adapted to fit the physical setting of the area, and the goals and vision of the producer who has a rich history of conservation. Harvesting precipitation is constantly at the forefront of operations through careful soil management, a network of small check dams and larger at-grade stabilization structures, and a focus on minimizing soil disturbance activities. Seven years of data indicated that almost all sediment losses occurred during a few large summer storms that exceed the design criteria. <http://www.extension.org/67574>

## Litter Generated Ammonia Captured By Activated Carbon Derived From Broiler Litter

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In 2011, the production rate of broilers was 8.6 billion with a value of \$23.2 billion (USDA 2012). Both CERCLA and EPCRA have reporting requirements for ammonia (NH<sub>3</sub>) of 100 lb of NH<sub>3</sub>/d or 18.3 tons/yr, a level that may affect large animal production facilities (NRC 2003). Although USEPA (2009) has provided an exemption for animal waste producing farms under CERCLA for reporting hazardous air emissions, it is expected that this exemption will be revoked once valid methodologies are established for monitoring. Two of the 24 sites in the NAEMS monitoring study reported similar NH<sub>3</sub> emissions of 3.6 – 5.3 tons of NH<sub>3</sub> per house per year (Burns et al. 2009, Heber 2010). Emissions of this level indicate a need for developing technologies that can reduce the NH<sub>3</sub> levels produced by broiler operations. This research is focused on the use of broiler litter as activated carbon (BAC) to reduce aerial NH<sub>3</sub> generated

by litter, an opportunity to not only reuse the manure, but also treat the emissions from or within broiler houses. The objective of this study was to evaluate the efficacy of BAC to remove NH<sub>3</sub> volatilized from litter samples in a laboratory acid-trap system. Preliminary studies using NH<sub>3</sub>/air mixture indicated that the BAC capacity to adsorb NH<sub>3</sub> was approximately double that of Vapure 612, a commercial carbon. In the litter emission study, the BAC and Vapure performance was comparable. Breakthrough for both carbons occurred within 14 hours of the test start. At the end of the 3 day test, the NH<sub>3</sub> emission for BAC was 75% of the litter only control, whereas, the Vapure emission was 64% of the control. The results of the study demonstrate the potential for a cyclical waste utilization strategy in using broiler litter activated carbon to capture NH<sub>3</sub> volatilized from litter.

<http://www.extension.org/67575>

## **Greenhouse Gas Emissions from Land-Applied Swine Manure: Development of Method Based On Static Flux Chambers**

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Assessment of greenhouse gas (GHG) emissions from land-applied swine manure is needed for improved process-based modeling of nitrogen and carbon cycle in animal – crop production systems. In this research, we developed novel method for measurement and estimation of greenhouse gas (CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O) flux (mass/area/time) of land-applied swine manure. New method is based on gas emissions collection with static flux chambers (surface coverage area of 0.134 meters<sup>2</sup> and a head space volume of 6.98 L) and gas analysis with a GC-FID-ECD. New method is also applicable to measure fluxes of GHGs from area sources involving crops and soils, agricultural waste management, municipal and industrial waste. New method was used at the Ag 450 Farm Iowa State University (41.98N, 93.65W) from October 24, 2012 through December 14, 2012 to assess GHG emission from land-applied swine manure on crop land. Gas samples were collected daily from four static flux chambers. Gas method detection limits were 1.99 ppm, 170 ppb, and 20.7 ppb for CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O, respectively. Measured gas concentrations were used to estimate flux using four different models, i.e., (1) linear regression, (2) non-linear regression, (3) non-equilibrium, and (4) revised Hutchinson & Mosier (HMR). Sixteen days of baseline measurements (before manure application) were followed by manure application with deep injection (at 41.2 m<sup>3</sup>/ha), and thirty seven days of measurements after manure application. Preliminary net cumulative flux estimates ranged from 115,000 to 462,000 g/ha of CO<sub>2</sub>, -4.65 to 204 g/ha of CH<sub>4</sub>, and 860 to 2,720 g/ha N<sub>2</sub>O. These ranges are consistent with those reported in literature for similar climatic conditions and manure application method. <http://www.extension.org/67579>

## **Improving Methane Yields from Manure Solids through Pretreatment**

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A large fraction of municipal solid waste (MSW), crop residues, animal manures, forest residues, or dedicated energy crops are composed of lignocellulose. Lignocellulosic substrates consist of a tightly woven matrix of cellulose, hemicellulose, and lignin polymers. Biological degradation of these polymers is carried out by a variety of enzymes. Pretreatment can enhance the bio-digestibility of the wastes for ethanol and biogas production by increasing the accessibility of the enzymes to the substrate. Thus, pretreatment can increase the energy yield (biogas or ethanol) while decreasing the residual waste to be disposed.

This paper presents a description of the ABFX (Ammonium Bicarbonate Fiber Explosion) pretreatment process. The ABFX process is an extremely simple and inexpensive process that possesses the attributes of the Ammonia Fiber Explosion Process (AFEX) and CO<sub>2</sub> explosion process while eliminating the cost associated with high temperature, high pressure and ammonia recovery. The process uses ammonia bicarbonate (ABC) recovered from anaerobic digestate to pretreat the substrate. The ABC is simply added to the substrate, pumped to a reactor, heated to temperatures less than 100°C, for a short duration. The pressure created by ABC volatilization is then released and the gases (CO<sub>2</sub>, NH<sub>3</sub>, H<sub>2</sub>O) condensed at ambient temperature to produce ABC that is then reused in the process. The process can operate with low temperature waste heat.

This paper presents a description of the process and the results of a National Science Foundation Small Business Innovative Research investigation that compared the methane gas yields from both pretreated and untreated grass silage and pretreated and untreated screened (screw press) dairy manure solids. The ABFX pretreated manure solids produced 38% more methane gas than the untreated while the ABFX pretreated grass silage produced 14% more methane gas than the untreated. The economic benefits of the process will be discussed. <http://www.extension.org/67577>

### **Economical Recovery of Ammonia from Manure Digestate**

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The discharge of ammonia nitrogen is a well-recognized adverse consequence of anaerobic waste treatment. As a result, further treatment to remove ammonia is required. A wide variety of processes have been developed to address the “ammonia issue”. The Anammox (anaerobic ammonium oxidation) process is the least expensive and produces significantly less GHG (N<sub>2</sub>O). The Anammox process directly converts ammonia to nitrogen gas (N<sub>2</sub>) resulting in the loss of the ammonia resource at a treatment cost of approximately \$1,800 / ton N for a large facility. The ammonia that is destroyed must be replenished through the Haber-Bosch process that requires 32 GJ of energy per ton of ammonia to produce and similar energy consumption to transport. The production and transport have a cost of \$1,600 / ton N while producing substantial GHG emissions. The minimum total cost of destroying and replacing ammonia is greater than \$3,400 / ton N.

An economical process to capture residual ammonia nitrogen and reduce the production of new ammonia via the Haber process is needed. The CO<sub>2</sub>, N<sub>2</sub>O and NO<sub>x</sub> emissions from nitrification and denitrification of industrially created ammonia will be reduced as a result. The ammonia product should be sold at a profit, but less than \$1,700 / ton N.

This paper describes the ABC process and presents the ammonia recovery and biomethane production results of a pilot investigation of the ABC process for the recovery of ammonia nitrogen. The work was supported by the US Department of Agriculture (USDA) under a Small Business Innovative Research project. The ABC process uses no chemicals and very little energy. The process recovers the ammonia as crystalline ammonium bicarbonate (ABC). In the process of producing the ABC, carbon dioxide is removed from the biogas to produce “biomethane”, a transportation quality fuel at little or no cost. <http://www.extension.org/67578>

## **Evaluating the Dust Abatement Potential of Stocking Density Manipulation at Open-Lot Cattle Feedyards**

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Fugitive dust abatement from cattle feedlots continues to be an area of concern for feedlot managers and regulators. Currently, water application and manure harvesting are Beneficial Management Practices (BMP) commonly used for dust abatement. Stocking density manipulation could be used as an additional BMP. The moisture and compaction dynamics of an open-lot corral surface in a cattle feedyard depend strongly on the spatial density at which the animals are stocked. Because the moisture content and bulk density of the corral surface are directly related to its intrinsic dust susceptibility (Auvermann, 2003; Razote et al., 2006), emission of fugitive dust from a feedyard surface should be sensitive to changes in stocking density and the moisture- dynamics changes that it induces. Path averaged airborne dust concentrations were measured upwind and downwind of feedyard pens using an optical particle sizer OPS (model 3330, TSI inc., Shoreview, MN) and an aerosol monitor (model DUSTRAK II 8530, TSI inc., Shoreview, MN) mounted on mobile sampling platforms. Feedlot pens were stocked at two densities, 718 (control) and 1,435 hd ha<sup>-1</sup>. Doubled stocking density was achieved in two different ways, by (A) confining cattle to half the pen area using electric cross-fencing and (B) doubling the number of cattle in the pens. We will report differences in dust concentrations and corral surface conditions associated with pen stocking density. <http://www.extension.org/67576>

## **NRCS Manure Related Conservation Innovation Grants**

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The 2002 Farm Bill created a mechanism under the Environmental Quality Incentives Program (EQIP) for a program of Conservation Innovation Grants (CIG). These grants were “...intended to stimulate innovative approaches to leveraging Federal investment in environmental enhancement and protection, in conjunction with agricultural production...” The grants were to provide a mechanism for funding projects to aid in technology development and transfer. The USDA Natural Resources Conservation Service cannot do research, so these projects must be in the demonstration or tool creation stage. Since

the initial grant funding cycle in 2004, NRCS has provided funding through EQIP every year. To date nearly 500 grants have been awarded, with total funding in excess of \$180 million.

A large share of these CIGs has been strongly animal, and/or manure related. Almost 25 percent of the total number of grants has been animal related, and these grants have received slightly over 26 percent of the total dollars. About 19 percent of the total grants have been manure related and these have received about 22 percent of the funding. Those animal related grants that are not manure related largely deal with range and pasture systems.

A number of the manure related grants have been successful. Several feed management related projects have been major successes under the CIG program. Other successful projects have dealt with such technologies as anaerobic digesters; community digesters; environmental credit trading; lagoon management; manure to energy generation; alternative litter sources, storage, and handling; and pathogen, odor, and emissions mitigation, to name just a few.

The presentation will provide specific numbers of projects and funding per year, and information about actual projects that NRCS considers to have been successful. <http://www.extension.org/67585>

## **Benefits of Using Liquid-Solid Separation with Manure Treatment Lagoons**

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Jeffery Porter, Environmental Engineer, USDA-NRCS Manure Management Team

Treatment lagoons are one of the most common biological treatment methods used on swine and dairy farms that use recycled supernatant as a means to remove manure from animal housing facilities by flushing. A properly functioning treatment lagoon will provide adequate treatment to allow reuse of the effluent without compromising animal health or generating strong odor. In order to provide the needed levels of treatment prior to recycling the lagoon must have a minimum biological treatment volume and provide sufficient volume for settling and storage of solids and sludge. This presentation will provide a summary of the benefits of using liquid-solid separation to maintain and potentially reduce the required treatment volume, reduce sludge build-up, increase useful life of an existing lagoon, and to reduce the size of new lagoons. Information will also be provided concerning desired loading rates and supernatant concentrations for recycling, impacts of odor production potential, and the benefits of improving utilization of plant nutrients for crop production. <http://www.extension.org/67583>

## **Production of Fuel Crops to Make Biodiesel Using Animal Manure**

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Wilder Ferreira, Extension Economist, Clemson University

A review of the literature indicated that good quality biodiesel can be used in farm equipment at concentrations from 20% (B20) to 100% (B100) depending on air temperature and the design of the engine. Using biodiesel reduces emissions of carbon monoxide, sulfur containing pollutants that

contribute to acid rain, unburned hydrocarbons, and particulates. Using B100 in a diesel engine can reduce fuel efficiency by about 8%, but had no other negative impacts when operated during warm weather. Using B20 to B50 has been shown to be sufficient to make loss of fuel efficiency inconsequential and allows operation of tractors in cold weather. The potential for using soybeans and canola as fuel crops was investigated using crop production budgets and a simple cost analysis of biodiesel production. The results indicated that:

- (1) soybeans are too valuable to be used as a fuel crop,
- (2) canola can yield more fuel per acre than soybeans,
- (3) fertilizer costs can account for 44% of the cost of producing canola,
- (4) animal producers have a substantial advantage since manure can be used as a source of plant nutrients for canola,
- (5) obtaining fair market value for canola meal is an essential part of lowering the cost to produce biodiesel, and
- (6) making biodiesel for on-farm use or in a cooperative arrangement in a farming community appears to hold an opportunity for animal producers.

<http://www.extension.org/67581>

## **Combustion of Poultry Litter: A Comparison of Using Litter for On-Farm Space Heating Versus Generation of Electricity**

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Modern poultry production requires substantial amounts of energy for space heating (propane/LP gas), ventilation, feed handling, and lighting. It was determined that annual LP gas consumption in broiler houses can range from 150 to 300 gallons of LP per 1000 square feet of floor space with an average of about 240 gal LP/1000 ft<sup>2</sup> observed in South Carolina. Similarly, broiler production in South Carolina requires about 2326 kWh/1000 ft<sup>2</sup> of house area. As a result, a 6-house broiler farm in SC uses about 30,240 gallons of LP and 293.076 kWh of electricity annually. The cost for energy for a 6-house farm is on the order of \$57,456 per year for LP (\$1.90/gal LP) and \$35,169 per year for electricity (\$0.12/kWh). Energy costs have more than doubled over the last decade and as a result producers are very interested in ways to reduce on-farm energy costs by using the energy contained in the litter.

This presentation will compare using litter as a replacement for LP gas for on-farm space heating with using litter to generate electricity. The comparison includes heating system efficiency, amount of LP off-set possible, value of plant nutrients in the litter, quantity and value of plant nutrients in the litter ash, impact of brokerage, and costs of producing the energy. It was concluded that using litter on-farm as a source of space heat and using the litter ash as fertilizer could provide a potential value of \$48 per ton of litter. However, on-farm combustion of litter to produce electricity resulted in a loss of about - \$3/ton of litter. Therefore, if a heating and ash management system can be implemented in a cost-effective manner use of litter to off-set 90% or more of the heating energy requirements would be the better of these two alternatives. <http://www.extension.org/67582>

## **On-Farm Comparison of Two Liquid Dairy Manure Application Methods in Terms of Ammonia Emission, Odor Emission, and Costs**

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Sai Krishna Reddy Yadanaparthi, Mario De Haro Marti, Wilson Gray, Howard Neibling, and Mireille Chahine

Ammonia and odor emissions from land application of liquid dairy manure, and costs associated with manure land application methods are serious concerns for dairy owners, regulators, academic, and the general public. Odor and ammonia samples from agricultural fields receiving liquid dairy manure applied by surface broadcast and subsurface injection methods were collected and analyzed. Costs associated with both of the manure application methods were estimated. The test results showed that subsurface injection reduced both the odor and ammonia emissions compared with surface broadcast; therefore, applying liquid dairy manure by subsurface injection could be recommended as one of the best management practices to control ammonia and odor emissions. The estimated costs associated with subsurface injection were higher than surface broadcast. However the higher costs could be partially compensated by the higher nitrogen fertilizer value captured in the soil by the deep injection method. <http://www.extension.org/67584>

## **Effects of corn processing method and dietary inclusion of wet distillers grain with solubles on enteric methane emissions of finishing cattle.**

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The use of wet distiller's grains with solubles (WDGS) in feedlot diets has increased as a result of the growing U.S. ethanol industry. However, few studies have evaluated the use of WDGS in finishing diets based on steam-flaked corn (SFC), the processing method used extensively in the Southern Great Plains. The effects of corn processing method and WDGS on enteric methane (CH<sub>4</sub>) production, carbon dioxide (CO<sub>2</sub>) production and energy metabolism were evaluated in two respiration calorimetry studies. In Exp. 1, the effects of corn processing method (SFC or dry rolled corn – DRC) and WDGS inclusion (0 or 30% of diet dry matter- DM) were studied using a 2 x 2 factorial arrangement of treatments and four Jersey steers in a 4 x 4 Latin square design. In Exp. 2, the effects of WDGS inclusion rate (0, 15, 30, or 45% of diet DM) on CH<sub>4</sub> and CO<sub>2</sub> production were measured in a 4 x 4 Latin square design. In both experiments, steers were fed at 2 times their maintenance energy requirement. All diets, except the 30% and 45% WDGS diets in Exp. 2, were balanced for ruminally degradable protein (RDP) and fat content. Each period of the Latin squares consisted of a 16-day diet adaptation and 5-days of total fecal, urine, and gas (oxygen consumption, and CO<sub>2</sub> and CH<sub>4</sub> production) collections. In Exp. 1, steers consuming SFC-based diets produced less (P < 0.05) enteric CH<sub>4</sub> (11.6 vs. 14.1 L/kg of DMI and 2.47 vs. 3.04 % of gross energy intake [GEI]) and tended (P < 0.17 ) to produce less CO<sub>2</sub> (2,513 vs. 2,645 L/d) than steers consuming DRC-based diets. Inclusion of WDGS did not affect (P > 0.52) CH<sub>4</sub> or CO<sub>2</sub> production. Nitrogen excretion was not affected by grain processing but calves fed diets containing 30% WDGS had

greater ( $P < 0.01$ ) N intake (114 vs. 140 g/d) and urinary N excretion (40 vs. 54 g/d) than steers fed diets containing 0% WDGS. In Exp. 2, enteric CH<sub>4</sub> production was similar for the 0 and 15% WDGS diets (10.9 vs. 11.2 L/kg DM intake: 2.44 vs. 2.46% of GEI) but increased ( $P < 0.05$ ) in the 30% (13.2 L/kg DMI: 2.85% of GEI) and 45% (17.9 L/kg DMI: 3.73% of GEI) WDGS diets. Carbon dioxide production was not affected by WDGS content of the diets (mean 2,846 L/d) but the CO<sub>2</sub>:CH<sub>4</sub> production ratio decreased linearly ( $P < 0.01$ ) from 42.6 to 27.0 in 0% and 45% WDGS diets, respectively. Because of greater N intake, total and urinary N excretion increased linearly ( $P < 0.01$ ) with increasing WDGS inclusion in the diet. Results indicate that cattle consuming SFC-based diets produce less enteric CH<sub>4</sub> and retain more energy than cattle fed DRC-based diets. When dietary fat levels were held constant, dietary inclusion of WDGS at 15% of diet DM did not affect enteric CH<sub>4</sub> production, WDGS inclusion at 45% of diet DM significantly increased enteric CH<sub>4</sub> production and WDGS inclusion at 30% of diet DM had variable effects on enteric CH<sub>4</sub> production. <http://www.extension.org/67580>

## **Influence of Swine Manure Application Method on Concentrations of Methanogens and Denitrifiers in Agricultural Soils**

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Soil microbial communities have been proposed as indicators of soil quality due to their importance as drivers of global biogeochemical cycles and their sensitivity to management and climatic conditions. Despite the importance of the soil microbiota to nutrient transformation and chemical cycling, physiochemical properties rather than biological properties of soils are traditionally used as measures of environmental status. In general, much is unknown regarding the effect of management fluctuations on important functional groups in soils systems (i.e., methanogens, nitrifiers and denitrifiers). It is only recently that it has been possible, through application of sophisticated molecular microbiological methods, to sensitively and specifically target important microbial populations that contribute to nutrient cycling and plant health present at the field-scale and in differentially managed soil systems. In this study, quantitative, real-time PCR (qPCR) was used to quantify changes in denitrifiers (narG) and methanogens (mcrA) in agricultural soils with three different swine effluent application methods including surface application, direct injection, and application in combination with soil aeration. Results show that concentrations of bacteria were high in all treatments ( $2.9 \pm 1.4 \times 10^9$  cells per gram of soil); about 25% higher than in controls with no slurry added. Concentrations of methanogens and denitrifiers were slightly higher (around 50%) when slurry was applied by injection or aeration ( $5.3 \pm 2.4 \times 10^7$  cells and  $2.8 \pm 1.8 \times 10^7$  cells per gram of soil, respectively) as compared to no till ( $2.4 \pm 1.6 \times 10^7$  cells and  $1.6 \pm 1.0 \times 10^7$  cells per gram of soil, respectively). These results suggest that application method has little influence on concentrations of functional groups of microorganisms. These results will be discussed in light of results of GHG sampling conducted during the same study. <http://www.extension.org/67590>

## **Manure Management and Temperature Impacts on Gas Concentrations in Monoslope Cattle Facilities**

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Md Rajibul Al Mamun, Ferouz Y. Ayadi, Stephen Pohl, Scott Cortus and Richard Nicolai, South Dakota State University; Mindy J. Spiehs, USDA-ARS Meat Animal Research Center; Beth E. Doran and Kris Kohl, Iowa State University Extension and Outreach

Roofed and confined cattle feeding facilities are increasingly popular in the Northern Great Plains. However, little is known about the impact of these housing systems and associated manure management methods on the air quality inside and outside the barn. The objective of this study was to determine gas concentrations in monoslope beef cattle facilities, and relate these concentrations to environmental and manure management factors. Ammonia, hydrogen sulfide and methane concentrations were sequentially sampled from two south wall locations and three north wall locations in two pens at four barns for month-long periods during fall, winter, spring and summer seasons. Two barns maintained deep-bedded manure packs (Bedpack), whereas two barns scraped manure and bedding from the pens weekly (Scrape). Weather, airspeed and temperature data were collected simultaneously at each monitoring sites. The maximum hourly mean concentrations measured at the north or south wall of either pen in the barn was used in this analysis. The seasonal average hourly mean of maximum concentrations and ambient temperature were calculated. The seasonal average maximum ammonia concentration ranged from 1.4 to 3.3 ppm with the Scrape barns and from 0.2 to 7.1 ppm with the Bedpack barns. The range of maximum hydrogen sulfide concentrations was 0 to 54 ppb in the Scrape barns and 0 to 392 ppb in the Bedpack barns. The maximum methane concentration ranges were 5.9 to 10.0 and 3.1 to 15.8 ppm in the Scrape and Bedpack barns, respectively. There are indications of differences between gas release rates for bedpack and scrape manure management systems, and increasing release rates with temperature, for ammonia and hydrogen sulfide. Methane concentrations are more consistent between systems and for different temperature conditions. Emission values will incorporate these concentration data, in conjunction with airflow data, which also varies between sites and temperature conditions. <http://www.extension.org/67587>

## **Manure Application Risk Management on Regional and National Scales**

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Nichole Embertson, Whatcom Conservation District; Jeppe Kgaersgaard, South Dakota State University

Join us for a session on manure application risk management. Because the economics and environmental impacts of livestock production cross watershed boundaries and affects both the rural and urban population, the issue of manure management has been the subject of debate and new policies in recent years. Non-point source discharges of nutrients and bacteria can be substantial if the manure is not managed properly. This session explores what we have learned about risks and risk management relating to manure application. We invite abstracts relating to research and management of manure application. In addition, 2013 marks the adoption of the revised 590 standard across the United States for NRCS-based nutrient management. This session will include a roundtable discussion on unique adaptations by states to the national standard. The session will conclude with a planning session to identify how we can, cooperatively, prepare for future policy and standard development, including discussion of collaborative research opportunities. <http://www.extension.org/67589>

## Balancing Earth, Air and Fire in The Kansas Flint Hills

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Native Americans placed great value on the four elements of life, earth, water, air and fire. They recognized, as we do today, that fire is the most powerful land management tool. The 4.8 million acre Flint Hills region of Kansas is the largest remaining expanse of tallgrass prairie in North America. Prescribed fire is routinely practiced in the region to enhance livestock forage quality, control invasive species, provide grassland wildlife habitat and improve plant vigor. But where there is fire, there is smoke, and there are public health concerns when excessive smoke is in the atmosphere. Ground level ozone can have serious public health consequences and major cities adjacent to the Flint Hills, have recorded excessive ozone levels resulting from Flint Hills prescribed fire. A collaborative effort including the Kansas Dept of Health & Environment, EPA, K-State Research & Extension, Kansas Livestock Association and other groups completed the Flint Hills smoke management plan in December, 2010, with the objective of reducing health concerns from prescribed fire, while retaining it as a land management tool. The plan established a website of "best smoke management practices" and a comprehensive education and outreach effort for land managers was implemented, involving prescribed fire schools, news articles and radio airplay. Results of the plan are positive, indicating that Kansas has responded to the smoke issue appropriately and will retain prescribed fire as a management practice that maintains both the tallgrass prairie of the hills, and the air quality of adjacent metro areas. The inter-relationships of earth, water, air and fire are continual, each impacting the other. The Kansas Flint Hills now has a plan to ensure harmony of these essential elements of life.

<http://www.extension.org/67588>

## On-Farm Field Days as a Tool to Demonstrate Agricultural Waste Management Practices and Educate Producers

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Teaching Best Management Practices (BMP) or introducing new agricultural waste management practices to livestock producers and farmers is a challenge. This poster describes a series of on-farm field days designed to deliver information and demonstrate on-site several waste management techniques, most of them well established in other parts of the country but sparsely used in Idaho. During these field days, Extension personnel presented each technique and offered written information on how to apply them. But without a doubt, presentations by the livestock producers and farmers who are already applying the techniques and hosted each field day at their farms was the main tool to spark interest and conversations with attendees. Four field days were delivered in 2012 with more programmed for 2013. Demonstrated techniques reduce ammonia and odor emissions, increase nitrogen retention from manure, reduce run-off risks, and reduce emissions of greenhouse gases. Topics addressed on each field day were, a: Dairy manure collection and composting, 20 attendees. b: Dairy manure land application

ten attendees. c: Grape vine prunings and dairy manure composting, 50 attendees. d: Mortality and offal on-farm composting, 40 attendees. In all cases farm owners and their managers presented and were available to answer attendees' questions, sharing their experience, and opinions regarding the demonstrated practices. Many attendees expressed their interest and willingness to adopt some of the demonstrated practices. On-farm field days are an excellent tool to increase understanding and adoption of BMP and new technologies. Hearing experiences first hand from producers applying the techniques and being able to see them in action are excellent outreach tools. On-farm field days also fit the fast pace, busy schedule of modern producers who can later visit with Extension and other personnel if they need more details, information, and help on how to adopt the techniques they are interested in. <http://www.extension.org/67725>

## **Reducing Phosphorus Loading into Ohio's Lakes through Manure Applications on Growing Crops**

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Glen Arnold, The Ohio State University Extension

The Maumee River watershed contributes 3% of the water but more than 40% of the nutrients entering Lake Erie. Data from the Ohio Tributary Loading Program has identified increasing levels of dissolved reactive phosphorus as the prime suspect in the recurrence of harmful algal blooms within Lake Erie. Livestock manure represents approximately 25% of the phosphorus applied in the watershed and can be a source of dissolved reactive phosphorus.

One project is a three year research project on applying liquid swine manure as a spring top-dress nitrogen source for soft red winter wheat. Field-scale randomized block design replicated plots were conducted on farms. Liquid swine manure was surface applied and incorporated on all plots using a Peecon toolbar and compared to urea (46-0-0) fertilizer surface applied with a fertilizer buggy for wheat yield. Manure applications were made using a standard 5,000 gallon manure tanker in early April after the wheat had broken dormancy and field conditions were deemed suitable. Manure was applied at rates to approximate the nitrogen amount in the urea treatments. There was no statistical yield difference between using livestock manure or purchased urea fertilizer as the top-dress nitrogen source.

Another research project started in 2011 compared fall and spring applied manure. The fall treatment included an application of manure just before planting of a wheat cover crop. The wheat was killed in the spring and followed with a corn crop. A direct injection manure application was made to the corn that had not received manure in the fall. The fall applied manure had an average yield of 109 bu/ac and the spring applied had an average yield of 205 bu/ac.

The potential to use liquid manure on growing crops opens a new window of opportunity to reduce phosphorus loading into Lake Erie. <http://www.extension.org/67586>

## **Assessment of Bioaerosol Transport at Large Dairy Operations**

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Because animal confinement increases the microbial load within production facilities, on-site and near off-site exposures to airborne microorganisms and microbial byproducts are higher than in natural environments. The inhalation of bioaerosols or ingestion after deposition on food crops and fomites, can be detrimental to health through infection, allergy, or toxicosis. In an effort to assess the off-site transport of bioaerosols, airborne bacteria, fungi, and endotoxin were collected at a 10,000 cow dairy operation. Compared to background locations, the general trend was that bioaerosol concentrations were higher immediately downwind, then decreased with distance from the animal housing. While bioaerosol concentrations did not follow a seasonal trend, they did significantly correlate with meteorological factors such as temperature and solar radiation. Bioaerosol concentrations were also found to be greatest at night, which can be attributed to changes in animal activity and wind speed and reduced exposure of the microorganisms to UV radiation. An analysis of clones generated from air samples collected downwind from the animal housing and pivots spraying dairy wastewater revealed that none of sequence matches were affiliated with bacteria known to be pathogenic to otherwise healthy humans. Results from ongoing research to better understand bioaerosol formation and drift losses during spray irrigation events of dairy wastewater will also be discussed.

<http://www.extension.org/67599>

## **Estimation of On-Farm Greenhouse Gas Emissions from Poultry Houses**

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Brian Fairchild, University of Georgia, Casey Ritz, University of Georgia, Brian Kiepper, University of Georgia, Michael Lacy, University of Georgia

Much of the greenhouse gases (GHG) generated from the poultry industry is primarily from feed production. The poultry producer does not have control over the production and distribution of the feed used on the farm. However, they can control other emissions that occur on the farm such as emissions from the utilization of fossil fuels and from manure management. A series of studies were conducted to evaluate on-farm greenhouse gas emissions from broiler, breeder and pullets houses in addition to an in-line commercial layer complex. Data was collected from distributed questionnaires and included; the activity data from the facility operations (in the form of fuel bills and electricity bills), house size and age, flock size, number of flocks per year, and manure management system. Emissions were calculated using GHG calculation tools and emission factors from IPCC. The carbon dioxide, nitrous oxide and methane emissions were computed and a carbon footprint was determined and expressed in tonnes carbon dioxide equivalents (CO<sub>2</sub>e).

The results from the study showed that about 90% of the emissions from the broiler and pullet farms were from propane and diesel gas use, while only 6% of the total emissions from breeder farms were from propane and diesel gas use. On breeder farms, about 29% of GHG emissions were the result of electricity use while the pullet and broiler farms had only 3% emissions from electricity use. Emissions from manure management in the layer facility were responsible for 53% of the total emission from the

facility, while electricity use represented 28% of the total emissions. The results from these studies identified the major sources of on-farm of GHG emissions. This will allow us to target these areas for abatement and mitigation strategies. <http://www.extension.org/67591>

## **Protecting Puget Sound Watersheds from Agricultural Pollution Using a Progressive Manure Application Risk Management (ARM) System**

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Chris Clark, Whatcom Conservation District, Lynden, WA, Steve Cox, US Geological Survey, Tacoma, WA, George Boggs, Whatcom Conservation District, Lynden, WA

Throughout the Puget Sound region of Northwest Washington, impacted and poorly managed agriculture has repeatedly been advanced as a leading contributor to air and water pollution. Improvements in field application methods and timing are necessary in order to protect important resources from further negative impacts. This study aimed to develop an innovative Application Risk Management (ARM) System that targets the transport of manure nutrients (N, P) and fecal coliform (FC) via runoff, leaching, and/or volatilization by promoting science-based assessment tools linked to measurable outcomes. The study had four overlapping phases. Phase 1 was the creation of a field-level risk assessment tool that identified protection areas and gave individual risk ratings for runoff and leaching potential based on 15 aspects of soil properties and field characteristics. Phase 2 was the development of real-time assessment tools. A Manure Spreading Advisory, based on 72-hour precipitation forecast, gives farmers a real-time idea of current runoff risk. If risk was low, farmers continue their assessment by filling out a web-based ARM Worksheet which provides an overall risk rating and recommended application rate for a specific field based on forecast, soil characteristics, application technology, and protective measures. Dynamic seasonal manure setback distance guidance provides protection and optimal field use. Phase 3 was the in-field assessment of threshold levels, parameters, and guidelines used to develop the tools. In order to assess the effect of manure application strategies on forage fields, measurement and interaction of vadose zone soil water, groundwater, surface water, air, soil, manure, forage, and meteorological parameters were conducted on three diverse fields in Whatcom County, WA from 2011-2012, with the adoption of three more by 2014. Phase 4 of the project includes the adaptation of tools, integration into Nutrient Management Planning, and dissemination of the ARM System through media, technology, and adoption by other Districts. <http://www.extension.org/67594>

## **Model of a Successful Regulatory-Industry Partnership to Address air Emissions from dairy operations in Yakima, WA**

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Gary Pruitt, Yakima Regional Clean Air Agency Air, Yakima, WA, Hasan Tahat, Yakima Regional Clean Air Agency Air, Yakima, WA, Pius Ndegwa, Washington State University, Pullman, WA

The community in the Yakima Region of Washington State has raised concerns over the potential adverse effects of air emissions from dairy operations. To address these concerns, the Yakima Regional

Clean Air Agency (YRCAA) proposed a draft policy in October 2010 to control and mitigate emissions through implementation of site-specific best management practices (BMPs) on dairy operations. To validate the policy, a “Pilot Research Project” was launched in February 2011 to gather information for one year to test the feasibility of implementing and determining policy effectiveness.

Twelve operations, representing ~40% of the estimated Regional cow numbers, volunteered to participate. A description of proven BMPs and a BMP selection-guide were created to help producers develop site-specific Air Quality Management Plans (AQMP). Each AQMP identified, systematically, specific BMPs to mitigate emissions from each area of the dairy system (nutrition, feed management, milk parlor, housing-drylot, housing-freestall, grazing, manure management, land application, other) based on effectiveness, practicality and economics. The pollutants addressed in each AQMP included ammonia, nitrous oxide, hydrogen sulfide, volatile organic compounds, odor, particulate matter, oxides of nitrogen, and methane. A universal score-sheet was created to assess implementation of BMPs at each dairy. The YRCAA inspectors were trained to evaluate, score, and record BMP implementation. A whole-farm score was generated during each visit, which identified areas of improvement to be addressed.

The process was very unique in that the dairy industry took a proactive role and actively participated. Using science and air quality experts to create and validate the evaluation tools and process also brought authority to the process. The policy was revised based on information collected from the pilot project and was adopted in February 2012. To date, 22 operations, representing 57% of total cow numbers in the Yakima Region, are enrolled. <http://www.extension.org/67596>

## **Design, Hydrologic Performance, and Effluent Characteristics Of A Woodchip Heavy-Use Area With Subsurface Drainage For Wintering Beef Cattle**

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John Miller, West Virginia University, Thomas Basden, West Virginia University

Benefits to cattle welfare and pasture condition from wintering or confining animals on woodchip heavy use areas have been reported elsewhere in the world, but no known installations of this Best Management Practice have occurred in the United States. Furthermore, increasing environmental concern and regulatory scrutiny of winter feeding areas and other heavy use areas demand improved management of nutrient-laden runoff. A pilot study was initiated to evaluate the environmental impact of such a woodchip heavy use area as a winter herd management method for a pasture-based beef operation in northern West Virginia. A dosed vegetative treatment system was installed to treat drainage effluent. Effluent volume was recorded and nutrient concentrations were monitored during three years of winter stocking. Measured data and hydrologic performance of this system was used for a comparison to runoff and nutrient loadings from other types of open-lot systems. While a degree of pollutant reduction and retention occurred during percolation through the woodchip media, low-cost control of effluent from such systems remains a challenge, as in similar open-lot situations. Woodchip heavy use area and drainage system design specifications are also reported with adjusted design recommendations. Results indicate what the potential for expanded application of these systems is and

offer a baseline for continuing research of this relatively unexplored technology in the region and elsewhere. <http://www.extension.org/67726>

## **Youth Agriculture Greenhouse Gas Educational Lab Materials via Pork Production Scenarios**

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Many of today's high school students have little insight into the basic day-to-day operational decisions and challenges faced by Agricultural producers. Therefore, there is a need for the development of ag-centric and dynamic educational material. Furthermore; there is an even greater need to provide high-school instructors with innovative classroom materials and instructional tools that are conducive to the structured conveyance of ag principles. Targeting the need for these innovative ag educational materials within Arkansas classrooms, this project presents an dynamic lab activity with emphasis on introductory level subject matter about Arkansas swine production systems and the related greenhouse gas emissions. Due to the particular nature of the subject matter, the activity materials were crafted into two complementary products for practicality. The first product is a compilation of swine production reference materials including: terminology and layman definitions of Arkansas swine management strategies and the basic dynamics of greenhouse gasses (CO<sub>2</sub>, N<sub>2</sub>O, CH<sub>4</sub>) as they relate to swine production. The second product is a scenario based critical thinking exercise, implemented from a manipulative decision-tree platform. The primary objectives of this effort are to:

1. Educate students within the state of Arkansas about the various management systems intrinsic to swine production operations within their state.
2. Provide students insight into the management obstacles that Arkansas swine producers are challenged with in balancing Carbon footprints, economic resources, natural resources, and legal compliance with production profitability and productivity.

<http://www.extension.org/67593>

## **How Do Environmental Risk Management Strategies Fit Into The Overall Risk Management Plan For Working Farms?**

Dennis, Frame, UW Discovery farms [drframe@wisc.edu](mailto:drframe@wisc.edu)

This workshop will focus on how dairy farmers in Wisconsin evaluate the risk of nutrient and sediment loss on their operations and what best management practices are adopted to reduce these risks. Dennis will describe how farm families evaluate all the risk factors facing their operation (weather, production, marketing, labor, safety and environmental risks) and discuss how a farmer has to balance the risk and rewards for each of these challenges. It is helpful to gain an appreciation for the numerous challenges farmers face on a daily basis and the amount of time committed to the evaluation and implementation of soil and water best management practices on each farm. Conservation practices are often applied in a "one size fits all" approach and are not developed and implemented to fit the needs of each farming operation. The large diversity of both farming systems and physical settings require a collaborative evaluation and implementation process between producers and conservation technicians to develop

economic, effective, and practical conservation practices to fit the specific circumstances of individual farming operations. <http://www.extension.org/67592>

## **Phosphorus: Producer Perspective**

Dennis Frame, University of Wisconsin Discovery Farms

## **Reducing Risks of Liquid Manure Reaching Surface Waters: Management Options**

Larry Geohring

## **Coupling Dairy Manure Anaerobic Digesters with Commercial Greenhouses – An assessment of Technical and Economic Feasibility**

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Tim Shelford, Cornell PRO-DAIRY

Despite all of the positive environmental benefits of anaerobic digestion, the economics are not sufficient for widespread adoption by US farmers when selling surplus power to the grid. Often farms are only paid the wholesale price (2 to 3 cents/kWh) for electricity, making it difficult to justify generating it in the first place. In addition, typically in the Northeast, approximately 40% of the energy from a digester goes unused (excess heat). Therefore, promising value-added technology/business partnerships need to be evaluated and demonstrated, such as partnering anaerobic digestion with commercial greenhouses.

Greenhouses are an ideal end user of the waste heat and surplus electricity produced by a digester. In the Northeast and other similar climates, heat and electricity represent a major expense for greenhouse growers. Greenhouses can make use of excess heat to provide the necessary growing conditions for year-round production and excess electricity can be used to run supplemental lighting to keep production constant year-round.

To facilitate the adoption of digester/greenhouse unions, we are developing a comprehensive computer model of both the energy output of farm-based digesters, the energy requirements of the associated farm, and the energy required by greenhouses, in terms of timing and magnitude. We will use existing and project-developed data collected from five Northeast digesters and three greenhouse operations to aid in developing and validating the model. The model will be complex enough to handle varying biomass inputs and required outputs, and the economics of operation. We will use the model to run several real-world “what ifs” and use the outputs for making recommendations to existing anaerobic digesters considering coupling with greenhouses. System economics are also going to be included.

<http://www.extension.org/67727>

## Online Bioenergy Training Modular Course Series

Charles Gould Michigan State University Extension [gouldm@msu.edu](mailto:gouldm@msu.edu)

The Energy Independence, Bioenergy Generation and Environmental Sustainability Training Center provides educational training resources focused not only on the technical feasibility of bioenergy generation, but also on approaches and processes that assist communities in understanding the comprehensive implications of bio-based alternative energy. These training resources consist of three peer-reviewed, research-based online modular courses developed by content experts from across the North Central Region. Course 1 addresses bioenergy and sustainability, Course 2 addresses on-farm energy conservation and efficiency, and Course 3 addresses anaerobic digestion. Topics within each course range from general concepts to more specific issues/concerns surrounding bioenergy generation and environmental sustainability. The targeted audience is Extension educators. The intended outcome of the courses is to bring viable bioenergy projects into communities by providing Extension educators with tools and knowledge they can use to make this happen. This presentation will provide participants with an overview of all three courses and how to use the tools to bring bioenergy projects into a community. <http://www.extension.org/67728>

## Feeding Cattle without the Feedlot

Jason Gross, University of Nebraska Lincoln Extension [jgross3@unl.edu](mailto:jgross3@unl.edu)

Christopher Henry, PhD, P.E., Assistant Professor and Water Management Engineer, University of Arkansas [cghenry@uark.edu](mailto:cghenry@uark.edu)

Typically cattle producers can have improved animal performance through controlled systems such as an open lot feedlot. Open lots provide for improved control of diet, health, and monitoring of activity of the animals. Feeding areas such as these also can have disadvantages such as solid manure accumulation, surface water contamination when runoff water is uncontrolled, such systems are labor and machine intensive, and can contribute herd health issues because of high stocking densities, dust, or mud. Forage based grazing can negate many of these issues and is arguably more sustainable and environmentally friendly. However intensive grazing strategies must be employed to obtain comparable productivity. Development of technology that allows for these benefits is needed. Cross fencing and rotational grazing practices would benefit from more flexible and less labor intensive ways of controlling the grazing area.

A device has been developed by UNL Extension that adapts a center pivot irrigation system into a moveable fence by placing the fence on the center pivot structure. Livestock producers can move anywhere from several hundred to several thousand feet of fence by simply moving the center pivot (while not irrigating). Swath grazing, forage grazing, or crop residue grazing can be accomplished more efficiently by only allowing minimal access to the forage. Essentially moving the animals to the feed rather than bringing the feed to the animals. Advancing a cross fence periodically not improves the grazing efficiency, but it encourages a natural spread of manure and gives the producer more control of remaining crop residue, a necessary requirement to maintain pasture status and avoid the Animal Feeding Operation designation. The device was tested on working farms over a two year period and

improved profitability and minimized environmental impact compared to the operator's previous practices. <http://www.extension.org/67595>

## **Automating Management for a Vegetative Treatment System**

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Chris Henry PhD PE, Assistant Professor and Water Management Engineer, University of Arkansas  
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Vegetative Treatment Systems are an alternative to runoff retention ponds for open lot feedlots. To operate effectively they must be managed soon after a runoff event has occurred. University of Nebraska Lincoln Extension has been evaluating several methods of sensor control to help the livestock producer to better manage the runoff water application. One system was designed and developed that incorporated a human machine interface (HMI) into the design of the pump station as a proof of concept for a Sprinkler Vegetative Treatment System. The HMI provides the user with information about the soil moisture profile in the vegetative treatment area, sediment basin depth status, pump operation on a touchscreen interface. The HMI is connected to the internet and provides simple message system alerts critical to proper operation of the VTS. The system also logs the parameters including precipitation for potential regulator record keeping requirements. Adaption of industrial automation such as this has the potential to enhance management by providing historic and real time information to producer about the performance of the VTS, especially during unattended operation. The second system is a Sprinkler Vegetative Treatment System that uses a more economical data collector with soil moisture sensors. The logging of soil moistures along with rainfall data can assist the producer on when and where to apply runoff water to individual sets of sprinkler application system.

As more electrical control systems are being developed for all phases of farming, UNL Extension will continue to evaluate these systems for their utility in runoff water treatment systems.

<http://www.extension.org/67598>

## **Adoption Trends of Nutrient Related Practices on Canadian Livestock Farms**

Dennis Haak, Agriculture and Agri-Food Canada [dennis.haak@agr.gc.ca](mailto:dennis.haak@agr.gc.ca)

This presentation will provide key results of the 2011 Farm Environmental Management Survey (FEMS) for practices related to manure nutrient management on Canadian livestock farms. A number of landscape based practices are evaluated for both confined livestock and grazing livestock. For confined livestock this includes various aspects of manure management such as time, rate, and method of land application. For grazing livestock specific practices include degree of access to surface water bodies, and management of in field winter feeding systems such as swath or bale grazing. For confined livestock a number of farmyard based practices are also evaluated. These include size and features of manure storages, manure treatment technologies, and management of wastewater. The presentation will also provide a comparison of adoption of these practices with the previous FEMS 2006 survey. FEMS is a joint initiative of Statistics Canada (StatsCan) and Agriculture and Agri-Food Canada (AAFC) in collaboration with various provincial government agriculture departments. The survey is used, together

with other data sources, to generate agri-environmental indicators that measure effectiveness of past programs and policies, and help develop appropriate future responses. (Note: Data is to be released to AAFC in September, 2012. Analysis to be done in the fall 2012 and early winter 2013. Abstract can be updated at a later date prior to the conference to include key results. <http://www.extension.org/67729>)

## **Phosphorus Concentrations Have Been Declining In The Illinois River: Was It Point Sources, Farm-Level Nutrient Management, Or What?**

Brian Haggard, Arkansas Water Resources Center, [haggard@uark.edu](mailto:haggard@uark.edu)

Thad Scott, Crop, Soil and Environmental Sciences Department, Division of Agriculture, University of Arkansas System

Elevated phosphorus concentrations in the Illinois River Watershed (IRW) have long been an environmental issue between the states of Arkansas and Oklahoma, which has led to the development of a watershed-reservoir model and future TMDL by the U.S. Environmental Protection Agency. Here, we examine phosphorus concentrations from multiple sources, including the Arkansas Water Resources Center and the U.S. Geological Survey, to evaluate trends in flow-adjusted concentrations.

Flow-adjusted phosphorus concentrations have been decreasing in the Illinois River at Arkansas Highway 59, and this translates into decreases further downstream to Tahlequah, Oklahoma. However, flow-adjusted concentrations in Flint Creek have been increasing over time until the last few years. These decreases are tied to the reductions in effluent phosphorus, which have occurred over the last couple decades. But, the application of poultry litter has also likely decreased within the IRW. A nutrient mass balance of the Watershed Research and Education Center in Fayetteville, Arkansas showed that reduced litter applications and increased forage export (i.e., hay being removed from fields) can result in phosphorus export at the farm-scale. The missing piece of this study would be understanding legacy phosphorus, and how this influences source apportionment and changes over time.

<http://www.extension.org/67730>

## **What Happens When You Mix Chitosan and Poultry Litter?**

Brian Haggard, Arkansas Water Resources Center, [haggard@uark.edu](mailto:haggard@uark.edu)

I.M. Bailey, Formerly Biological Engineering Program, University of Arkansas, D.A. Zaharoff, Biomedical Engineering Department, University of Arkansas

The solubility of phosphorus (P) and low nitrogen(N):P ratio of poultry litter present environmental challenges when using this resource to supply nutrients to crops and forages. Here, we explore the use of chitosan to reduce water extractable P (WEP) in poultry litter and potentially increase the N:P ratio. Chitosan is derived from chitin, which is a waste product from the commercial shellfish industry; chitin is processed into chitosan through deacetylation, removing acetyl groups from this long-chained molecule. Chitin has been successfully used in manure separation and flocculation in wastewater treatment processes, as well as immobilizing algae in wastewater streams to uptake nutrients.

We performed a series a lab studies to evaluate how chitosan might reduce WEP, influence ammonia volatilization and potentially increase the N:P ratio of poultry litter. Our experiments showed that chitosan was effective at reducing WEP content of poultry litter and increasing the N:P ratio, but ammonia volatilization might be increased under moist conditions. We would like to take this from the lab to small plot and then field trials in the near future. <http://www.extension.org/67731>

## **Managing Livestock Ammonia: A Volatile, Promiscuous, Fugitive in the Atmosphere (Emphasizing Rocky Mountain National Park)**

Jay Ham, Colorado State University

<http://www.extension.org/67745>

## **Making Sense of Smells -Communicating Odors to Diverse Audiences**

Douglas Hamilton, Oklahoma Cooperative Extension Service [dhamilt@okstate.edu](mailto:dhamilt@okstate.edu)

Emilia Paloma Cuesta-Alonso,\* Covadonga Consulting

Students attending this two hour workshop will learn to use an innovative visual technique to describe farmstead odors to general audiences without resorting to chemical jargon. Students will also participate in a mock laboratory exercise to demonstrate how odor intensity is measured.

This workshop is beneficial to K-12 teachers, university extension and teaching faculty, public relations professionals, and regulatory agency personnel. Attendees will receive annotated PowerPoint slide sets for all lectures, and lesson plan for the laboratory exercise. Additional instructional material covering a more biology and chemistry intense lecture and four additional laboratory exercises will be given.

The visualization technique based on shapes and colors was developed at Oklahoma State University in the mid 1990s, and has been used to talk about odors with many diverse audiences. The method demonstrates that odors have “structure”, and can be measured using four concepts: character, concentration, intensity, and persistence.

In this workshop, students will use the visualization technique, and apply and evaluate the measurement concepts in a simple “sniffing” exercise. The exercise entails smelling perfume dilutions representing odor intensity. Results of the exercise will be analyzed in “real time”. Further analyses of previous exercise runs will be compared and contrasted to the workshop results. Results of laboratories conducted using farmstead odors and the noses of over 250 college freshmen will be presented.

<http://www.extension.org/67597>

## **Evaluation of a Trickle Flow Leachate Bed Reactor For Anaerobic Digestion Of High Solids Cattle Manure**

Asma Hanif Abdul Karim, Colorado State University [asmahanif1988@gmail.com](mailto:asmahanif1988@gmail.com)

Anaerobic digestion (AD) of cattle manure is of increasing interest in Colorado due to its abundant availability. Colorado is the second highest producer of high solids cattle waste (HSCW) in the United

States (U.S.). Despite the available resources, Colorado currently has only one operational anaerobic digester treating manure (AgSTAR EPA, 2011), which is located at a hog farm. Arid climate and limited water resources in Colorado render the implementation of high water demanding conventional AD processes.

Studies to date have proposed high solids AD systems capable of digesting organic solid waste (OSW) not more than 40% total solids (TS). Lab tests have shown that HSCW produced in Greeley (Colorado) has an average 89.4% TS. Multi stage anaerobic digester proposed in the current study is capable of handling HSCW up to 90% TS. In this system, hydrolysis and methanogenesis are carried out in separate reactors for the optimization of each stage. Hydrolysis is carried out in a trickle flow leachate bed reactor (TFLBR) and methanogenesis can be carried out either in a upflow sludge blanket (UASB) reactor or a fixed film reactor. The objective of this research was to evaluate and optimize the performance of the TFLBR. The system was operated as a batch process with a hydraulic retention time (HRT) of 42 days. Organic leaching potential of a single pass TFLBR configuration was evaluated. In a typical system, addition of nutrients would not be essential as the manure itself is nutrient rich. But due to experiment set up here, nutrient washout was a concern. And so a comparison between nutrient dosed and non-nutrient dosed TFLBR was performed. 44.15% and 62.49% of total chemical oxygen demand (COD) was leached out from non-nutrient dosed and nutrient dosed TFLBR respectively. Nutrient dosing contributed to better leachate quality when compared to non-nutrient dosed TFLBR; however biochemical methane potential (BCMP) tests indicated a similar methane potential of 24.5L CH<sub>4</sub>/Kg COD. This could be due to excessive nutrient toxicity and/or an increase in volatile fatty acids (VFA) in the leachate samples. Concentration of inorganics leached from the TFLBR was monitored periodically. <http://www.extension.org/67604>

## **Design, Construction and Implementation of a Pilot Scale Anaerobic Digester at the University of Missouri-Columbia's Swine Teaching and Research Farm**

Brandon Harvey, University of Missouri [bchfzf@mail.missouri.edu](mailto:bchfzf@mail.missouri.edu)

Other Speakers: Teng-Teoh Lim<sup>1</sup>, Kevin Rohrer<sup>2</sup>. 1 Agricultural Systems Management, University of Missouri; 2 Martin Machinery, LLC.

Animal manure is often utilized by the American agriculture industry as fertilizer without considering the potential energy production. It is well established that on-farm anaerobic digestion (AD) can be effective in providing energy, reducing greenhouse gas emissions, and controlling air and water pollutions. Knowledge of the ADs on biogas production, digested and stored manure nutrients, and air emissions must reach parties of interest. A modular, pilot-scale, mesophilic AD system is being installed for the new swine finishing facility at University of Missouri-Columbia Research Farm. The new AD design utilizes three insulated, reinforced fiber-glass tanks of 2500-gallon in size, which are commercially available. One tank is designed for feedstock storage and mixing, and the other two tanks are for digestion. The dual-tank set up provides research flexibility as either single stage with two-stream parallel replication or dual-stage single-stream experiments. The design employs small biogas (generated by the AD) boilers for heating the digester tanks and system building. It also features a feedstock-digestate heat-exchanger for heat reclamation to reduce net energy input; which will be

critical to the small and mid-size AD systems not generating electricity (no waste-heat from engines). The system also includes a geothermal heat exchanger for biogas cooling to collect condensate in the biogas along with a small iron sponge to reduce H<sub>2</sub>S concentrations which improves the biogas quality. Excess biogas will be burned in boiler and the heat produced will be dissipated through a dual purpose radiator. The radiator provides building heat in winter and releases heat outside in summer. The goals of this project are to demonstrate AD for small and mid-size swine productions, quantify and characterize manure nutrient changes due to AD and storage, and develop baseline emission factors for raw and digested manure. This paper reports the design, construction and implementation of the AD system.  
<http://www.extension.org/67607>

## **Converting Onion Waste into Energy as a Co-digestant with Dairy Waste**

Gary Hawkins, University of Georgia, [ghawkins@uga.edu](mailto:ghawkins@uga.edu)

Consumers demand high quality fruits and vegetables. As a result, packing sheds around the country cull or remove bad fruits and vegetables prior to packing then in boxes for shipment to stores. The culling process produces millions of pounds of waste fruits and vegetables annually. This culled fruit or vegetable then has to be disposed of in some form or fashion. Therefore, a project was designed to investigate the feasibility of using culled onions in conjunction with dairy waste to produce methane gas. The experiment used 90 liter downflow anaerobic filters to process a 50/50 mix of onion juice and dairy waste. Results from this study indicate the co-digestion of culled onions and dairy waste provides a good way to dispose of the waste onions while at the same time producing a renewable energy that can potentially be used in the packing shed where the onions are separated. The 50/50 blend of onion waste and dairy waste has consistently returned an average of 15 liters of biogas (70-75% methane) per 3 liters of mixed waste entering the digesters with a cleaning efficiency over 85%.

<http://www.extension.org/67735>

## **Extension Outreach Response to Livestock Mortality Events Associated With Algal Toxin Production in Georgia Farm Ponds**

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Cyanobacterial toxins have been implicated in fish, wildlife and livestock mortality events. Cyanobacteria blooms, which often produce toxins, are exacerbated by hot, dry weather. The majority of Georgia, with the exception of the coastal Plain and the Northwestern corner, was in a severe to exceptional drought

condition during 2012. In May 2012, we began receiving reports of livestock deaths associated with algal blooms. Based on clinical signs and algal screening, we were able to document four cattle deaths at one central Georgia pond with a dense *Microcystis aeruginosa* bloom ( $4.4 \times 10^6$  cells/mL) and >40ppb microcystin. Since this incident, we have received and screened numerous water samples from livestock drinking water ponds throughout the state. We document cyanoblooms, predominantly *Microcystis*, in the majority of ponds screened (9/12) and microcystin in all samples screened for toxin (8/8). We have made algacide treatment recommendations to the farmers for immediate relief and discussed best management practices for reducing nutrient loading and algal blooms in the future. The livestock deaths, although unfortunate, have highlighted an important issue for Georgia farmers and pond owners that will likely be increasingly prevalent under projected climatic models. In response to these events we have coordinated with the University of Georgia's Agriculture and Environmental Services Laboratory to establish an algal screening and cyanotoxin testing service. This testing service will enable us to better serve the citizens of our state and provide a platform to disseminate information aimed at improving water resource management and livestock health <http://www.extension.org/67606>

### **Smartphone Apps for Manure Management**

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Technology is driving many exciting possibilities in agriculture. The increase in use of smartphones, tablets, and other mobile devices is changing the way people consume information and interact with each other. One exciting opportunity is to utilize smartphone apps to make farm record keeping easier. With that in mind, two apps were created for livestock and poultry farms.

"Manure Calculator" has three sections. 1) calculate the amount of manure spread (calibrate your spreader) 2) calculate the amount of nutrients applied by using either your own manure test or using book values and 3) calculate the economic value of that manure. The app keeps a history of past entries and allows the user to email a single entry or an entire history to themselves for record keeping purposes.

"Manure Monitor" is a utility that includes a farm emergency plan (for manure spills). The plan is updated by one person and everyone else can "sync" with that plan from their own devices. Other aspects of the app do not sync, but include carcass disposal, rainfall records, liquid manure storage levels, and others.

Both apps are available in iOS and Android platforms. <http://www.extension.org/67608>

### **Comparison of Liquid Swine Manure And Aqua-Ammonia Nitrogen Application Timing On Subsurface Drainage Water Quality In Iowa**

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Xiaobo Zhou, Iowa State University, Carl Pederson, Iowa State University

In Iowa and many other Midwestern states, excess water is removed artificially through subsurface drainage systems. While these drainage systems are vital for crop production, nitrogen (N), added as

manure or commercial fertilizer, or derived from soil organic matter, can be carried as nitrate-nitrogen (NO<sub>3</sub>-N) to downstream water bodies. A five-year, five-replication, field study was conducted in north-central Iowa with the objective to determine the influence of seasonal N application as ammonia or liquid swine manure on flow-weighted NO<sub>3</sub>-N concentrations and losses in subsurface drainage water and crop yields in a corn-soybean rotation. Four aqua-ammonia N treatments (150 or 225 lb-N/acre applied for corn in late fall or as an early season side-dress) and three manure treatments (200 lb-N/acre for corn in late fall or spring or 150 lb-N/acre in the fall for both corn and soybean) were imposed on subsurface drained, continuous-flow-monitored plots. Four-year average flow-weighted NO<sub>3</sub>-N concentrations measured in drainage water were ranked: spring aqua-ammonia 225 (23 ppm) = fall manure 150 every year (23 ppm) > fall aqua-ammonia 225 (19ppm) = spring manure 200 (18 ppm) = fall manure 200 (17 ppm) > spring aqua-ammonia 150 (15 ppm) = fall aqua-ammonia 150 (14 ppm). Corn yields were significantly greater (p=0.05) for the spring and fall manure-200 rates than for non-manure treatments. Soybean yields were significantly greater (p=0.05) for the treatments with a spring nitrogen application to the previous corn crop. <http://www.extension.org/67600>

### **Waste Disposal by the Veterinary Community**

Kristi Henderson, American Veterinary Medical Association [khenderson@avma.org](mailto:khenderson@avma.org)

The presentation will provide a basic overview of resources offered by the American Veterinary Medical Association to its members and the public regarding various disposal issues encountered by the veterinary community and animal owners. Resources to be discussed, include “Disposal by Veterinary Practices: What Goes Where?” (<http://www.avma.org/wastedisposal>), “One Health” (<http://www.avma.org/onehealth>), and “Green Veterinary Practices” (<https://www.avma.org/PracticeManagement/Facilities/Pages/Green-Veterinary-Practices184.aspx>).

<http://www.extension.org/67601>

### **Use of filters in drainage control structures to reduce the risk associated with manure application on tile-drained fields**

Stephanie Herbstritt, University of Illinois at Urbana/Champaign [herbstr2@illinois.edu](mailto:herbstr2@illinois.edu)

Julie Honegger, Anne Kwedar, Richard Cooke

In livestock producing areas, animal manure is often applied to cropland to enhance soil fertility. Guidelines have been developed for manure application on fields underlain by subsurface (tile) drainage systems. Some of these guidelines, such as avoiding manure application if rain is predicted and not applying manure over a flowing tile, though effective, involve some level of risk. We believe that the level of risk can be reduced by filtering contaminants from the water leaving the drains. The control structures recommended for use with drainage systems underlying fields to which manure is applied, provide ready-made receptacles for filters. In this report we discuss the development and testing of a filter to remove contaminants from lagoon effluent. <http://www.extension.org/67605>

### **Silage Leachate Characteristics**

Mike Holly, University of Wisconsin-Madison [maholly@wisc.edu](mailto:maholly@wisc.edu)

R. Larson, University of Wisconsin-Madison

Silage leachate is a high strength waste which contributes to surface and groundwater contamination of various pollutants from runoff, direct leaching through concrete storage structures, and infiltration of runoff. Feed storage is required for the majority of dairy operations in the country (which are expanding in size and feed storage requirements) leading to widespread potential contamination. Limited data on silage leachate quality and treatment has made management and regulation based solely on observation. This project investigated three bunker silage storage sites to assess the water quality characteristics of silage leachate and runoff from various feed sources and surrounding environmental factors. Surface samples were collected from feed storage structures and analyzed for numerous water quality parameters. Using collected hydrologic data, contaminant loading was analyzed for various storm events and assessed for first flush effects and potential to impact handling and treatment designs. Determination of first flush provides essential data for separation of waste streams (high and low strength) to ease management in terms of operation and cost, reduce loading to treatment systems, and reducing the overall environmental impact. <http://www.extension.org/67602>

### **Treatment of Silage Runoff with Vegetated Filter Strip**

Michael Holly, University of Wisconsin-Madison [maholly@wisc.edu](mailto:maholly@wisc.edu)

Rebecca Larson\* University of Wisconsin-Madison

Agricultural filter strips are commonly used to treat runoff from agricultural farmstead areas. Many filter strips have been assessed in terms of surface water quality impacts but have failed to determine the fate of pollutants once they have infiltrated the soil subsurface. Two side-by-side filter strips plots were installed to assess the performance of and determine the fate of contaminants in a filter strip system. One of the two plots also contained a pretreatment system to facilitate nitrogen removal in an attempt to reduce nitrate leaching. Both plots were lined with an impermeable membrane to collect subsurface leachate as well as surface runoff. A mass balance could then be determined for these filter strip systems to assess the fate of nutrients and the ability of a low cost pretreatment system to reduce nitrate leaching. <http://www.extension.org/67603>

### **Feed Management: Certification Training Workshops, ARPAS Certification and Results From Fifty-One Contracted Dairies**

Virginia Ishler, Penn State University [vishler@psu.edu](mailto:vishler@psu.edu)

Rebecca White, Penn State University\*, Dan Ludwig, Pennsylvania USDA-NRCS\*

In 2007, Mid-Atlantic Water Program (MAWP) scientists applied the national feed management program to meet the needs of dairy consultants to implement feed management in the Chesapeake Basin. The university specialists decided the greatest opportunity to positively affect water quality was to implement the national initiative: Development and Integration of a National Feed Management Education Program and Assessment Tools into a Comprehensive Nutrient Management Plan, which was being led by Washington State University. This program certifies consultants in precision feed management, a practice that reduces nutrient loads in animal wastes by minimizing the phosphorus and

nitrogen content fed to cattle. The certification training began in 2007 and has been ongoing every year since. There have been 296 consultants and NRCS personnel that have attended the certification training conducted by the Penn State Extension Dairy Team. Eighty-one of the 98 consultants listed on the American Registry of Professional Scientists (ARPAS) as passing the feed management exam in dairy attended our training. Pennsylvania currently has twenty-three NRCS qualified nutritionists to write feed management plans for dairy and five for beef. This means they have passed the ARPAS feed management exam AND submitted the two required feed management plans to NRCS for review.

In Fiscal Year 2011, NRCS reported seeing Feed Management reported on less than 10,000 Animal Units on a national basis. Feed Management is a conservation practice that can have major impacts on watersheds across the nation. Feed Management, when implemented, can improve both water and soil quality resource concerns. In reaction to the amount of Feed Management applied nationally, this workshop will give certified nutritionists or other ARPAS members the opportunity to attend an ARPAS Feed Management certification workshop and take the Feed Management exam upon the conclusion of the workshop. <http://www.extension.org/67613>

## **Sustainable Dairy Cropping Systems**

Virginia Ishler, Penn State University [vishler@psu.edu](mailto:vishler@psu.edu)

Robert Meinen, Penn State University\*, Heather Karsten, Penn State University, Glenna Malcolm, Penn State University

An interdisciplinary team of Penn State and USDA-ARS researchers are evaluating a Sustainable Cropping System to test the hypothesis that a dairy farm can minimize off-farm inputs and environmental impacts, and be productive, profitable and sustainable. Established in 2010 at the Penn State Agronomy Research Farm, the farm produces grain, forage and tractor fuel at 1/20th the scale of an average sized Pennsylvania dairy of 240 acres. The farm includes two diverse 6-yr crop rotations that include manure injection, perennial legumes, cover and green manure crops; a cover crop roller, winter canola, and a straight vegetable oil tractor. Within each crop rotation two management practices for no-till crop production are compared:

1. Forage Rotation compares injected manure (IM) to broadcast manure (BM); and
2. Grain Rotation compares a combination of weed management strategies designed to reduce herbicide (RH) use relative to a “standard” herbicide (SH) weed management program.

The two diverse cropping systems are designed to provide all the forage and feed for 65 lactating cows housed in a tie-stall barn, 10 dry cows and 75 young-stock. Crops are analyzed for crude protein, neutral detergent fiber, and net energy of lactation; the production of a “virtual dairy herd” is simulated using the 2001 NRC dairy nutrition model. Performance of the two farm scenarios (BMSH or IMRH) is compared. Income-over-feed costs are monitored monthly to evaluate impact of forage quality and quantity on profitability. The economic performance of the two cropping systems: BMSH vs. IMRH will be highlighted. In 2010, the IMRH scenario had a slight trend of higher income over feed cost compared to the BMSH scenario. <http://www.extension.org/67614>

## Small and Backyard Poultry Flocks

Jacque Jacob University of Kentucky [jacque.jacob@uky.edu](mailto:jacque.jacob@uky.edu)

Because of their size, it is possible to raise most poultry species (chickens, turkeys, ducks, geese, pigeon, etc.) with only a minimal amount of acreage. This has made them increasingly popular in rural, suburban, and urban areas throughout the United States. They are suitable for 4-H/classroom projects, backyard flocks, as well as small- and medium-sized production flocks. Many of those who have started raising poultry have limited experience with poultry production. <http://www.extension.org/67609>

## Money from Something: Carbon Market Developments, Trends, and Profitability for Agriculture

Jim Jensen, WSU Energy Program [jensenj@energy.wsu.edu](mailto:jensenj@energy.wsu.edu)

For more than a decade, the potential to earn revenue from climate-saving activities in agriculture has been touted throughout farm-related industries. This presentation will assume a basic knowledge of the concept of carbon markets as a kind of ecosystem service market. The focus will instead be put on current market opportunities and the importance of learning from past mistakes. Included in the discussion will be carbon offset opportunities for methane capture from manure digesters and composting and nitrous oxide reduction from controls on nitrogen fertilization. Participants will learn about voluntary and compliance market opportunities and the value of offsets versus transactions costs in today's markets. Sources of market information will also be discussed.

- Ecosystem services markets: Carbon credits and more.
- Types of offsets relevant to livestock and crop producers (e.g., methane and nitrous oxide).
- Rules of the road: How to read the key parts of project protocols.
- Once and future markets: Consider the differences between voluntary and compliance markets.
- Show us the money: Have any producers really made money from carbon markets?

<http://www.extension.org/67612>

## Interactive Displays on Environmental Stewardship for General Agricultural Audiences

Leslie J. Johnson, University of Nebraska, [leslie.johnson@unl.edu](mailto:leslie.johnson@unl.edu)

Charles A. Shapiro\*, University of Nebraska - Lincoln

Extension displays are not always easy to develop. Interactive displays for general audiences are even more difficult. Each year, the University of Nebraska – Lincoln develops multiple displays for Husker Harvest Days, a Nebraska-based agricultural trade show. The University's 2012 theme was "Strengthening the State of Beef". The Animal Manure Management workgroup, along with others working in environmental stewardship at the University of Nebraska – Lincoln came together to develop a backdrop titled "Nebraska's beef industry thrives by its stewardship". Along with the backdrop, multiple interactive displays were used to grab the attention of an agricultural audience not necessarily involved with beef production.

The Animal Manure Management workgroup's displays focused on the value of manure and the nutrients it contains. The display included demonstration of manure related iPad apps and a manure jeopardy game as well as a display that visually showed the amount of nutrients in two different types of manure, stockpiled and freshly scraped manure. Glass containers held corn, soybeans and fertilizers containing equal nutrient contents of each other. We engaged the audience by asking them which vessel contained more nitrogen or phosphorus. Mostly people were surprised at the nutrient content of the manure relative to bottles of corn or fertilizer. <http://www.extension.org/67733>

## **Manure Application Method And Timing Effects On Emission Of Ammonia And Nitrous Oxide**

Bill Jokela, USDA-ARS Dairy Forage Research Center, Marshfield, WI [bill.jokela@ars.usda.gov](mailto:bill.jokela@ars.usda.gov)

Carrie A. M. Laboski, and Todd W. Andraski, Soil Science Dept., Univ. of Wisconsin, Madison, WI

Manure is a valuable source of N for crop production, but gaseous losses of manure N as ammonia (NH<sub>3</sub>) and nitrous oxide (N<sub>2</sub>O) reduce N available to the crop, adversely affect air quality, and contribute to increased greenhouse gas emission. We conducted a field study on corn to evaluate the effect of liquid dairy manure applied pre-plant (injection or surface broadcast with immediate or 3-day disk incorporation) or sidedressed at 6-leaf stage (injected or surface-applied) on emission of NH<sub>3</sub> and N<sub>2</sub>O. Manure was applied at a rate of 6500 gal/acre, which supplied an average of 150 lb/acre of total N and 65 lb/acre of NH<sub>4</sub>-N. Ammonia emission was measured for 3 days after manure application using the dynamic chamber/equilibrium concentration technique, and N<sub>2</sub>O flux was quantified using the static chamber method at intervals of 3 to 14 days throughout the season. Ammonia-N losses were typically 30 to 50 lb/acre from pre-plant surface application, most of the loss occurring in the first 6 to 12 hours after application. Emission rates were reduced 60-80% by quick incorporation and over 90% by injection. Losses of N<sub>2</sub>O were relatively low (1 lb/acre or less annually), but pronounced peaks of N<sub>2</sub>O flux occurred from either pre-plant or sidedress injected manure in different years. Results show that NH<sub>3</sub> emission from manure can be reduced substantially by injection or quick incorporation, but there may be some tradeoff with N<sub>2</sub>O flux from injection. <http://www.extension.org/67611>

## **Valuing Feedstocks for Anaerobic Digestion – Balancing Energy Potential and Nutrient Content**

Dana Kirk, Michigan State University [kirkdana@msu.edu](mailto:kirkdana@msu.edu)

Louis Faivor

To improve the energy production and revenue generation, many farm digester operators are including off-farm feedstocks in the blend. Off-farm feedstocks are raw materials with high carbon concentrations that can be degraded anaerobically. Common off-farm feedstocks include food service or retail waste, food processing byproducts, residuals from biofuels production and FOG (fat, oil & grease) resulting from food preparation. Typically, off-farm feedstocks have a higher energy potential when compared to manure. Manures generally have biogas potential in the range of 280 to 500 L of biogas/kg of VS, compared to off-farm feedstocks which can range from 300 to 1,300 L of biogas/kg of

VS . In addition to the increased biogas production, revenue can also be generated from tipping fees collected for feedstock brought onto a farm. The tipping fee is typically comparable to the cost of disposing of the material at a landfill or wastewater treatment plant.

While off-farm feedstocks do offer opportunities to improve the profitability of anaerobic digestion systems, operators must also consider the costs associated with bring material onto the farm. Water contained in off-farm feedstock contributes to the manure volume and adds cost during land application. Nutrients contained in feedstocks need to be measured and considered in the context of nutrient management planning. In addition, the regulatory and record keeping requirements associated with off-farm feedstock should also be factored into any cost-benefit analysis.

The thrust of the presentation will discuss how to evaluate the advantages and disadvantages of off-farm feedstocks using examples from the ADREC feedstock database. <http://www.extension.org/67610>

## **Impacts of a Changing Climate on Animal Agriculture**

Pamela Knox, University of Georgia [pknox@uga.edu](mailto:pknox@uga.edu)

Weather and climate have both short-term and long-term impacts on livestock development and management. This talk will focus on longer-term trends in climate and drought over time across the United States and the impacts of changes in these factors on animal agriculture. We will start by examining the trends in temperature and precipitation that have occurred over different regions of the US over the past century and how they have varied from one area to another. Then we will look at how future climate is predicted and problems in making useful predictions. We will follow that by looking at some of the most reliable predictions of future climate and discuss the potential impacts on livestock health, forage and feed supply, and farm management practices and the importance of resilience in farm practices. We will conclude by identifying both the challenges and the opportunities for future livestock producers in a changing climate. <http://www.extension.org/67615>

## **On-Site Analytical Laboratories to Monitor Process Stability Of Anaerobic Digestion Systems**

Rodrigo Labatut, Cornell University [ral32@cornell.edu](mailto:ral32@cornell.edu)

Curt Gooch, Cornell University

The anaerobic digestion of complex materials is a highly dynamic, multi-step process, where physicochemical and biochemical reactions take place in sequential and parallel ways. The stability of the process depends on a delicate balance between the formation and consumption of products. When the concentration of a particular substance reaches the homeostatic equilibrium of certain organism or group of organisms, such balanced is disrupted, and the process becomes upset. If measures to correct the source of the problem are not taken, substrate stabilization and biogas production will progressively decrease, and eventually stop. Recovery of a digester can take several weeks to months, during which, energy generation and waste treatment are not possible, resulting in increased operational costs for the facility. To detect process perturbations and prevent major digester upsets, periodic monitoring is essential. In this study, analytical laboratories were installed on selected on-farm anaerobic digestion

systems in New York State, to periodically monitor key process parameters and to evaluate performance and stability of the operations. Preliminary results showed that analytical labs were critical to detect process upsets efficiently, particularly in co-digestion systems, where loading rates and influent characteristics are usually variable. The laboratory is rather optional in manure-only operations, where the influent consists of a steady and predictable waste. <http://www.extension.org/67739>

## **Using AWM and SPAW For Evaluating Animal Waste Storage Structures**

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Pat Willey, Punya Khanal

The AWM (Animal Waste Management) software is primarily a design tool. It has been traditionally used for designing animal waste storage structures (tanks, ponds, lagoons, etc). Recently, it was upgraded to incorporate the evaluation function that enables the user to evaluate existing animal waste storage structures for their design adequacy. On the other hand, SPAW (Soil-Plant-Air-Water) is a water budgeting tool for farm fields, ponds and inundated wetlands. The SPAW model performs daily hydrologic water budgeting using a modified SCS Runoff Curve Number method. The POND module of the SPAW simulates a water budget for a small pond/ reservoir/lagoon as well as performs statistical analysis of pond inundation cycles based on the wetland growing season. The SPAW water budget outputs from one or more fields are used as input for the POND module.

This paper demonstrates, with an example, how these two tools (AWM & SPAW) can be used for evaluating existing animal waste storage structures for adequate design and operational feasibility. The AWM evaluates the capacity of the designed dimensions for the waste flowing into the structure and inflow from the extreme storm events; and the SPAW evaluates operational feasibility using long term simulations based on daily input of waste, rainfall, and other hydrologic interactions. The paper also elaborates the data sources such as soils, climate, evaporation, etc. and the process of compiling and formatting these data for SPAW simulations. <http://www.extension.org/67741>

## **Inactivation of Dairy Manure-Borne Pathogens by Anaerobic Digestion and Bedding Recovery Units**

Rebecca Larson\*, University of Wisconsin-Madison" [ralarson2@wisc.edu](mailto:ralarson2@wisc.edu)

Mark Borchardt, USDA, Susan Spencer, USDA

A study was conducted to evaluate the pathogen inactivation on 9 dairy facilities in Wisconsin with a combination of anaerobic digestion and solid/liquid separation technologies. Samples were collected every 2 weeks over the course of eight months to assess dairy pathogen inactivation in full-scale operational digesters and solid/liquid separators. Samples were then analyzed by qPCR for pathogens including protozoa, bacteria, bovine viruses, and indicators. Preliminary results indicate full-scale anaerobic digesters reduce pathogen levels by 99% to 99.9%. And after digestion and separation of the digestate, the liquid fraction contains the majority of pathogens. Although the solids fraction contained fewer pathogens, the concentration could still be above the infectious dose, particularly for calves.

Results have implications for a variety of digestate end uses including bedding and land spreading. <http://www.extension.org/67742>

## **Impact of Mixing Regime on Methanogen Biomass During Anaerobic Digestion**

Rebecca Larson, University of Wisconsin-Madison [ralarson2@wisc.edu](mailto:ralarson2@wisc.edu)

A study was conducted to assess the performance of various mixing regimes on methanogen biomass content in anaerobic digesters. Methane production in anaerobic digesters is directly related to the methanogens within the system. Current systems involve mixing to increase biogas production and system efficiency, however little is known about the underlying mechanisms of this relationship. In this study three pilot scale anaerobic digestion systems with three different mixing regimes were run with replication to examine the impacts to methanogen biomass content and biogas production. The results will provide insight for operational recommendations as well as the basic microbial processes with digestion systems which are critical for optimization. <http://www.extension.org/67744>

## **The Farm Manure to Energy Initiative: Demonstrating and Evaluating Manure To Energy Technologies That Concentrate Excess Nutrients In The Chesapeake Bay Region**

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Note that abstracts from other partners around the U.S. working with on-farm thermochemical technologies could be combined into a panel discussion. If the focus is alternatives to land application, the category is broader and includes work being done on advanced solid liquid separation technologies, struvite formation, etc. The Farm Manure to Energy Initiative consists of a coalition of partners working collaboratively to determine whether manure to energy technologies capable of concentrating excess manure phosphorus are feasible options for animal producers in the Chesapeake Bay watershed. Currently, all the Bay states are working to achieve nutrient reduction goals from various pollution sources. Significant reductions in phosphorus pollution from agriculture, particularly with respect to phosphorus losses from land application of manure are needed to support a healthy aquatic ecosystem. Producers in high-density animal agricultural production areas such as Lancaster County region of Pennsylvania, the Delmarva Peninsula, and the Shenandoah Valley region of Virginia, need viable alternatives to local land application in order to meet nutrient reduction goals.

Partners began this effort by releasing a request for proposals for technology vendors and farm hosts. Criteria for vendors included ability to concentrate excess phosphorus, cost-effectiveness, experience using manure as a feedstock and experience with on-farm installations. Promising technologies were selected for demonstration on small and large host farms in Pennsylvania, Delaware, Maryland, and Virginia.

These field demonstrations will be monitored to determine whether the technologies are environmental beneficial, and economically and technically feasible. Specific measures of performance include: reliability and heat distribution, in-house air quality, avoided propane or electricity use, costs to install

and maintain, fertilizer and economic value of ash or biochar produced, air emissions, and fate of poultry litter nutrients. Technology evaluation results will be shared on a clearinghouse website developed in partnership with eXtension.

The Farm Manure to Energy Initiative is also supporting efforts to develop markets for nutrient rich ash and biochar co-products. Field trials using nutrient rich ash and biochar from poultry litter thermochemical processes for fresh market vegetable production are currently underway at Virginia Tech's Eastern Shore Agricultural Research and Experiment Station. <http://www.extension.org/67617>

## **Watershed Nitrogen Reduction Planning Tool**

William Lazarus, University of Minnesota Department of Applied Economics [wlazarus@umn.edu](mailto:wlazarus@umn.edu)

A watershed-level nitrogen reduction planning tool (Excel spreadsheet with VBA macros) has been developed that compares the effectiveness and cost of nine different “best management practices” (BMPs), alone and in combination, for reducing N loads leaving a Minnesota watershed. The BMPs are: reducing corn N fertilizer rates to extension recommended rates, changing fertilizer application timing, seeding cover crops, installing tile line bioreactors or controlled drainage, planting riparian buffers, or converting some corn and soybean acres to a perennial crop. The tool was developed for the Minnesota Pollution Control Agency as part of a comprehensive study of surface water nitrogen conditions, sources, pathways to waters, trends and solutions. The intended audience is local policymakers and resource planners rather than farmers.

The spreadsheet contains data for fifteen high-nitrogen-load watersheds that make up most of the southern half of the state. The soil, crop, and nitrogen loading data are calculated for each of 36 separate agroecoregions, which are units having relatively homogeneous climate, soil and landscapes, and land use/land cover. A watershed typically includes parts of several regions which are aggregated when the user selects a watershed for analysis.

Using the model involves three steps. The first step is to select a watershed, enter hypothetical adoption rates for each BMP, and compare the effectiveness and cost of the individual BMPs. The second step is to compare suites of the BMPs that would attain any given reduction in the N load at minimum cost. The third step is to “drill down” to the details and assumptions behind the models of effectiveness and costs of any particular BMP and make any adjustments to reflect your particular situation. <http://www.extension.org/67624>

## **Designing Wells for Maximum Production, Well Life, and Energy Efficiency**

Jay Lazarus, Glorieta Geoscience, Inc. [lazarus@glorietageo.com](mailto:lazarus@glorietageo.com)

Jim Riesterer

Agriculture is the largest user of ground water in the United States. Ground water at dairies is used for cow drinking, milking parlor clean-up and crop irrigation. Ground water is produced from wells that often are improperly designed and completed. Inefficient well design, including improperly sized pumps, results in increased pumping costs and increases the frequency that wells and/or pumps have to be

replaced. Inefficient wells require significantly more energy to pump lesser amounts of water than properly designed wells. Sand production from unconsolidated or poorly-consolidated aquifers reduces the effective life of the well and pump. Sand production is significantly reduced by properly sizing the well screen and filter pack. Pilot holes are drilled so grain size analyses can be conducted and well screen and filter pack can be properly sized. Geophysical logs may be utilized to identify zones of maximum potential production. The pilot holes are reamed out to the design diameter and the well is constructed with an optimal screen and filter pack combination. Efficient wells are designed with maximum open-area and proper filter packs, so well screens are not dewatered and the well does not pump sand or air. Production tests on the completed well allow the pump motor and bowls to be sized and set to a depth that will maximize pump efficiency and water production while minimizing power costs. An efficient, sand-free well will save a farmer significant money on energy costs to produce water, and the well and pump lifetime will be extended significantly. Water wells should be designed carefully to maximize well and pump efficiency in order to conserve energy and not produce sand.

<http://www.extension.org/67625>

### **Livestock GRACEnet**

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Livestock GRACEnet is a United States Department of Agriculture, Agricultural Research Service working group focused on atmospheric emissions from livestock production in the USA. The working group presently has 24 scientists from 13 locations covering the major animal production systems in the USA (dairy, beef, swine, and poultry). The mission of Livestock GRACEnet is to lead the development of management practices that reduce greenhouse gas, ammonia, and other emissions and provide a sound scientific basis for accurate measurement and modeling of emissions from livestock agriculture. The working group fosters collaboration among fellow scientists and stakeholders to identify and develop appropriate management practices; supports the needs of policy makers and regulators for consistent, accurate data and information; fosters scientific transparency and rigor and transfers new knowledge efficiently to stakeholders and the scientific community. Success in the group's mission will help ensure the economic viability of the livestock industry, improve vitality and quality of life in rural areas, and provide beneficial environmental services. Some of the research highlights of the group are provided as examples of current work within Livestock GRACEnet. These include efforts aimed at improving emissions inventories, developing mitigation strategies, improving process-based models for estimating emissions, and producing fact sheets to inform producers about successful management practices that can be put to use now. <http://www.extension.org/67623>

### **Emissions from Western Dairy Production**

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Concentrated dairy operations emit trace gases such as ammonia (NH<sub>3</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O) to the atmosphere. The implementation of air quality regulations in livestock-producing states increases the need for accurate on-farm determination of emission rates. Our objective is to compare the emission rates of NH<sub>3</sub>, CH<sub>4</sub>, and N<sub>2</sub>O from three commercial dairies in southern Idaho that vary in size, animal housing, and manure handling systems. The three dairies consisted of a small open lot dairy (700 cows), large open lot dairy (10,000 cows) and a large open-freestall dairy (10,000 cows) with an anaerobic digester. Both housing and manure management systems were monitored in order to determine “whole farm emissions” and determine the effects of manure handling practices on emissions from the different farm sectors. Gas concentrations and wind statistics were measured and used with an inverse dispersion model to calculate emission rates. Average emissions from the housing area per cow per day for the three farms ranged from 0.10 – 0.14 kg NH<sub>3</sub>, 0.33-0.49 kg CH<sub>4</sub> and 0.01 - 0.02 kg N<sub>2</sub>O. Average emissions from the wastewater ponds (g cow<sup>-1</sup> d<sup>-1</sup>) were 10 - 129 NH<sub>3</sub>, 27 – 1,028 CH<sub>4</sub> and 3.7 – 4.9 N<sub>2</sub>O. Data from this study can be used to develop trace gas emissions factors from dairies in southern Idaho and other production systems in similar climatic regions.

<http://www.extension.org/67622>

## **A Review Of Effectiveness Of Vegetative Buffers For Mitigating Air Emissions From Livestock Facilities**

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Air emissions from livestock facilities are receiving increasing attention because of concerns related to nuisance, health and upcoming air quality regulations. Vegetative buffers have been proposed as a potential cost effective mitigation strategy to reduce dust, odor and other air pollutants from farm and can be an important part of air quality management plan. However, the effectiveness of vegetative buffers in mitigating air emissions seems to be site specific and can be affected by many factors. This study aims to provide a thorough literature review on the performance of vegetative buffers in mitigating air emissions, to investigate critical factors, and to identify research gaps. The results will be used as basis for planning future wind tunnel and field studies. The ultimate objective is to develop general guidance for vegetative buffer design and to demonstrate the variety and effectiveness of vegetative buffers for mitigating air emissions from livestock facilities. <http://www.extension.org/67620>

## **Demonstration of a Pilot Scale Leach-bed Multistage Digester for Treating Dry-lot Wastes**

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Sybil Sharvelle

Dry-lot feedlot wastes have historically been a challenging feed-stock for digestion due to the dry recalcitrant nature of the waste, and the presence of settleable sand. Leach-bed dry digestion systems could theoretically circumnavigate these difficulties but poor hydraulic conductivities are noted in the literature. In addition to the poor hydraulic conductivities there are often serious problems with system stability and operation. A leach-bed based design which addresses the hydraulic limitations of previous systems and utilizes a multiple process stages to enhance system stability is currently under

development. By adding readily available inert shear stabilizers and biodegradable porosity improvers, hydraulic improvements have been demonstrated to be an order of magnitude higher than without the modifications. By utilizing a multiple stage process the liquid leachate generated from the leachate beds is treated through two stages, the buffering/storage tank and the high rate methanogenic reactor. The buffering tank is a tank for the leachate to reach chemical equilibrium and to store the leachate before it is precisely metered into the methanogenic tank. Within the high rate methanogenic reactor compounds with the leachate are converted into methane which is removed and combusted. This system is demonstrated in a 48' long refrigeration transport trailer which is essentially energy independent under continuously operation. This system will provide support for the validation of the technology with various wastes and will also serve as a research vessel for the continual optimization of this technology. <http://www.extension.org/67621>

## **Integrating Probable Fieldwork Days into Nutrient Management Plans**

John Lory, University of Missouri

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Weather conditions impact land application of manure. Wet soils hinder equipment from accessing fields. Regulations prohibit application on frozen or snow cover soils. Uncertain soil and atmospheric conditions can cause the best plans to fail. Nutrient management plans that are expected to succeed might fail given any particular year's weather. Incorporating fieldwork days information into nutrient management plans can make them more robust to uncertain weather conditions.

The USDA publishes the number of fieldwork days for different crop reporting districts within states. These data are from field reporters who provide their opinion on the number of days that were available for farmers to conduct fieldwork such as disking, planting and harvesting. USDA Fieldwork Days data cover the growing season (approximately April to December). Estimates of fieldwork days do not exist for the non-growing season (approximately December to April). However, certain states have agricultural weather station networks that collect soil temperature and other critical information that can be used to estimate the number of fieldwork days that exist for manure application within regulatory limits.

This project integrates fieldwork days from the USDA Fieldwork Days data with the Missouri Agricultural Weather Station Network winter soil temperature and precipitation data for the corresponding crop reporting district. This compiled database gives a complete year of fieldwork day estimates. The data are used in a model that allows nutrient management planners to incorporate climatological impacts into their land application plans. Users specify their equipment complement and size, quantity of manure, and desired beginning and ending dates. The model reports output in a cumulative distribution function that estimates the probability of completing fieldwork within the specified parameters and a sensitivity table of ending dates. <http://www.extension.org/67619>

## **Feed Management Planners Certification Program to Reduce Nutrient Loads in Impaired Watersheds**

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In 2007, Mid-Atlantic Water Program (MAWP) scientists applied the national feed management program to meet the needs of dairy consultants to implement feed management in the Chesapeake Basin. This program certifies consultants in precision feed management, a practice that reduces nutrient loads in animal wastes by minimizing the phosphorus and nitrogen content in the feed.

With the recent release of the US Environmental Protection Agency's Total Maximum Daily Load for the Chesapeake Bay, the agricultural community is looking for the best practices to control nutrient pollution while minimizing impacts to profit. Over the years, the work of this project team has established precision feed management as both an economically and environmentally viable best management practice. As such, state watershed implementation plans include precision feed management as a method to meet load allocations.

Pennsylvania currently has twenty-four NRCS qualified nutritionists to write feed management plans. In 2011, fifty-one operations received EQIP or CBWI funding through USDA-NRCS for feed management, with the majority consisting of dairy farms. Farms are currently in the process of being assessed on how well they implemented recommendations from the benchmark plan and are working through their first quarterly report.

Additional efforts have been implemented to educate consultants about the regulations and issues affecting dairy producers. Currently, the Pennsylvania team is working with producers to monitor income over feed costs and to develop a cash flow plan, which provides the opportunity to implement precision feeding practices while monitoring the economic benefits to the herd.

Funding from the MAWP was critical to providing these trainings and establishing precision feed management as a best management practice that farmers can realistically utilize. The infrastructure is in place to address the demand for more feed management plans and the MAWP will continue to meet the educational needs of this audience. <http://www.extension.org/67618>

## **Developing a Modeling Framework to Characterize Manure Flows in the Texas Panhandle in Response to Fertilizer Prices, Biofuel Demand, and Other Externalities**

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In recent years, sharply rising costs of inorganic fertilizers have contributed to an increased demand for manure and compost in crop production acreage, transforming cattle manure from a valueless waste to a viable alternative to commercial fertilizer. If additional demand for manure as a bio-fuel were to arise manure could take on two distinct values, a fertilizer value and a fuel value. This potential "dual" value of manure begs several questions. What would the fertilizer and fuel markets of manure look like? Is

there enough manure supply for the markets to operate independently? If not, which market would prevail? In essence, how, if at all, would manure's potential value as a bio-fuel distort the traditional Panhandle manure market? A modeling framework was developed to assess the potential impacts of a manure-fired ethanol plant on the existing Texas Panhandle manure fertilizer market. Two manure-allocation runs were performed using a spreadsheet model. Run #1 allocated all available manure from dairies and feedlots to cropland as manure fertilizer; run #2 first allocated fuel manure to the ethanol plant and then allocated the remaining manure to cropland. Both model runs assumed a time horizon of one year and no antecedent nutrients in cropland soils. Other constraints included only irrigated acreages received manure and no supplemental fertilizer was used. The model revealed a 6.4% increase in cost per acre of fertilizing with manure for fields whose nutrient requirements were fully satisfied in both runs. The increase in cost per acre was likely due to an increase in hauling distances attributed to fewer CAFOs available for fertilizer manure. The model is not presented as a dynamic, systems model, but rather a static model with the potential to be incorporated into a more dynamic systems-based modeling environment. Suggestions for further model development and expansion including GAMS integration are presented. <http://www.extension.org/67646>

## **Integrating Manure into Feed Ration Optimization**

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Ration optimization models currently minimize the purchase price of feeds used to meet nutrient requirements. Not included in optimization models is the value of manure nutrients resulting from ration alternatives. This project extends the linear program that is used to minimize ration cost to include the value of manure excreted and stored. Microsoft EXCEL's Solver GRG Nonlinear Add-in is used to optimize the integrated decision because of the non-linear aspects of manure excretion as a function of feed fed. Several economic and production changes over the last 10 years warrant an investigation of the impact of optimizing both feed and manure decisions simultaneously. Distillers Dried Grains with Solubles (DDGS) have become a common feed high in phosphorus, lessening the need for inorganic phosphorus sources. Including DDGS in the diet also increases the manure concentration of phosphorus. If phosphorus is needed on nearby crop fields, there is potential to increase manure value while simultaneously reducing feed cost. In contrast, feeding phytase may reduce feed cost, while reducing manure value if phosphorus in manure is valued. Feeding synthetic amino acids can also reduce feed cost while reducing the amount of nitrogen excreted and available as a fertilizer in the manure. Adding to the importance of considering manure value is the increased costs of fertilizers. Manure is increasingly seen as a viable alternative to commercial fertilizers and might affect the whole farm profitability if included in the ration cost decision. This project considers swine rations and examines how they might have changed during the past 10 years if manure value had been incorporated into the ration optimization decision. We will attempt to determine when manure fertilizer value relative to feed costs justifies integrating feed and manure optimization. Results indicate that incorporating manure value into the optimization routine would change some diet formulations. <http://www.extension.org/67648>

## **The National Air Quality Site-Assessment Tool (NAQSAT)**

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The National Air Quality Site Assessment Tool (NAQSAT) has been developed for the voluntary use of livestock producers and their advisors or consultants. It is intended to provide assistance to livestock and poultry producers in determining the areas in their operations where there are opportunities to make changes that result in reduced air emissions. Air emissions research from livestock production systems is increasing every year. NAQSAT is based on the most accurate, credible data currently available regarding mitigation strategies for air emissions of ammonia, methane, volatile organic compounds, hydrogen sulfide, particulates, and odor. <http://www.extension.org/67654>

## **Factors Affecting Manure Transfers in the Midwest**

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With livestock operations becoming larger and more specialized, and a requirement for phosphorus based application, there is a need for farmers to transfer manure off their farm in order for manure to be applied at agronomic rates.

A survey of livestock farmers in Iowa and Missouri was conducted in the spring of 2006. It was a random sample stratified by livestock type and farm sales. The major types of livestock were dairy cows, beef cattle on feed, beef cows, swine 55lbs or less, swine more than 55lbs, broilers, and turkeys. This survey examined manure management practices in general and also included questions regarding the sale and transfer of manure. For this analysis, farmers with pasture-only operations were excluded which left 921 observations.

Over 81% of turkey farmers and over 57% of broiler operations provide manure to other farmers. Farmers providing turkey manure are also the most likely to receive money for the manure with 83% being paid for the manure versus 82% of the broiler operations. Turkey and broiler litter is also transported the furthest (13.7 and 14.8 miles on average, respectively). Turkey manure also sold for the highest price.

A probit regression analysis was conducted to determine the factors that affect whether or not a farmer provides animal manure to others. Younger farmers were significantly more likely to provide manure but education level had no significant effect. The more wheat or pasture a farm had, the less likely they were to provide manure. The percent of land rented had no effect. Increases in livestock numbers for all types except beef and swine less than 55 pounds increased the likelihood of providing manure, as expected. Whether they used a commercial fertilizer on their manured fields had no relationship to whether they provided manure to others. <http://www.extension.org/67652>

## **Factors Affecting the Price of Manure Applied on Corn**

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Increasing fertilizer prices may affect demand for manure nutrients. The 2010 USDA Agricultural Resource Management Survey (ARMS) Corn data shows that 622 of 2654 surveyed farmers (23.4 percent) applied some manure to their corn fields while 52 (almost two percent) applied compost. The ARMS data will be used to examine the price paid for manure as a function of type of manure (i.e. species), form of manure, distance, size of farm, location, yield goal and whether the application rates of manure were influenced by Federal, State or local policies. Based on economic theory and the few empirical studies on manure use, it is hypothesized that swine manure will command a lower price than manure from cattle or poultry operations, all else equal. Liquid manure, due to dilution and volatilization of nutrients, will have a negative effect on price received. Due to transportation costs, which are included in the ARMS manure cost question, distance is hypothesized to have a positive effect on price. Farms in areas with high nutrient demand, such as the Corn Belt, are hypothesized to pay higher prices for manure while those in areas with excess manure nutrients, such as the Chesapeake Bay area, will pay lower prices or even be compensated to accept manure. Similarly, if policy affects application of manure, it is an indication that there are problems of excess manure in the area so prices are expected to be lower. Higher yield goals are expected to be positively associated with the price paid for manure since nutrient requirements will be higher. <http://www.extension.org/67651>

### **Climate Change Extension: Presenting the Science Is Necessary but Insufficient**

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Social-science literature, as well as our own experience, indicates that the presentation of scientific information on climate change (CC) is likely to be unpersuasive to the many Americans currently doubtful about the phenomenon. Research shows that this is because one's position on CC is imbued with cultural meaning for most Americans. Agricultural audiences are particularly skeptical of human-influenced CC. Therefore, we have concluded that outreach to agricultural audiences must be expanded beyond the presentation of geophysical data. Our current efforts in CC outreach include the following: (1) legitimate affirmation of producers for reducing the carbon footprint of food production over the decades (as measured by CO<sub>2</sub>-e per unit of agricultural production); (2) designing communication efforts on this highly divisive topic which are respectful of the diversity of worldviews present in our citizens; (3) presenting CC in ways that speak to core values of agricultural communities; and (4) avoiding any "blaming" language, pointing out that all citizens share in producing carbon emissions. Social science shows the importance, to the extent possible, of emphasizing optimism as well as our personal and collective capacity to address CC. Finally, we believe our public credibility as science educators demands that we focus our outreach efforts strictly on the scientific aspects of CC, refraining from promotion of particular policy solutions. Outreach based on these principles is expected to enhance agricultural producers' understanding of anthropogenic CC and its implications. <http://www.extension.org/67647>

### **Effects of Climate Change on Pasture Production and Forage Quality**

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Pastures cover more than 14 million hectares in the eastern half of the United States and support grazing animal and hay production while also contributing to the maintenance of overall environmental quality and ecosystem services. Climate change is likely to alter the function of these ecosystems. In order to explore this possibility, we initiated a multi-factor climate change study, elevating air temperature (+3oC) and increasing growing season precipitation (+30% of long-term mean annual), in a central Kentucky pasture managed for hay production. Treatments began in May 2009 and have run continuously since. We measured the effects of warming and increased precipitation on pasture production, forage quality metrics, and for endophyte-infected tall fescue, ergot alkaloid concentrations. Effects of warming and increased precipitation on total yearly pasture production varied depending on the year of study (trt × year p-value < 0.0001); however, climate treatments never reduced production below that of the ambient control. Some forage quality metrics, such as lignin concentrations, were not affected by the climate treatments; however, warming reduced neutral detergent fiber content and treatment effects on crude protein varied but were most pronounced later in the growing season. For endophyte-infected tall fescue, warming increased both ergovaline and ergovalinine concentrations (+40% of that in control ambient plots) throughout the study. These results indicate that central Kentucky pastures may be relatively resilient to future climate change; however, warming induced increases in ergot alkaloid concentrations in endophyte-infected tall fescue suggests that animal issues associated with fescue toxicosis are likely to be exacerbated under future climatic conditions.

<http://www.extension.org/67650>

## **Reducing Negative Impacts of Poultry Litter on Water Quality by Developing Alternative Markets for Poultry Litter Biochar**

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Manure from confined animal operations is an environmental liability because of the potential for water and air pollution. The poultry industry in the Chesapeake Bay watershed is under increased regulatory scrutiny due to nitrogen and phosphorous inputs into the Bay. Although poultry litter (PL) is valued as a fertilizer, the cost of shipping the bulky material out of the watershed is prohibitive. One potential solution is to turn the excess litter into energy through pyrolysis. If a market can be developed for poultry litter biochar, more N and P could be removed from the Chesapeake Bay watershed. Our overall program goals are to develop a comprehensive strategy to convert poultry litter from an environmental liability into an economic and ecological asset and to develop a comprehensive conceptual model for improving poultry litter waste management through market-driven alternatives. Our specific objectives are to characterize the properties and variability of biochar from a commercial poultry/ litter biochar producer, evaluate PL biochar for two potential commercial uses; greenhouse plant production and as an amendment for degraded mine soils. Our preliminary evidence indicated there was significant particle size-by-element heterogeneity. Larger particles contained larger P concentrations (2,600 ppm) than smaller particles (1,500 ppm) whereas smaller particles contained more Na (5,000 ppm) and K

(32,000 ppm) than did large particles (3,300 ppm Na and 13,000 K). Preliminary lettuce seed germination and plant growth experiments with PL biochar have indicated that higher concentrations of biochar, resulted in greater plant growth, but germination success was decreased. However, if the excess salts can be managed PL biochar can be used for greenhouse plant production and as a soil amendment. Ongoing PL biochar research is aimed at developing techniques and protocols to produce amendments that improve soil fertility while controlling the negative impact of salts (primarily K and Na). <http://www.extension.org/67649>

## **Dry Anaerobic Digestion (AD) for High Solids Manures**

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Anaerobic digestion of animal manure has generally been limited to wet digestion where total solids are less than 12%. This has restricted adoption of biogas production primarily to dairy and hog operations, or required substantial water usage to dilute manures with higher solids content. The DRANCO-Farm dry anaerobic digestion technology processes solid manures and other dry crop residues on a continuous basis with solids content in the digester up to 45%. This flexibility can allow farms to take advantage of the Biomass Crop Assistance Program (BCAP) incentives. By processing in a semi-solid state, there is no sedimentation or floating crust layer to impede biogas formation. Sand, small stones, or other contaminants are well-tolerated, allowing use of scraped feedlot manure or sand bedding. Operating at high solids increases the ratio of energy and revenue production per capital and operating dollar invested, and avoids excessive water use and need for larger post treatment or storage. By reducing the water volume, digester heating requirements are dramatically reduced, ensuring that sufficient digester heat can be maintained even in the coldest areas. This leaves more energy for other beneficial uses, including expanded post-processing of separated fibers. An integrated post-digestion zone stabilizes the digestate prior to extraction. <http://www.extension.org/67653>

## **Watershed Management Resources DVD**

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Andrea Nysten, Agriculture and Agri-Food Canada

The Watershed Management Resources (WMR) DVD is an interactive e-learning tool created by Agriculture and Agri-Food Canada. This self-paced DVD provides users with interactive flash animations, video clips and text screens which educate about issues of water quality, beneficial management practices (BMPs) and watershed management. The DVD was created for a wide variety of audiences including watershed groups, government and non-government organizations, post-secondary students and any others who wish to learn more about water quality, water sampling and integrated watershed management. This tool promotes a synergistic approach to watershed management and increases leadership capacity by encouraging all members of a watershed community to work together to reduce harmful impacts to watersheds and monitor their watershed for improvements.

The presentation will showcase clips from the DVD while highlighting the main messages it provides. Essential information on the topics of watershed management (watershed basics, water quality,

agricultural impacts on watersheds, watershed monitoring and best management practices), surface water sampling (methodologies and design options) and the hydrologic cycle will be explained throughout the presentation. <http://www.extension.org/67743>

## **Gypsum Bedding – Risks and Recommendations for Manure Handling**

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Gypsum products created from construction industry waste streams provide low-input cost bedding. Some dairies report decreased somatic cell counts in milk with its use.

Recently, several incidents involving human and livestock death or injury have highlighted the possible creation of dangerous gases at farms using gypsum bedding. Human lives were lost at two separate events. In a third incident, a 2-year old and 4-year old were found unconscious adjacent to a manure storage where gypsum was present. In the European Union (EU) several agencies have forbade the use of gypsum as bedding based on losses of livestock as well as previous policies that restricted gypsum from landfill disposal.

Gypsum is a common term for hydrated calcium sulfate ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ). It is suspected that under the right manure storage conditions anaerobic bacteria convert the sulfur (S) in gypsum to hydrogen sulfide ( $\text{H}_2\text{S}$ ), a gas that can be deadly. Movement such as agitation of manure can lead to large  $\text{H}_2\text{S}$  fluxes and localized dangerous levels of the gas.

While this is concerning, there remain many farms that utilize gypsum without incident. Data on this subject are lacking.

The goal of this proposed symposium presentation is to update attendees on this ‘current event’ in manure management. Some laboratory studies are expected to complete between the time of this abstract composition (October 2012) and the symposium date. A general outline of the presentation includes:

- Recap of cases leading to concern with this product
- Policies of the EU and US
- Industrial standards for dangerous  $\text{H}_2\text{S}$  levels (OSHA and other)
- Biological and chemical avenues of  $\text{H}_2\text{S}$  production
- Research review of gypsum use in manure

- Recommendations for safety, management and education

<http://www.extension.org/67660>

## **Ammonia and Greenhouse Gas Emissions in Swine Mortality Composts of Sawdust, Broiler Litter, and Swine Lagoon Effluent**

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Michael R. McLaughlin, John P. Brooks, and Ardeshir Adeli, USDA-ARS

Animal agriculture is looking for innovative means to dispose of mortalities. Composting is an environmentally friendly option that retains the nutrients of the animal and organic materials. Southern U.S. swine farrowing operations often use sawdust as a C source for mortality composting. The objective of this study was to compare the farm standard mortality composting procedure (using sawdust and water) with other mixtures having supplementary C and N provided by broiler litter and by replacing water with swine lagoon effluent. Covered, heavy duty plastic recycling bins (227 L) contained three replications of four treatments: sawdust/water, sawdust/litter/water, sawdust/effluent and sawdust/litter/effluent. Temperature, water content, nutrients, bacterial survival and emissions of ammonia, carbon dioxide, methane, and nitrous oxide were measured intermittently during the 4 month composting period. Relative to duration, ammonia flux was greatest just after the start of the experiment (up to 100 mg m<sup>-2</sup> h<sup>-1</sup>) and was evident after the first turn or mixing within each bin (1 month later). Carbon dioxide flux followed a similar trend to ammonia, apparent initially (up to 50 mg m<sup>-2</sup> h<sup>-1</sup>), after the first turn, and also after the second turn. Methane emissions were most pronounced after the second turn (up to 200 mg m<sup>-2</sup> h<sup>-1</sup>) while nitrous oxide emissions were greatest after the first turn. Treatments containing lagoon effluent were associated with the highest emissions for each gas species. Considering only the results of emission estimates from this study, replacing water with effluent is not recommended for emission reduction from swine mortality composts.

<http://www.extension.org/67661>

## **White Meat-Green Farm: Case Study of Brinson Farms**

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Comprehensive on-farm resource utilization and renewable energy generation at the farm scale are not new concepts. However, truly encompassing implementation of these ideals is lacking. Brinson Farms operates 10 commercial broiler houses. The farm generates heat for its houses using biomass boilers and litter anaerobic digestion to produce methane. Solar panels assist in heating process water for the boilers and digester. Biomass feedstock includes litter as well as municipal yard wastes. Liquid fertilizer is a product of the digester while residual solids are included in the farm's composting operation. The operator has used a futuristic approach to not only attain energy independence for the farm, but also to comprehensively utilize byproducts of production and other local "wastes", diverting them from local landfills. Considering the propane cost for a single winter flock has reached \$66,000 and the annual

electric bill may be \$120,000, energy costs very much affect grower profitability. This approach decreases the uncertainty in energy costs. Brinson Farms provides a unique look into ensuring long-term farm sustainability in an environmentally friendly way and with a wide-ranging systems approach to management. <http://www.extension.org/67659>

## **Effects of Feeding Distiller's Byproducts on Reduced Sulfur Emissions**

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Mindy J. Spiehs, Bryan L. Woodbury

Odorous reduced sulfur compounds are produced during manure decomposition and emitted from confined animal feeding operations. Feeding high-sulfur distiller's byproducts may increase the emission of these compounds. A series of studies were conducted to evaluate the relative impact of feeding high-sulfur wet distiller's grain plus solubles (WDGS) to beef cattle. In the first study, beef cattle in sixteen small-scale pens were fed varying amounts (0%, 20%, 40%, and 60%) of WDGS. Fresh manure composites were collected four times from each pen during the study, and the relative emissions were measured using a laboratory wind tunnel chamber. The relative emission of reduced sulfur was significantly greater (4 to 22-fold) in the 40% and 60% WDGS manures for all time periods compared to the 0% manure composite. A follow up study in eight production-scale feedlot pens feeding either 0% or 40% WDGS demonstrated that reduced sulfur emissions were consistently larger (up to 2.6-fold) from the manure and soil collected near the feed bunk when cattle were fed the 40% diet. In a final study examining the relative emission from the whole feedlot pen surface over many months, emissions principally came from the wetter edges of the pen when animal were fed higher levels of WDGS in their diet. Taken together, the results indicate that very large operations need to consider both the sulfur content and the feeding level of WDGS in order to comply with reduced sulfur emission guidelines. More intensive manure management of the edges of pens may minimize emissions, but further research is needed to demonstrate whether this management practice is truly effective.

<http://www.extension.org/67657>

## **Best Management Practices for Reducing Greenhouse Gas Emissions from Manure Application in Semi-Arid Regions**

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Pakorn Sutitarnnontr, Utah State University, Enzhu Hu, Utah State University, Markus Tuller, University of Arizona, Jim Walworth, University of Arizona, Scott B. Jones, Utah State University

Gas emissions from animal feeding operations (AFOs) create adverse impacts ranging from short-term local effects on air quality, particularly odor, to the long-term effects from greenhouse gas generation. Best management practices (BMPs) have been designed and implemented to mitigate gas emissions from farm operations. Our study investigates emission control strategies widely used in AFOs including manure management and land application. The primary objectives were to evaluate the efficiency and identify improvement of the currently available BMPs. We simulated and monitored gaseous emissions from a range of manure application and incorporation methods. The gaseous emissions were monitored

using the closed dynamic chamber (CDC) method with a Fourier Transformed Infrared (FTIR) spectroscopy gas analyzer, which is capable of monitoring 15 pre-programmed gases simultaneously including typical gaseous compounds and greenhouse gases emitted from manure sources; namely, ammonia, carbon dioxide, methane, nitrous oxide, oxides of nitrogen, and volatile organic compounds. In this presentation, we will discuss the efficiency of the current manure management BMPs to reduce air emissions from dairy operations, based on the gaseous emission monitoring during the course of our experiment. Results from our study should enhance development and implementation of more flexible and more efficient air quality management approaches for dairy operations.

<http://www.extension.org/67662>

## **Development of an Acid Scrubber for Reducing Ammonia Emissions from Animal Rearing Facilities**

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Rory Maguire, Virginia Tech, Mark Reiter, Virginia Tech, Jactone Orogo Ogejo, Virginia Tech, Robert Burns, University of Tennessee, Hong Li, University of Delaware, Dana Miles, USDA/ARS, Michael Buser, Oklahoma State University

Recent research has shown that over half of nitrogen excreted by chickens is lost into the atmosphere via ammonia volatilization before the litter is removed from poultry houses. Large quantities of particulate matter and volatile organic compounds (VOCs) are also emitted from animal rearing facilities. During the past decade we have developed and patented an acid scrubber for capturing ammonia, VOCs and dust from air exhausted from poultry and swine barns. The objectives of this project were; (1) to re-design the scrubber to improve the ammonia removal efficacy, (2) conduct full-scale testing of the scrubber under controlled conditions at various ventilation rates, (3) evaluate the cost, practicality and efficacy of various acids for scrubbing ammonia, and (4) install scrubbers on exhaust fans of poultry houses located in Virginia and Arkansas and measure the efficiency of ammonia removal from the exhaust air. The efficiency of ammonia removal by the scrubber varied from 55-95%, depending on the type of acid used, air flow rate, and the internal scrubber configuration. This technology could potentially result in the capture of a large fraction of the N lost from AFOs, while simultaneously reducing emissions of bacteria, dust, and odors, which would improve the social, economic, and environmental sustainability of poultry and swine production.

<http://www.extension.org/67663>

## **Greenhouse Gas Emissions of Beef Cattle Under Grazing Conditions In Florida**

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Dr. Clyde W. Fraisse, University of Florida, Dr. Nicolas DiLorenzo, University of Florida, Dr. Martin R. Moreno, University of Florida, Dr. Lynn E. Sollenberger, University of Florida Darren D. Henry, University of Florida, Francine M. C. Silva, University of Florida

Human's influence in the enhanced greenhouse gas effect has been widely acknowledged, and agriculture has an important part in it. Therefore, it is important to analyze and quantify greenhouse

gases (GHG) sources such as cow-calf production systems, which are very common in Florida. The objective of this study was to calculate the carbon footprint of a typical cow-calf operation in Florida, the Buck Island Ranch (BIR). Data from BIR was analyzed using the methodology from the Intergovernmental Panel on Climate Change (IPCC) along with the Inventory of Greenhouse Gas Emissions and Sinks: 1990 – 2006 to estimate GHG emissions. Results show that Buck Island Ranch produces an average of 11,733.4 tons of carbon dioxide equivalent/year. The larger GHG source is enteric fermentation, responsible for around 59% of total emissions, followed by livestock waste with 23% of emissions. The other 18% of total GHG emitted is related other sources, like fertilizer and lime applications (3.8% and 5.6%, respectively), tractor operations (1.6%) and pasture burning (1.4%). Emissions do not vary much between years because the most important source (enteric fermentation) is influenced mainly by the number of animals and feed quality, which do not vary significantly with time. Variation in the emissions is mostly related to fertilizer and lime applications. We also conducted a sensitivity analysis to evaluate the enteric fermentation emission model. Our results indicated that the weight gain was the most important parameter influencing the model's output. To further verify model outputs we are now conducting field experiments in which beef heifers were maintained under grazing conditions on *Paspalum notatum* and methane emissions are measured using the sulfur hexafluoride (SF6) technique. Contrary to our expectations, initial results indicate that methane emissions are not strongly related to weight gain. Further analysis is being conducted and field results verified.

<http://www.extension.org/67658>

## **Ammonia Mitigation and Capture as a Liquid Fertilizer from Manure Using Gas-Permeable Membrane**

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Amir Samani Majd, Graduate Student, Texas A&M University

Excessive emissions of NH<sub>3</sub> from animal manure negatively impact the environment with potential to pollute air, soil and water, and produce pungent odors. The objective of this study was to assess NH<sub>3</sub> mitigation from liquid dairy manure (LM) using tubular acid-filled gas-permeable membranes (GPM) and potentially produce ammonium sulfate fertilizer during the mitigation process. Laboratory studies showed that two sulfuric acid-filled GPM systems; one submerged below the LM surface and the other one suspended above the LM surface resulted in nearly 50% removal of NH<sub>3</sub> from the LM and it was captured as ammonium sulfate solution in less than 20 days. The GPM system was capable of removing NH<sub>3</sub> from the air above the LM further improving the overall NH<sub>3</sub> capturing efficiency. New experiments in laboratory and field studies are underway to further improve NH<sub>3</sub> mitigation and capturing efficiencies by modifying concentrations of acidic solution, changing GPM tube diameters and increasing the acid solution circulation flow rate in the GPM tube. Results of NH<sub>3</sub> mitigation and capture as fertilizer from liquid animal manure in laboratory and field studies will be presented at this conference. <http://www.extension.org/67655>

## **Ammonia Mitigation Using Electrolyzed Water Spray Scrubber**

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Amir M. Samani Majd, Ahmad Kalbasi, Gerald Riskowski

Ammonia (NH<sub>3</sub>) emissions from poultry houses are an environmental challenge because of the large volume of polluted ventilation air. The objective of this research was to evaluate electrolyzed water as a solution for a lab-scale spray scrubber for removing NH<sub>3</sub> from air. A one-stage spray scrubber was fabricated to treat 50 cfm (1.42 m<sup>3</sup>/min) of introduced mixed NH<sub>3</sub>-air with an approximate NH<sub>3</sub> concentration of 20 ppm. The mixed air was blown, countercurrent, to the 5-ft vertical scrubber body using a fan. Eight scrubber design variables were studied including contact times, nozzle types and scrubber solutions. Three contact times were 0.3, 0.6 and 0.9 s. The two narrow and standard nozzles sprinkled in a full-cone spray pattern but at different angles of 26° and 52°, respectively. The scrubber solutions variables tested were reverse osmosis (RO) water and two types of electrolyzed water (50 ppm of total chlorine) with pH = 9.0 and pH = 6.5. The 18 combinations of treatments were tested in three replications and statistically analyzed to investigate the objective. The result showed that all of the experiments were able to mitigate the NH<sub>3</sub>, but at different efficiencies. The maximum efficiency of 53% was acquired with the narrow nozzle, 0.9s contact time and electrolyzed water with pH = 6.5. Therefore, it was concluded that increasing the contact time, decreasing the pH of electrolyzed water and using the narrow angle, higher flow rate nozzle increased the scrubber efficiency.

<http://www.extension.org/67656>

## Adaptation Methods and Bioclimate Scenarios

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The ability of livestock to breed, grow, and lactate to their maximal genetic potential, and their capacity to maintain health is dramatically influenced by meteorological and biological environment and their interactions. Meteorological features affect animals both indirectly and directly. Indirect effects include those that meteorological factors exert on grassland and crops, and on water availability. Additionally, climate also affects survival of pathogens and/or their vectors, which may cause risks for health in animals and humans. On this regard, several studies on variation of abundance of *C. imicola*, the main bluetongue virus vector in the Mediterranean basin, provided evidence that the ongoing climate change has played an important role in the recent emergence of the disease in Europe, by favouring the geographical spread of *C. imicola* from Africa to northern areas. The direct effects of climate on animal production depend on the ability of animals to maintain a normal body temperature under unfavourable weather conditions. In other words, cold or heat stress result from an imbalance between the net amount of energy flowing from the animal body to its surrounding environment and the amount of heat energy produced by the animal. A series of studies carried out at Mediterranean level, one of the hot spot in the context of global warming, pointed out a continuous increase of the risk for livestock living in the area to suffer from heat stress related conditions. Climate change is imposing a growing attention to appropriate adaptation measures, which may help farm animals to face with conditions of environmental warmth. These may include set up of meteorological warning systems, revision of health maintenance strategies, correction of feeding plans, shade, sprinkling, air movement, active cooling,

genetic selection, and others. Comprehensive frameworks need to be developed to identify and target adaptation options that are appropriate for specific contexts. <http://www.extension.org/67665>

### **Case Study: Earthen Lagoon Closure**

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The closure of earthen lagoons associated with a caged egg-laying operation was used as a case study. This case study presents information on the steps taken to close the lagoons, including topographic survey needs, analysis of sludge and wastewater at different times during the closure process, methods for excavating and removing the sludge, and the costs associated with the closure of earthen lagoons. The sludge has a high fertilizer value for P2O5 and other micro- and macro-nutrients. The cost of the closure for this case exceeded the expected cost for the earthwork for the construction of a new facility. <http://www.extension.org/67664>

### **Potential Air Quality Impacts of Anaerobic Digestion of Dairy Manure**

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Anaerobic digestion (AD) of livestock manure is better known for the economic return derived from biogas for energy rather than for its, inherent, environmental benefits. The effect of AD of dairy manure on the emissions of odor, ammonia (NH<sub>3</sub>), and greenhouse gases (GHG) including: carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), and methane (CH<sub>4</sub>), during manure storage and also in subsequent land applications will be presented. Air samples were collected in 10-L Tedlar bags, at pertinent locations within the AD system, and shipped immediately to the lab for odor analyses by a trained odor panel using the “Dynamic Dilution Forced-choice Olfactometer.” Measurements of GHG emissions from both AD and non-AD manure storages were made using a floating chamber and a photoacoustic gas analyzer (INNOVA model 1412). Emissions of GHG were determined using the standard closed chamber method from field plots applied with AD and non-AD manure. Although odor analyses of collected air samples indicated increased detection threshold (D/T), odor strength (intensity) and unpleasantness (hedonic tone) decreased after AD of manure. Data indicated significantly higher fluxes of GHG from land applied with non-AD manure than from land applied with AD manure. Injection of non-AD manure further increased CH<sub>4</sub> flux from applied manure. More than 50% emissions of CO<sub>2</sub> and CH<sub>4</sub> were observed during the first 3 days after manure was land applied. Emissions of GHG from the anaerobic lagoon holding AD manure, during all four seasons, were significantly lower than from the anaerobic lagoon with non-AD manure. In contrast, the reverse was observed with NH<sub>3</sub> emissions suggesting potential increased emissions of NH<sub>3</sub> during storage of post AD manure. <http://www.extension.org/67666>

## **Framing Climate Change: Recent Research Trends on Communication Strategies and Public Opinion**

Erik Nisbet

### **Climate Change and Food Security in Nigeria**

Michael Oke, Agric Link Multipurpose Cooperative Society Limited      agricproject

Climate Change is a global phenomenon. The Nigerian experience this year brings out the urgent need to act proactively in matters of environment, because the costs of environmental disaster can be enormous in material and human terms. Resulted into increase in prices, loss of crops on the field, while waiting to harvest and others who may have had crop failure due to submerging of crops and displacement of farming families from their comfort. There are being a report from Adamawa ,Benue, Niger,Kwara,Delta And Anambra States in Nigeria .Different questionnaires were distributed too ascertain the effect on food production , diseases on plants and pictures were taken to support .This paper therefore look at the various Government effort in addressing the issues from the challenging from the floods such as the emergency relief, food and shelter for the displaces populations .The paper also suggest weather –index crop insurance schemes for farmers in the area –based flood insurances, to ensure disaster payments to farmers and communities from flood and droughts, flood recession in food production intervention , early maturing crops and distribution of relief materials .

<http://www.extension.org/67667>

### **Operation of Internal Combustion Engines on Digas for Electricity Production**

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Digester gas (digas) can be used effectively in internal combustion engines for electricity production to offset operating costs and/or sell to the utility. Stationary industrial engines are generally employed for this purpose. Four application areas where systems have been successfully demonstrated are sewage processing plants, animal waste facilities, landfills, and agricultural waste processing systems. Digas is generated through anaerobic digestion, or biomethanization, for all these cases. There are many common engine technical issues within these areas, although the overall systems employed in each case are different. In this presentation issues pertinent to running engines on digas are explored. This presentation focuses on animal waste facilities, but draws upon the other application areas for technical insight related to the engine. Specific stationary engine types are discussed. High engine efficiency and power density are important to the economic viability of anaerobic digestion systems. Engine operational and design changes are analyzed to maintain high efficiency and power density for digas fueling. Management of engine maintenance problems is also a key to economic viability. Corrosive gases contained in digas, such as hydrogen sulfide, can be problematic. The impact and mitigation of corrosive gases are evaluated. <http://www.extension.org/67668>

## Quantification of Sodium Pentobarbital Residues from Equine Mortality Compost Piles

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Rodney Farris, Oklahoma State University; Gene Parker, Oklahoma State University; Jean Bonhotal, Cornell Waste Management Institute; Mary Schwarz, Cornell Waste Management Institute

Preliminary research has shown that sodium pentobarbital, a euthanasia drug, can persist up to 180 days in equine mortality compost piles. This experiment attempts to expand upon past research by quantifying pentobarbital residues in equine mortality compost piles over a longer duration using innovative sampling schemes. Six, 3.7 m<sup>2</sup> plots were used to construct separate compost bins with 3 bins serving as control. Each bin was constructed with 1.2 m high horse panels. Soil samples were collected in each bin area. The carbonaceous material consisted of wood chips that were added at a depth of 0.46 m creating the base. Twenty-four whiffle balls, pre-filled with wood chips were placed on the center of each pad. Nylon twine was tied to each ball for retrieval. A licensed veterinarian provided six horse carcasses for use in the experiment. These horses had required euthanasia for health reasons. All horses were weighed and then sedated with an intravenous injection of 8 ml of xylazine. After sedation the three horses in the treatment group were euthanized by intravenous injection of 60 ml of sodium pentobarbital. The three control group horses were anesthetized by intravenous injection of 15 ml of ketamine hydrochloride and then humanely euthanized by precise gunshot to the temporal lobe. Following euthanasia, each carcass was placed on the center of the woodchip pad and surrounded with 0.6 m of additional wood chips. Serum and liver samples were immediately obtained while whiffle ball, soil and compost samples were obtained over time. Each sample was analyzed for pentobarbital residues. Compost pile and ambient temperatures were also recorded. Data illustrates pentobarbital persistence up to 367 days in compost piles with no clear trend of concentration reduction. <http://www.extension.org/67671>

## Designing Structures to Remove Phosphorus from Drainage Waters

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Chad Penn, Oklahoma State University, Josh McGrath, University of Maryland

Excess phosphorus (P) in surface waters contributes to eutrophication. An appreciable source of P to surface waters is P transported from agriculture, residential, and horticultural land. Soils that have continuously received excess P beyond plant needs typically become “built up” to high levels of soil P. These soils release dissolved P during rainfall/runoff events. Current best management practices (BMPs) mostly address particulate P (i.e. P bound to soil particles) transport, not dissolved P. Dissolved P is more damaging than particulate P because it is immediately 100% available to aquatic life. Even if all P applications to high P soils are ceased and BMPs are implemented to reduce erosion (i.e. particulate P transport), dissolved P transport will continue to occur for at least 15 years, assuming that plants are harvested from the site. In response to this problem, several groups have developed P removal structures, which are units filled with P sorbing materials and designed to channel runoff water through them while retaining the filter material and P. The goal is to prevent P from entering a surface water

body and allow filtered P to be removed from the watershed after the P-saturated material is removed. The P sorbing materials utilized are typically by-products from various industries and include steel slag, FGD gypsum, drinking water treatment residuals, and acid mine drainage residuals. A modeling tool has been developed for (1) sizing a structure based on filter media properties and watershed characteristics, (2) predicting the lifetime of a P removal structure, and (3) estimating total P removal. In addition to the modeling tool, data from full scale filters will be presented. <http://www.extension.org/67669>

### **Alternative Poultry Litter Storage for Improved Transportation and Use**

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Chad Penn, Jeff Vitale, Scott Fine, Hailin Zhang and Jason Warren - Oklahoma State University

Transportation of poultry litter out of nutrient limited watersheds such as the Illinois River basin (eastern Oklahoma) is a logical solution for minimizing phosphorus (P) losses from soils to surface waters. Transportation costs are based on mass of load and distance transported. This study investigated an alternative litter storage technique designed to promote carbon (C) degradation, thereby concentrating nutrients for the purpose of decreasing transportation costs through decreased mass. Poultry litter was stored in 0.90-Mg conical piles under semipermeable tarps and adjusted to 40% moisture content, tested with and without addition of alum (aluminum sulfate).

An additional study was conducted using 3.6-Mg piles under the same conditions, except tested with and without use of aeration pipes. Samples were analyzed before and after (8 wk) storage. Litter mass degradation (i.e., loss in mass due to organic matter decomposition) was estimated on the basis of changes in litter total P contents. Additional characterization included pH, total nutrients, moisture content, total C, and degree of humification. Litter storage significantly decreased litter mass (16 to 27%), concentrated nutrients such as P and potassium (K) and increased proportion of fulvic and humic acids. The addition of aeration pipes increased mass degradation relative to piles without aeration pipes. Nitrogen volatilization losses were minimized with alum additions. Increases in P and K concentrations resulted in greater monetary value per unit mass compared with fresh litter. Such increases translate to increased litter shipping distance and cost savings of \$17.2 million over 25 yr for litter movement out of eastern Oklahoma. <http://www.extension.org/67672>

### **Pesticide Application Air Quality Emissions Inventory Project**

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The Federal Environmental Protection Agency (EPA) requires states to submit to them air quality emission inventories for all types of sources every three years. In 2012, the Central States Air Resource Agencies Association (CenSARA) and its contractor, TranSystems Corporation (TranSystems), developed a 2011 agricultural pesticide emissions inventory for the association's member states of Arkansas, Iowa,

Kansas, Louisiana, Minnesota, Missouri, Nebraska, Oklahoma, and Texas. Crops grown in this region total more than 140 million acres and are routinely treated with pesticide products, such as herbicides, insecticides, and fungicides. Row crops, such as corn, soybeans, and sorghum and non-row crops, such as fruit orchards, were included in the work. Hazardous air pollutants (HAPs) and/or volatile organic compounds (VOCs) are in pesticide ingredients; VOCs being a main contributor to ground-level ozone, commonly known as smog. In this work, 458 active ingredient-specific VOC emission factors were developed, based primarily on empirically derived pesticide chemical data maintained by the California Department of Pesticide Regulations; county level active ingredient throughputs were derived from the best available information. An emissions calculation tool was developed to produce emissions, following a linear crop to acreage relationship as the default. Participating states can use the tool to input local practices such as the selection of crops and/or the choice of pesticide products, as well as the extent and amount of applications. The work also included a survey to try to understand the timeframes pesticides are applied to various crops. These parameters can significantly alter the default linear relationship. The final product provided the individual states with 2011 emission estimates and a methodology to account for better data when obtained, which can result in a more accurate emission inventory for this source category. <http://www.extension.org/67678>

## **Overview of Solid-Liquid Separation Alternatives for Manure Handling and Treatment Document**

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Dr. John Chastain, Professor and Extension Agricultural Engineer, School of Agricultural, Forestry, and Environmental Sciences, Clemson University

Solid-liquid separation of animal manures and other agricultural products can be an integral part of a livestock operation ranging from improved facility performance to enhanced nutrient management. A document entitled “Solid-Liquid Separation Alternatives for Manure Handling and Treatment” has been created through work by Clemson University and funding from USDA-Natural Resources Conservation Service. The purpose of this document is to assist in solid-liquid separation technology selection, evaluation of separation performance, and quantifying the impact of solid-liquid separation on manure management. This presentation will provide an outline of this document including methods of solid-liquid separation, influence of manure characteristics and handling methods, fundamentals of solid-liquid separation, performance of various solid-liquid separation technologies, separation enhancement methods, and design considerations. An overview of various farm scale separation technologies is also presented in the solid-liquid separation document. <http://www.extension.org/67673>

## **What We Feed Dairy Cows Impacts Manure Chemistry and the Environment**

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Glen A. Broderick, USDA-ARS US Dairy Forage Research Center

During the last part of the 20th century, animal manure management became an environmental concern. In many regions of the USA legislation has been enacted to control manure management and the emission of polluting gasses from animal production systems. The purpose of this paper is to illustrate how mineral phosphorus (P) supplements, forage types and amounts, and the crude protein (CP) fed to lactating cows impact manure chemistry and the fate of manure nutrients in the environment. Source-sink relationships will be used to illustrate relationships between ration nutrient sources (forms and concentrations of P and CP) and nutrient sinks (milk and manure), and relationships between manure nutrient sources (soluble P, urea N) and sinks (soil test P, runoff P, atmospheric ammonia, soil inorganic N, crop N) and the impact of these relationships on the environment. For example, as ration P concentrations increase, the excretion of total P and soluble P in manure also increases. Runoff of soluble P from cropland after manure application, which pollutes surface waters, can be related back to the P excreted in manure, which in turn is linked to the amount of mineral P in cow rations. Likewise, the type and amount of CP and forage fed to dairy cows impact manure chemistry and manure N cycling in soil, including plant N uptake. Ammonia emissions from dairy barns and soil after manure application can be related back to the urea N excreted by dairy cows in urine, which is linked to the types and concentrations of CP and forages in cow rations. Our results demonstrate that profitable rations can be fed to satisfy the nutritional demands of healthy, high producing dairy cows, reduce manure excretion and therefore the environmental impacts of milk production. <http://www.extension.org/67674>

## **Lessons Learned from the Instillation and Monitoring of a Swine Finisher Biofilter**

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Rick Stowell, University of Nebraska – Lincoln

A 1440 cu. ft. woodchip biofilter was designed and built to treat the air coming from the cool season fans of a 2,000 head swine finishing operation. Key lessons learned during construction included improvements for design coordination, materials, and labor. After installation, biofilter moisture, odor performance, and static pressures were monitored. Biofilter moisture required more sprinkling than expected, with two, one hour sprinkler runs a day not keeping up during hot, dry conditions. Dry bed conditions likely led to little effect found during odor monitoring. The biofilter does appear to filter dust quite effectively. High static pressures (>0.2 in. of water) developed more rapidly than expected and prompted closer monitoring. <http://www.extension.org/67675>

## **Animal Agriculture for a Changing Climate – Stakeholder Forum**

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Gary L. Hawkins\*, Pam Knox\* University of Georgia, Liz Whitefield\*, Washington State University, David Smith\*, Texas A&M University, David Schmidt\*, University of Minnesota, Jenny Pronto\*, Cornell University

Climate change adaptation and mitigation is an emerging issue for animal agriculture research and extension. A national team of Extension professionals is developing a web-based educational course, website, and related materials to provide comprehensive education for Extension agents and educators about the latest research, management methods, and tools. The objectives of this project are: 1) to build a foundation of knowledge; 2) facilitate learning across U.S. regions, and; 3) provide a shorter time from research to extension to application. The project has a P.I. and an Extension professional in each of five regions across the United States as well as a national P.I. and project coordinator to facilitate having a coordinated national educational effort that is regionally relevant and accessible. The goal of the forum will be to hear from stakeholders: farmers, industry, Extension, and others on how this project, and Extension generally, can best serve their needs related to climate change.

<http://www.extension.org/67677>

### **Photometric Prediction Of Ground-Level PM10 Concentrations Measured By Teoms Downwind Of A Commercial Cattle Feedyard**

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Brent W. Auvermann\* (Texas A&M AgriLife Research and Extension Service), Taek Kwon (University of Minnesota Duluth), K. Jack Bush (Texas A&M AgriLife Research), Gary W. Marek (Texas A&M AgriLife Research), and Kevin Heflin (Texas A&M AgriLife Research)

Fugitive dust from confined livestock operations is a primary air quality issue associated with impaired visibility, nuisance odor, and other quality-of-life factors. Particulate matter has conventionally been measured using costly scientific instruments such as transmissometers, nephelometers, or tapered-element, oscillating microbalances (TEOMs). The use of digital imaging and automated data-acquisition systems has become a standard practice in some locations to track visibility conditions on roadways; however, the concept of using photometry to measure fugitive dust concentrations near confined livestock operations is relatively new. We have developed a photometric method to estimate path-averaged particulate matter (PM10) concentrations using digital SLR cameras and high-contrast visibility targets. Digital imaging, followed by automated image processing and interpretation, would be a plausible, cost-effective alternative for operators of confined livestock facilities to monitor on-site dust concentrations. We report on the development and ongoing evaluation of such a method for use by cattle feeders and open-lot dairy producers. <http://www.extension.org/67676>

### **Feedlot Ammonia BMP Adoption: Barriers and Opportunities**

James Pritchett, Colorado State University

Gaseous ammonia emissions from feedlot operations pose serious risks to human and ecosystem health. In particular, nitrogen deposition in Colorado's Rocky Mountain National Park may be associated with livestock feeding in the western Corn Belt and Colorado. Feedlot operators can implement a variety of Best Management Practices (BMPs) to reduce ammonia emissions. These BMPs vary in effectiveness, simplicity, managerial time, effort and financial capital. Although the ammonia-mitigating potential of various BMPs is well-researched, little research examines the barriers that prevent feedlot operations from adopting these BMPs. <http://www.extension.org/67792>

## Anaerobic Digester Workforce Training Curriculum Development

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Curt Gooch, Cornell University

The Cornell University PRO-DAIRY Anaerobic Digester Workforce Development Project is a project funded by the New York State Energy Research and Development Authority, aimed at developing and delivering high quality educational programs targeted to a range of workforces within the dairy farm-based anaerobic digestion (AD) sector of the clean energy field. Included in the project plans, were six technical short-courses that would provide educational training to persons who are involved in the planning and implementation of dairy farm-based anaerobic digestion systems and to those currently or who would soon be managing an operating system. The short-courses developed are:

- Introduction to Farm-based Anaerobic Digestion
- Technical Feasibility of On-farm Anaerobic Digestion
- Economic Feasibility of On-farm Anaerobic Digestion and Economic Assessment Model Instruction Guide
- Practical Considerations and Implementation of Anaerobic Digestion System from Planning and Design to Construction
- Technician's Start-Up and Operation
- Biogas Clean-up and Utilization Systems Selection, Operation and Maintenance

These six courses were developed to target audiences with varying knowledge levels, starting from a basic introduction to anaerobic digestion technology, and advancing to a comprehensive presentation of information needed to operate and maintain different components in an AD system. The goal was to develop an educated AD workforce, realizing that not all participants would follow the full schedule of course offerings, but would emerge from whatever course(s) they participated in, with the ability to promote and progress the industry. An overview of each course and the intended audience will be provided, along with statistics of the training program to date. Future target audiences and strategies will also be discussed. <http://www.extension.org/67679>

## Will Spreading Bans Reduce Manure Runoff Events?

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Eric Cooley, Dennis Frame

The Wisconsin Discovery Farms Program was one of the first on-farm evaluation projects to identify the risk of manure applications in the late winter period. Data from several of our farms have shown that manure applied during February and March has an increased risk of running off and contributing to high nutrient losses in surface water. This data has been used to justify the establishment of recommendations, rules and regulations on winter manure spreading. But, do bans on winter manure spreading (spreading on frozen or snow covered ground) actually reduce the risk of manure runoff? A close evaluation of the data indicates that spreading during early winter (November - January) is much different than during late winter when frost can extend deeper and be more solid in the soil profile.

Total winter application bans also increase the volume of manure that needs to be stored and increase the risk of runoff during the spring spreading season.

Based on the data from the Wisconsin Discovery Farms Program, manure spreading bans should be established based on field conditions, and not a calendar. There are times when applying manure early in the winter is optimal because lack of snow and/or frost affords the opportunity for manure to come into contact with the soil. There are also times when manure can be safely applied in late March, when the soils have thawed, snowmelt is finished and the fields are fit. Not allowing farmers to begin fieldwork based on calendar dates can greatly increase the potential for runoff because the window for manure applications is smaller and the potential for runoff from saturated soils and spring rains is greater. <http://www.extension.org/67684>

## Using Soil Moisture to Predict the Risk of Runoff on Non-Frozen Ground

Tim Radatz, MAWRC [radatz@mawrc.org](mailto:radatz@mawrc.org)

Identifying time periods when land application of manure is likely to contribute to surface runoff contamination is important for making proper management decisions and reducing the risk of surface water contamination. Data from the Wisconsin Discovery Farms Program has identified two key time periods with an elevated risk of surface runoff from agricultural fields: the late winter period (February - March) and the late spring period (May - June). Eighty-one percent of the average annual surface runoff was observed during these two time periods with the late winter period accounting for 50% and the late spring period accounting for 31%. Recently, a great deal of attention has been focused on reducing nutrient and sediment losses from the winter period. However, sediment and nutrient losses during the late spring period can be significant and it is important to understand landscape and weather conditions that lead to elevated runoff risk during this time period. Data collected over the past 12 years of the Wisconsin Discovery Farm Program indicate that the vast majority (86%) of non-frozen ground runoff occurs when soil moisture is in excess of 35%. High antecedent soil moisture can indicate risk for surface runoff in agricultural watersheds and can also influence the quantity of surface runoff generated during rainfall events. Avoiding manure applications during time periods with a high probability of rainfall and when soil moisture is at or near threshold levels decreases the risk of surface water contamination. Agricultural producers can utilize soil moisture measurement to guide the timing and rate of manure application to further reduce environmental risk. <http://www.extension.org/67683>

## Tile Drainage Field Day to Promote Manure Management

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Seeing is believing and in August, 2012 a regional field day was held in southern Michigan in conjunction with the Michigan Land Improvement Contractors and Michigan State University Extension to bridge the management practices and new technologies between tile drainage and manure management. Tile drainage contractors, farmers and agri-business had the opportunity to see sub surface drainage installation and also learn about new management technologies to assist in reducing the risks of both manure and fertilizers from reaching tile outlets and surface waters. These technologies included installation of water control devices, bark bed bio-reactors, sub-irrigation to manage dairy waste water,

cover crops and tillage to disrupt soil macropores. The field demonstrations were teamed up with educational sessions under tents. Planning and developing a field event with onsite drainage installations is a time commitment but proves very important for awareness and education on an important topic. <http://www.extension.org/67686>

## **The Iowa Manure Management Action Group (IMMAG): A 15-Year Partnership**

Angela Rieck-Hinz, Iowa State University [amrieck@iastate.edu](mailto:amrieck@iastate.edu)

IMMAG was a concept born in 1997 to provide a comprehensive vehicle to deliver manure management information. It is hard to imagine, but at that time web pages were just beginning to be used as vehicles to share information, and even harder to imagine is the fact that while information on manure management existed, it was difficult to access, and it was just not a topic that garnered much positive attention.

As the livestock sector in Iowa changed during that time, it became apparent that a mechanism needed to evolve that could keep livestock producers in tune with changing regulations, up-to-date on the current research and in tune with best management practices that help to assure manure's value as a crop nutrient resource and not a waste product.

IMMAG began as state-level technical committee comprised of public and private-sector entities with the objectives to 1) provide access to comprehensive information on manure management issues; 2) develop relevant educational materials and 3) provide them in a format that could be easily accessible.

Now, 15 years later, what was supposed to be short-term, one-year effort, has turned into a major outreach and education effort for Iowa State University Extension and Outreach and their partners. In addition to the web page, IMMAG has hosted many field days and training workshops over the years as well as coordinated the development of countless fact sheets, newsletters and other educational pieces.

The concept of bringing these groups together has proven successful as needs have been identified and educational materials have been developed and distributed. Communication among groups, as related to manure issues, has increased and collaboration of planning processes for nutrient management has been facilitated to ensure all entities have similar processes. <http://www.extension.org/67681>

## **Water Quality Initiatives for Small Iowa Beef and Dairy Feedlot Operations (Small Feedlot Project)**

Angela Rieck-Hinz, Iowa State University, [amrieck@iastate.edu](mailto:amrieck@iastate.edu)

Shawn Shouse, Iowa State University\*

The Small Feedlot Project is a cooperative effort between state and federal regulatory agencies, public research and extension, technical agencies and the private sector in Iowa. The primary objectives are to 1) educate producers to better understand the pollution potential of open feedlot runoff, 2) train producers to accurately assess the water pollution potential of their own feedlots, 3) assist producers to

identify and evaluate appropriate runoff control alternatives, and 4) provide technical assistance to producers to implement solutions that improve the environmental performance of their feedlots.

Traditionally, small feedlots and dairies have not been engaged in environmental regulations and awareness in Iowa due to the environmental focus being directed at large feedlots and confinement feeding operations. Many small feedlot and dairy managers do not even recognize or admit that regulations do apply to their livestock operation. This effort primarily uses traditional extension outreach methods, field days and publications, to raise awareness. Unique to this outreach effort are the goal to provide a producer network to share information and ideas to learn more about manure runoff control structures and best management practices to reduce impacts on water quality, and the focus on controls beyond minimum rule requirements, but tailored to small operations.

This talk will discuss some of the challenges faced by small feedlot producers, identification of parameters to help producers overcome some of these challenges, and methods and educational materials aimed at helping raise environmental awareness and foster action among these producers.

<http://www.extension.org/67682>

## **Cellulose-Based Industrial Wastewater By-Product as Broiler Bedding Material**

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B.H. Kiepper, and B.D. Fairchild

The increased cost and decreased availability of traditional poultry bedding material, such as pine shavings, has facilitated the need to identify alternative bedding materials for poultry growers. The objective of this study was to evaluate a cellulose by-product from the paper manufacturing industry on its comparability to pine shavings on broiler production performance standards and litter quality parameters. The experimental design consisted of 25 pens (3.7 m<sup>2</sup> each) containing 55 Cobb broilers (0.07 m<sup>2</sup>/bird) per pen. Five treatments with five replicate pens per treatment were set up to evaluate varying levels of cellulose inclusion as bedding. The five cellulose treatments consisted of 0% (Control, 100% pine shavings), 25%, 50%, 75% and 100% cellulose by-product. The first phase of the experiment included litter moisture, litter pH, and footpad dermatitis (FPD) scores at Day 7. At Day 7, the mean litter moisture (%) of the Control (23.9) and 25% (23.9) treatments were not significantly different from the 50% (16.9) treatment, but were significantly greater than the 75% (15.0) and 100% (14.8) treatments. At Day 7, the mean percentage (%) of birds with no footpad downgrades in the 100% (99) and 75% (95) treatments were not significantly different from the 50% (87) treatment, but were significantly greater than the 25% (76) and Control (66) treatments. An evaluation of litter moisture versus FPD scores produced a correlation coefficient of 0.73, indicating a strong cause-and-effect relationship between increasing litter moisture and incidence of FPD. Based on phase one results, the cellulose by-product is at least comparable if not superior to pine shavings as a broiler bedding material based on litter moisture and subsequent incidence of FPD during the brooding phase of broiler production. <http://www.extension.org/67685>

## Organic Mulches in Ginseng Production

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During ginseng production, pesticides are intensively applied to the fields, creating risks to farm workers health and the environment. To reduce pest infestation, and consequently pesticide loading, organic mulches with potential disease suppressive properties were investigated as replacements for the conventional straw mulch. A four year study was initiated as ginseng is usually harvested after four years in Wisconsin. The results after one year are being presented. Anaerobic digestate solids (dairy manure feedstock) and vermicompost (grain feedstock) were applied at rates of 1/2" or 1" per plot, prior to planting (fall) and/ or in the spring prior to germination. Soil samples were obtained one month following planting to determine seed damage by pest infestation; germination rates were calculated in the spring. Fewer seeds were damaged by pests in the plots with anaerobic digestate (AD) solids mulch compared to the vermicompost plots, and were similar to the controls. Germination rates for certain vermicompost and AD solids plots were equivalent to the controls. AD solids and vermicompost mulch showed beneficial results after the first year of this experiment. <http://www.extension.org/67688>

## Co-Pyrolyzing Plastic Mulch Waste with Animal Manures

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Patrick G. Hunt, Keri B. Cantrell, Ariel A. Szogi\*, Scott R. Yates, Michale Jackson, David Compton, USDA-ARS

Pyrolyzing various livestock and agricultural wastes produces power and value-added byproducts. It also substantially reduces ultimate waste volume to be disposed of and improves soil fertility and promotes carbon sequestration via soil application of biochar. Researchers found that manure-derived biochars containing high levels of nutrients can upgrade soil quality and remove contaminants in water and soil. However, the combustible gas produced from manure pyrolysis does not provide enough energy to sustain the process. Spent agricultural plastics are usually disposed in landfills, which is not only expensive, but also not environmentally sustainable as the space for landfill is increasingly limited in the U.S. Pyrolysis of spent agricultural plastic produces high energy combustible gas, oil and wax. Thus, co-pyrolyzing animal manures with plastic may achieve an energetically sustainable pyrolysis process. The objective of this work was to investigate the feasibility of co-pyrolyzing agricultural plastic mulch wastes with animal manures. Dried swine manure and spent fumigation plastic mulch were used as a hybrid feedstock for a batch pyrolysis reactor system. The reactor sample was heated to 500 °C at an approximate heating rate of 7 °C/min and stayed at 500 °C for 2 hrs before cooled down to room temperature. Gaseous, liquid, and solid end products were analyzed for their chemical and thermal properties. Preliminary results indicated that pyrolysis of spent fumigant plastic alone produced fumigant-free combustible gases, liquid oil, and paraffin-like waxes. Results from thermogravimetric analyses and chemical characteristics of end products will be presented at the meeting.

<http://www.extension.org/67687>

## Software for Evaluating the Environmental Impact of Dairy and Beef Production Systems

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Quantifying the long term environmental impacts of dairy and beef production is complex due to the many interactions among the physical and biological components of farms that affect the amount and type of emissions that occur. Emissions are influenced by climate and soil characteristics as well as internal management practices. Important environmental impacts include sediment erosion, leaching and runoff of nitrogen and phosphorus, and air emissions of greenhouse gases, ammonia, hydrogen sulfide and volatile organic compounds.

The Integrated Farm System Model (IFSM) is a comprehensive research tool that simulates production system performance over many years of weather to quantify losses to the environment and the economics of production. From the simulated performance and losses, environmental footprints are determined for carbon, energy use, water use and reactive nitrogen loss. Crop, dairy and beef producing farms can be simulated under different management scenarios to evaluate and compare potential environmental and economic benefits. Management choices can include crop production practices, machinery systems for tillage and harvest, feeding strategies, animal characteristics, and manure handling practices.

The Dairy Gas Emissions Model (DairyGEM) provides a simpler educational tool for studying management effects on greenhouse gas, ammonia and hydrogen sulfide emissions and the carbon, energy and water footprints of dairy production systems. Analyses with either of these tools illustrate the complexity of farming systems and the resultant effect of management choices. These software tools are available through Internet download [<http://www.ars.usda.gov/main/docs.htm?docid=2708>] for use in individual, workshop and classroom education. <http://www.extension.org/67689>

## Environmental Footprints of Beef Produced At the U.S. Meat Animal Research Center

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Brianna J. Isenberg, The Pennsylvania State University, E. John Pollak, USDA / ARS, Kimberly R. Stackhouse-Lawson, National Cattlemen's Beef Association

The environmental footprints of beef produced at the U.S. Meat Animal Research Center (MARC) in Clay Center, Nebraska were determined through a simulation of their production system. Relevant information for MARC operations was gathered and used to establish parameters representing their production system with the Integrated Farm System Model. The MARC farm, cow-calf and feedlot operations were each simulated over 25 years of recent historical weather to evaluate performance, environmental impact and economics. The farm operation included 2,072 acres of alfalfa and 2,865 acres of corn to produce feed predominately for the beef herd of 5,500 cows, 1200 replacement heifers and 3,720 cattle finished per year. Spring and fall cow calf herds were fed on 24,000 acres of pastureland supplemented through the winter with hay and silage produced by the farm operation.

Feedlot cattle were backgrounded three months on hay and silage and finished over 7 months on a diet high in corn grain and wet distiller's grain. Model simulated predictions for weather year 2011 agreed well with actual records for feed production and use, energy use and production costs. A 25-year simulation of their current production system gave a carbon footprint of 11 lb of carbon dioxide equivalent units per lb of live weight sold, and the energy required to produce that beef (energy footprint) was 11,200 Btu/lb. The total water required (water footprint) was 2,550 gallon/lb of live weight sold, and the water footprint excluding that obtained through precipitation was 340 gallon/lb. The simulated total cost of producing their beef was approximately \$1.00/lb of live weight sold, which agreed with their production records. Simulations are being developed for 2005 and 1970 to determine how the environmental footprints have changed over time. <http://www.extension.org/67680>

### **The Effect of Bulking Agent On Nutrient Loss And Greenhouse Gas Production From Composting Separated Hog Solids**

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In Manitoba, areas surrounding intensive hog producing facilities have excessive phosphorus in nearby land due to repeated slurry applications. Manure management policies are encouraging the use of solid-liquid separation, such as centrifugation, to remove the P-rich solid fraction and redistribute it at a location further away without the extra transport cost of hauling the heavy liquid fraction. Without the addition of carbon, separated hog solids (SHS) are odorous and are likely to lose most of the nitrogen through ammonia volatilization; however, managing the SHS by windrow composting can reduce odours, stabilize nutrients, and further reduce the volume being transported. However, SHS are a unique product to compost because of the relatively small particle size; thus SHS require a bulking agent to increase the pore size to prevent anaerobic conditions that can lead to greenhouse gas (GHG) emissions within the windrow, but the bulking agent must still allow for heat and moisture retention. Therefore the aim of this research is to compare wheat straw and wood shavings as bulking agents to reduce GHG and nitrogen losses during the composting process. In order to evaluate the loss of GHG's continuously throughout the composting process the use of a LI-8100 automated chamber system (LICOR BioSciences) and Fourier Transform Infrared Radiation (FTIR) multi-gas analyzer (Gasetm DX4015) will be used to simultaneously measure GHG's (carbon dioxide, methane, nitrous oxide) as well as additional nitrogen losses ( ammonia, nitrous dioxide, and nitrogen monoxide). Further research in developing beneficial management practices aimed at minimizing GHG's and nitrogen losses will promote the use of composting hog solids as a manure management strategy.

<http://www.extension.org/67690>

### **The Role of Drainage Depth and Intensity on Hydrology and Nutrient Loss in the Northern Corn-Belt**

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Dario Canelon, University of Minnesota; Mike Talbot, University of Minnesota

Water management in the crop root-zone is crucial to successful crop growth and production. Irrigation, surface, and subsurface drainage—and other practices—are routinely implemented throughout the world to improve crop productivity and working conditions of the soil. Water management practices also impact the environmental footprint of agricultural systems by affecting the flow of water, nutrients, sediment, and other constituents through field, farms, and watersheds. Water management practices for agriculture in the Midwestern US should be designed with both profitability and the environment in mind. The design of subsurface (tile) drainage systems has traditionally been more a matter of how much drainage one can afford, rather than the aforementioned objectives. The relationship among subsurface drainage design characteristics (depth, spacing, layout), farm profitability, and environmental impact are not well known at the farm scale. Thus, drainage system design may fail to meet one or more of these important objectives. This presentation will examine the effects of subsurface drainage system design criteria on productivity, profitability, and the environment, using the soils and climatic conditions of the northern corn-belt (southern Minnesota). <http://www.extension.org/67691>

### **Feasible Small-Scale Anaerobic Digestion – Case Study EUCOline Digestion System**

Steven Sell, & Amber Blythe BIOFerm Energy Systems [sels@biofermenergy.com](mailto:sels@biofermenergy.com)

While large-scale farms have typically been the focus of anaerobic digestion systems in the U.S., an emerging need has been identified to serve smaller farms with between 50 and 500 head of cattle. Implementing such a small, standardized, all-in-one system for these small farm applications has been developed. Small-scale digesters open the playing field for on-farm sustainability and waste management.

This presentation on small-scale digestion would discuss the inputs, processing, function, and outputs of BIOFerm™ Energy Systems' small agitated plug flow digester (EUCOline). This plug-and-play digester system has the ability to operate on dairy manure, bedding material, food waste, or other organic feedstocks with a combined total solids content of 15-20%. A case study would be presented that describes the site components needed, the feedstock amount and energy production, as well as biogas end use. Additional details would include farm logistics, potential sources of funding, installation, operation, and overall impact of the project.

This type of presentation would fill an information gap BIOFerm™ has discovered among dairy farmers who believe anaerobic digestion isn't feasible on a smaller scale. It would provide farmers who attend with an understanding of the technology, how it could work on their specific farm and hopefully reveal to them what their "waste is worth". <http://www.extension.org/67722>

### **Effect of Manure Handling On The Steroid Movement In Beef Cattle Systems**

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Sagor Biswas, University of Nebraska, William Kranz, University of Nebraska, David Shelton, University of Nebraska, Terry Mader, University of Nebraska, Daniel Snow, University of Nebraska, Shannon Bartelt-

Hunt, University of Nebraska, Simon van Donk, University of Nebraska, Tian Zhang, University of Nebraska, Mitiku Mamo, University of Nebraska, David Tarkalson, USDA-ARS

Manure generated from concentrated animal feeding operations may serve as a source of steroids in surface water and potentially in groundwater. The objectives of this research were to determine the amount of steroids and metabolites in runoff from beef cattle production pens, and from runoff and leaching from crop production fields. Cattle were fed a synthetic progestagen, and administered zeranol, trenbolone acetate, and estradiol implants, while a second group was not provided any growth promoters. Manure was sampled in the pens during feeding, run-off was collected during rainfall events, after feeding manure was collected and either composted or stockpiled overwinter. The following summer both composted and stockpiled manure it was spread on a field, with plots subjected to different tillage practices. Following application, two rainfall simulation events were conducted: one day (1 DAT) and one month later (30 DAT) to determine the effects of rainfall timing, manure handling (treated compost, untreated compost, treated stockpile and untreated stockpile) and tillage (no-till, moldboard plow+disk and disk) on the runoff losses of steroids. Results from the manure composting showed reduction in steroid concentrations over stockpiling for some compounds such as 4-androstenedione,  $\beta$ -zearalenol, and progesterone; though not for all steroids. Very low concentrations of steroids were found in most runoff samples, approaching or below detection limits. Considering only detection frequency, fewer runoff samples showed traces of steroids on the 1 DAT in comparison to the 30 DAT simulations. The amount of antecedent rainfall before runoff was affected by tillage, and was different for the 1 DAT and 30 DAT events. A second year's study with a smaller set of treatments, and use of a surrogate estrogen applied at known mass showed that plowing significantly reduced runoff losses of steroids. <http://www.extension.org/67695>

### **Arkansas Discovery Farms Program: Connecting Science to the Farm**

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Mike Daniels, University of Arkansas, Pearl Daniels, University of Arkansas, Neal Mays, University of Arkansas

Agriculture in Arkansas is under increasing pressure to manage nutrients and sediment in an environmentally sustainable manner. In many sectors of the farming community, this has created severe constraints to remaining economically viable and competitive in today's global market place. Increasing national attention is being focused on reducing nutrients to the Gulf of Mexico, which will further increase the need of agricultural producers to increase nutrient efficiency while declining groundwater levels in crop producing areas of eastern Arkansas will increase the need for greater water efficiency. We are monitoring runoff quality from seven farms at six locations as we are quantifying sediment and nutrient losses from all major row crop and livestock commodities including rice, soybean, corn, cotton, poultry and cattle.

We are currently monitoring the quality of runoff from 19 fields using automated water quality samplers that are now equipped modems that contact us via cell phone when sampling is initiated. On our row crop fields, we have increased our efforts to monitor irrigation water use and needs. All fields are

equipped with turbine-type irrigation flow meters that utilize dataloggers to automatically records flow data. On two farms, we split fields in half and monitored evapotranspiration with atmometers (ET gages) and compared to our computer irrigation scheduler to calibrate the ET gages as an easier field method for irrigation scheduling. While the water quality monitoring is a cornerstone, engaging agricultural producers to take ownership in finding solutions to minimize environmental impact is paramount to protecting voluntary efforts for the industry.

It is difficult to quantify impact at this point. As we continue to collect data, we hope we can provide timely information on both economic and natural resource sustainability on behalf of Arkansas Agriculture to regulators, lawmakers and other decision makers. <http://www.extension.org/67692>

### **Phosphorus Index and Applied Tools**

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The inconsistency among P Indices in terms of level of detail and scientific underpinnings among states, as well as in recommendations and interpretations based on site risk, prompted a review and possible revision of the 590 Standard and P-Indexing approach. The need for revision has been heightened by a slower than expected decrease in P-related water quality impairment and, in some cases, an increase in soil P to levels several fold greater than agronomic optimum due to the inability of the P Index to prevent the continued over-application of P to soils. While the basic scientific foundations of the P-Indexing approach are sound, these concerns are real. In this presentation, we propose the use of lower and upper boundaries of P Index use and describe an approach to evaluate individual State P Indices. <http://www.extension.org/67754>

### **Feasibility of Installation of Anaerobic Digesters at Cattle Operations and Demonstration of Decision Support Tool**

Sybil Sharvelle, Colorado State University [sybil.sharvelle@colostate.edu](mailto:sybil.sharvelle@colostate.edu)

An online decision support tool for determining feasibility of anaerobic digestion has been developed ([http://www.erams.info/AD\\_feasibility/](http://www.erams.info/AD_feasibility/)). This decision support tool is specifically targeted to cattle operations in the arid west and provides general information on anaerobic digestion (AD), recommendations on the technical and economic feasibility of AD based on producer provided information on management practices, recommendations on appropriate AD technology based on user defined criteria for the system, guidance on technology provider selection, and required maintenance for operation of an AD system. The goal of the tool is to enable and empower producers to make informed decisions about AD based on unbiased information rather than relying on the biased information often provided by technology providers. In this workshop, the drivers for technical and economic feasibility for on farm AD installation will be discussed and the online decision support tool will be demonstrated. <http://www.extension.org/67694>

### **Estimating Ammonia Emissions from Livestock Operations Using Low-Cost, Time-Averaged Concentration Measurements**

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Dr. Jay Ham, Colorado State University, Dept of Soil and Crop Sciences, Christina Williams, Colorado State University, Dept of Soil and Crop Sciences

Recent regulations on ammonia (NH<sub>3</sub>) and other gaseous emissions by the EPA requires managers of animal feeding operations (AFOs) to report their annual emissions of greenhouse gases (GHGs), with the possibility of federal funding in the near future to be allocated for enforcement of GHG reporting as well as to levy large fines against AFOs that exceed the regulation limitations for GHG emissions. The current method of estimating NH<sub>3</sub> emissions for AFOs is a “back of the envelope” type calculation based upon population and type of animal within an individual AFO. Emissions of NH<sub>3</sub> can vary drastically depending on climate, soil type, location, and other factors. This causes a need for accurate, nearly continuous, on-site measurements of NH<sub>3</sub>, which can be difficult to disseminate to and implement in an economically beneficial way by individual AFO facilities required to report NH<sub>3</sub>. Here we outline a robotic system developed for the measurement of NH<sub>3</sub> that is cost-efficient to employ and easy to maintain while providing accurate year-round data on NH<sub>3</sub> emissions. The system utilizes diffusive/passive samplers (e.g., Radiello, Sigma-Aldrich distributor) that are exposed to the environment under user-defined weather conditions which will yield observations of NH<sub>3</sub> concentrations for a period representing several weeks. Measurement data from the robotic systems can be easily converted to accurate emissions estimates by using an inverse model (e.g., using a simple software package). Data from the passive samplers will be shown for multiple sites and years of data acquired during extensive field testing of the robotic samplers at dairy and cattle feedlot operations in northeastern Colorado from 2011-2012. Emissions obtained using a simple inverse model on the data will be shown as well.

<http://www.extension.org/67697>

## Direct Measurements of Methane Emissions from a Dairy Lagoon in Northeast Colorado

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Dr. Jay Ham, Colorado State University, Dept of Soil and Crop Sciences, Christina Williams, Colorado State University, Dept of Soil and Crop Sciences

Methane (CH<sub>4</sub>) emissions from cattle feedlots and dairies could represent a large component of agriculture's greenhouse gas (GHG) inventory. A significant source of CH<sub>4</sub> is anaerobic lagoons used to store and process manure slurries. Understanding these systems is a crucial step in quantifying the carbon budgets of livestock operations. New open-path CH<sub>4</sub> analyzers provide a method for measuring CH<sub>4</sub> emissions from waste lagoons on a near continuous basis. The resulting data will help to better quantify GHG emissions related to beef and milk production. At a commercial dairy in northeastern Colorado during 2011 – 2012, emissions of CH<sub>4</sub> were measured at the on-site waste lagoon (3.1-ha) using a micrometeorological measurement technique called eddy covariance (EC). The only method to directly measure fluxes of energy and trace gases at the field-scale, EC is widely utilized around the globe to quantify carbon and water budgets for a variety of ecosystems and landscapes. Methane fluxes peaked around 7 mol m<sup>-2</sup> d<sup>-1</sup> in mid- to late-summer 2012, with much variability from Jul – Oct (5 +/- 1.4 mol m<sup>-2</sup> d<sup>-1</sup>). Yearly carbon budgets for the release of methane from the lagoon will be examined as well. <http://www.extension.org/67698>

## Next Generation Manure Technology - Waste to Energy and Environmental Revenues

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The Loyd Ray Farms project is the first swine waste project in the State of North Carolina to generate and transfer renewable energy credits (RECs) to a public utility. Utilizing an anaerobic digester as primary treatment, this waste treatment system is designed to meet the Environmental Performance Standards set forth by NC law for new and expanded swine facilities through the use of nitrification/denitrification and further treatment. The system implemented at this farm utilizes anaerobic digester technology to turn raw animal waste into biogas. The biogas is used to fuel a microturbine, generating electricity to power the environmental treatment system, and about half of the farm.

The farm is a finishing swine operation that houses approximately 9,000 pigs near Yadkinville, NC. The concept for this approach was conceived by the team in 2006, followed by economic and performance modeling, permitting, and construction of the commercial-scale system. The project was commissioned on May 27, 2011. Funding for construction was provided by Duke Energy and Duke University, with support from USDA-NRCS and the NC Division of Soil and Water Conservation. Google provides operational funding support in exchange for a portion of the carbon offsets created.

The project began as a conversation about greenhouse gas emissions, sources for renewable energy, and sustaining the state's swine industry among Duke Energy, Duke University, Google, and Cavanaugh. That conversation led to a project that is getting attention around the world, for its successes in combining strategies to address the concerns for generating renewable energy from agricultural sources, sustaining agriculture, and addressing farming's relationship to climate change.

The system's goals: generating about 500 megawatt-hours of electricity annually, reducing greenhouse gas emissions equivalent to 5,000 tons of carbon dioxide annually, reducing ammonia and odor emissions from the farm, and improving the quality of treated wastewater on the farm.

<http://www.extension.org/67693>

## Effect of Fractionation and Pyrolysis on Fuel Properties of Poultry Litter

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L. Mark Risse\*, K.C. Das, John Worley, and Sidney Thompson, University of Georgia

Raw poultry litter has certain drawbacks for energy production such as high ash and moisture content, a corrosive nature, and low heating values. A combined solution to utilization of raw poultry litter may involve fractionation and pyrolysis. Fractionation divides poultry litter into a fine, nutrient-rich fraction and a coarse, carbon dense fraction. Pyrolysis of the coarse fraction would remove the corrosive volatiles as bio-oil, leaving clean char. This paper presents the effect of fractionation and pyrolysis process parameters on the calorific value of char and on the characterization of bio-oil. Poultry litter samples collected from three commercial poultry farms were divided into 10 treatments that included 2 controls (raw poultry litter and its coarse fraction having particle size greater than 0.85 mm) and 8 other

treatments that were combinations of three factors: type (raw poultry litter or its coarse fraction), heating rate (30 or 10 °C/min), and pyrolysis temperature (300 or 500°C). After the screening process, the poultry litter samples were dried and pyrolyzed in a batch reactor under nitrogen atmosphere and char and condensate yields were recorded. The condensate was separated into three fractions on the basis of their density: heavy, medium, and light phase. Calorific value and proximate and nutrient analysis were performed for char, condensate, and feedstock. Results show that the char with the highest calorific value (17.39MJ/kg) was made from the coarse fraction at 300°C, which captured 68.71% of the feedstock energy. The char produced at 300°C had 42mg/kg arsenic content but no mercury. Almost all of the Al, Ca, Fe, K, Mg, Na, and P remained in the char. The pyrolysis process reduced ammoniacal-nitrogen (NH<sub>4</sub>-N) in char by 99.14% and nitrate-nitrogen (NO<sub>3</sub>-N) by 95.79% at 500°C. <http://www.extension.org/67699>

### **Efficient Utilization of Equine Manure**

Bryan Smith, Clemson University Cooperative Extension Service [wsmth@clemson.edu](mailto:wsmth@clemson.edu)

John P. Chastain, Ph.D., Professor and Extension Agricultural Engineer, Clemson University, Gary L. Heusner, Ph.D., Professor and Extension Specialist, University of Georgia

South Carolina is home to an estimated 18,000 horse owners, many of which own or house less than ten horses on their property. Owners of such small facilities regularly obtain assistance from the Clemson Extension service concerning soil fertility, forage options, and in some cases nutrient testing, but there is very little information available concerning efficient utilization of the manure produced from their facility. In many cases the manure and bedding removed from stalls is viewed as something to be disposed of rather than a possible nutrient source than can be utilized with proper management. This presentation provides an overview of horse manure production and nutrient content for the small horse facility owner, and addresses the best management techniques to utilize produced manure, including the benefits of composting the manure before utilization. <http://www.extension.org/67764>

### **Manure Spreader Calibration Field Days for Confined Animal Facility Operators in South Carolina**

Bryan Smith, Clemson University Cooperative Extension Service [wsmth@clemson.edu](mailto:wsmth@clemson.edu)

Brian L. Beer, M.S., Area Extension Agent – Livestock, Clemson Extension Service, Lee van Vlakte, M.S., Area Extension Agent – Livestock, Clemson Extension Service

Confined Animal Facility Operators in South Carolina either utilize the manure they produce directly on their own land or sell the manure to be used on another farm. The application of this manure is regulated by SC Regulation R.61-43, which provides application setback requirements, nutrient application rates, and other information pertaining to the utilization of the manure as a nutrient source. One requirement of this regulation is that growers must calibrate their spreader equipment once each year in order to provide an accurate application of the manure. Spreader calibration field days were developed for both liquid and solid manure application systems and held in multiple locations around South Carolina. The poster will detail the methods used, the amount of grower interaction and

participation, and the number of growers attending and utilizing this program.

<http://www.extension.org/67700>

## **South Carolina's Confined Animal Manure Manager Program**

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Jesse Adams III, M.S., Area Extension Agent – Livestock, Clemson Extension Service (ret.), Brian L. Beer, M.S., Area Extension Agent – Livestock, Clemson Extension Service, John P. Chastain, Ph.D., Professor and Extension Agricultural Engineer, Clemson University, Julie D. Helm, DVM, Livestock-Poultry Health Division, Clemson University, Stephen T. Henry, M.S., Environmental Engineer, USDA-NRCS, Tonya O’Cain, Agricultural Compliance Manager, SCDHEC, Lee van Vlakte, M.S., Area Extension Agent – Livestock, Clemson Extension Service

In 1998 the South Carolina Legislature enacted regulation R.61-43, titled “Standards for the Permitting of Agricultural Animal Facilities.” This regulation provides requirements on Confined Animal Facility location and permitting, facility management, vector control, mortality disposal, manure application and storage, and a number of other topics. A portion of this regulation stipulates that Clemson University shall provide training in the management of confined animal facilities and the proper application and utilization of manure produced from these facilities. The poster will detail the major points of the regulation and the development and presentation of the Confined Animal Manure Manager program in South Carolina to over 1,500 growers to date. <http://www.extension.org/67701>

## **Staying Ahead of the Curve: How Farmers and Industry Are Responding to the Issue of Climate Change - Farmer & Industry Panel**

David Smith, Texas A&M University [dwsmith@ag.tamu.edu](mailto:dwsmith@ag.tamu.edu)

Several farmers, ranchers, and industry groups are leading the way on the issue of climate change. These panelists will share how their farm or industry is responding to climate change, what factors are driving their decision to make changes, and the impact of climate change on long-term planning. This moderated session will encourage audience questions and facilitate exchange of ideas on how the agriculture industry can meet this challenge. The panel includes:

- Jamie Burr - Tyson Foods, Chair National Pork Board Environment Committee
- Abe Collins – cattle grazer, Cimarron Farm, Regenerative Farmscaping consultant, Board Member Soil Carbon Coalition
- Paul Helgeson - Sustainability Director with Gold’n Plump Chicken
- Andy Werkoven - dairyman and anaerobic digester co-owner, Werkhoven Dairy Inc., 2012 winner of US Dairy Sustainability Award

<http://www.extension.org/67696>

## **Particulate Matter Adjacent To Cattle Deep-Bedded Monoslope Facilities**

Mindy Spiehs, USDA ARS Meat Animal Research Center [mindy.spiehs@ars.usda.gov](mailto:mindy.spiehs@ars.usda.gov)

Greg A. Holt, USDA- ARS Cotton Production and Processing Research Unit, Lubbock, TX, Kris D. Kohl, Iowa State University Extension and Outreach, Storm Lake, IA, Beth E. Doran, Iowa State University Extension and Outreach, Orange City, IA, David B. Parker, Palo Duro Research Center, West Texas A & M University, Canyon, TX, Erin Cortus, South Dakota State University, Brookings, SD

Confined cattle facilities are an increasingly common housing system in the Northern Great Plains region. Many of these facilities add organic bedding material to the pens once or twice per week. Particulate matter concentrations and emissions from these facilities have not been evaluated. The objective of this study was to quantify particulate matter concentration adjacent to deep-bedded monoslope facility housing cattle and to compare the concentrations during normal operation and a bedding event. Three Lo-Vol Particulate Samplers were placed 4.6 m from the north side of the building, and three were placed 4.6 m from the south side of the building with 36.6 m between the samplers on each side. Average sampler flow rate was 16.7 L/min. Samples were collected over two five-day periods (April and June 2011). Each sample period included three 24-hour collections during normal operation and two 3-hr collections during a bedding event. Filters were collected, conditioned for 48 hr at 21.1 °C and 35% humidity, then weighed in micrograms and analyzed on a Beckman Coulter LS 230. During the April sampling period, average 24-hr particulate matter concentration ranged from 40.1 to 91.4 µg/m<sup>3</sup> during days of normal operation. Average 3-hr particulate matter concentration during bedding events ranged from 281.8 to 540.5 µg/m<sup>3</sup>. During the June sampling period, 24-hr particulate matter concentration on days of normal operation ranged from 52.7 to 64.6 µg/m<sup>3</sup>, while 3-hr particulate matter concentration during bedding events averaged 302.4 to 1684.2 µg/m<sup>3</sup>. In general, particulate matter concentrations adjacent to the deep-bedded monoslope facility were lower than previously reported for open lot feedlots. Concentrations were higher during the 3 hr bedding event than during normal operation. <http://www.extension.org/67704>

## **Economic Impacts of Heat Stress**

Normand St. Pierre, The Ohio State University

Farm animals have well known zones of thermal comfort (ZTC). The range of ZTC is primarily dependent on the species, the physiological status of the animals, the relative humidity and velocity of ambient air, and the degree of solar radiation. Economic losses are incurred by the U.S. livestock industries because farm animals are raised in locations and/or seasons where temperature conditions venture outside the ZTC. The objective of this presentation is to provide current estimates of the economic losses sustained by major U.S. livestock industries from thermal stress and to outline future challenges as animal productivity is improved.

<http://www.extension.org/67799>

## **Economic Analysis of Swine Diet Cost Versus Manure Value**

David Stender, Iowa State University Extension [dstender@iastate.edu](mailto:dstender@iastate.edu)

Matt Swantek, Co-Author, Iowa State University Swine Field Specialist

In high yielding row crop intensive regions the role of swine manure as a crop nutrient source has increased in value, replacing the purchase of increasingly expensive commercial fertilizer by providing the nutrient needs of crops. Nutrients from manure are recycled to fertilize high yielding crops in an environmentally friendly, synergistic system.

Access to the value of the nutrients in manure has been a primary motivation for constructing swine facilities. However, as the energy cost of swine diets has increased, feeding programs have been dramatically changed. Changes in ingredients composition has changed from manipulations of dietary formulations. These changes can alter the nutrient composition of the resulting manure and thus the nutrient value of the manure as fertilizer. What does not occur is the consideration that owners/users of the manure composition and if changes need to be made in application rates for optimizing fertilizer rates for crops.

The swine nutritionist can reduce the nitrogen (N) level in manure by 40 or 50% or they can increase the N level by 76%. If the nitrogen produced by a pig is, for example worth \$4 as a manure nutrient. The range in value will be from \$2/head to \$7/head depending on diet formulation. The broader analyses that producers should think about is comparing feed savings from diet manipulation to loss or gain of manure value from that manipulation. Case studies that will be discussed include low protein synthetic amino acid addition, phytase addition, and feeding DDGS.

Information will be presented that will compare feed cost savings from common diet manipulation strategies to the change in the nutrient value of the manure because of the diet manipulation. We are developing a simple spreadsheet to help understand the economics on a holistic operation basis, that we plan to make available to workshop participants. <http://www.extension.org/67703>

## **Global Supply of Phosphorus**

Mike Stewart

## **Highlights of the Air Quality Education in Animal Agriculture Project**

Rick Stowell, University of Nebraska [rstowell2@unl.edu](mailto:rstowell2@unl.edu)

Jill M. Heemstra and Dennis D. Schulte, University of Nebraska, Lincoln, NE, Ronald E. Sheffield, Louisiana State University, Baton Rouge, LA, Eileen F. Wheeler, The Pennsylvania State University, University Park, PA, Kevin A. Janni, University of Minnesota, St. Paul, MN

Through the Air Quality Education in Animal Agriculture (AQEAA) project, Land-Grant University specialists from across the U.S. have been collaborating in delivering applied, research-based air quality information to those who work with livestock and poultry producers. The AQEAA project developed Air Quality content on the Animal Manure Management eXtension website in collaboration with the Livestock and Poultry Environmental Learning Center (LPELC). The Air Quality web content makes widely accessible the educational resources produced by this project for use in developing the

knowledge base and skills of professionals who interact [and pre-professionals who plan to interact] with livestock and poultry producers.

The online materials include 18 written publications, 3 videos, and 16 recorded webinars (webcasts). Also made accessible are selected research and technology summaries as well as online content produced by other organizations. The AQEAA project also developed the skills of professionals regarding air quality topics via professional development events. Website usage information, participant polls, and stakeholder surveys provided evidence that the resources developed by this project are being utilized and that delivery of the information via eXtension has been an effective means of communicating information on this topic. Webcasts were especially effective in communicating information and providing continuing professional development. AQEAA-sponsored workshops were effective in providing in-depth air quality information and experiences to more than 300 professionals.

Collaboration with the LPELC facilitated having a ready eXtension outlet for project materials and is providing continued, sustainable access to online information from this project.

<http://www.extension.org/67706>

## **Assessing the Ability of Nitrogen Isotopes to Distinguish Ammonia Sources Affecting Rocky Mountain National Park**

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Jay M Ham, Colorado State University Department of Soil and Crop Sciences, Christina Williams, Colorado State University Department of Soil and Crop Sciences, Damaris Roosendaal Colorado State University Department of Chemistry, Thomas Borch, Colorado State University Department of Soil and Crop Sciences and Department of Chemistry

Extensive evidence has shown that Rocky Mountain National Park (RMNP) has undergone ecosystem changes due to excessive nitrogen (N) deposition. Previously, the Rocky Mountain Atmospheric Nitrogen and Sulfur (RoMANS) study was conducted to identify the species of N that deposit in RMNP. Results from the RoMANS study showed that reduced N contributions from within Colorado were 45% and 36% for the spring and summer, respectively. There is still much uncertainty as to how much each source within Colorado contributes to ammonia deposition in RMNP. The major goal of this study is to determine whether the isotopic signature of nitrogen can be used as a tracer for ammonia released from sources within Colorado into RMNP. Ammonium samplers were deployed in May of 2011. All samples were collected using passive samplers, Radiellos, deployed for two week and monthly integrations periods. Samples were collected from confined animal feeding operations (beef production), dairies, wastewater reclamation, urban, cropland and RMNP. Sample locations were chosen based its proximity in comparison to RMNP and the availability of meteorological data. The collected ammonia was analyzed using Ion Chromatography, and then diffused onto filters or oxidized for isotopic analysis. Additionally, soil emission studies (grasslands and forests) and weekly wet deposition were collected at two sites varying in elevation in RMNP. Results thus far have shown that wet deposition in the park was similar to previous years based on the amount of precipitation and N deposition. Ammonia isotopic data showed that some sources are significantly different than others,

such as wastewater reclamation, dairies, and beef production. However, cropland sources did not significantly differ from dairies and beef production. <http://www.extension.org/67707>

## **Activation Energy of Urea Hydrolysis and Ammonia Henry Constant Effects on Ammonia Release from Confined Animal Feeding Operations (CAFOs)**

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Jay M Ham, Colorado State University; Department of Soil and Crop Sciences, Thomas Borch, Colorado State University; Department of Soil and Crop Sciences and Department of Chemistry

Ammonia emissions from cattle feedlots have been a topic for much debate regarding air quality and environmental impacts. With increasing concern about future regulation of the industry, understanding the fundamentals of ammonia emission and volatilization from feedlots has become crucial. Wu et al. 2003 described ammonia flux as demonstrating a strong environmental dependency on the ammonium concentration, pH, and the product of the acid dissociation and Henry constant. The objectives of this research are to address the production of ammonia via urea hydrolysis and quantify its release from the soil surface based on the Henry constant. This will be accomplished by studying the rate of urea hydrolysis in feedlots systems, as well as by looking at a new approach to measuring the Henry constant. Urea hydrolysis results will be discussed from a variety of feedlot soils at a fixed water content and urea concentration. Measuring the Henry constant includes measuring the gas phase ammonia above the solution and the ammonia present in the solution. The Henry constant values should provide insight as to how feedlot soil matrices deviate from less complex systems. The results of this work will allow for a better understanding of the fate of ammonia in feedlot systems from production to emission.

<http://www.extension.org/67708>

## **Colorado Small Farms Programs**

Martha Sullins, Colorado State University, [Martha.sullins@colostate.edu](mailto:Martha.sullins@colostate.edu)

Colorado State University has been building educational programming to benefit small-scale crop and livestock producers across the state since 2007. The Colorado Building Farmers and Ranchers program uses a classroom, experiential learning and community-building approach to help smaller-scale and new agricultural producers build their businesses in a profitable, safe and sustainable manner. To date, we have graduated more than 300 producers, 65% of whom have completed business plans to expand or develop their agricultural business. These producers are primarily characterized by their focus on direct marketing, and many are located relatively close to urban areas; locations that provide both marketing opportunities as well as production constraints. The classroom education takes place over 8 weeks and helps producers build sustainable business plans, and develop a network of producers and technical assistance providers (e.g. NRCS, FSA, county planning staff).

Topics covered include developing a production plan, recordkeeping, pricing, risk management, and on-farm food safety. In addition, since small-scale livestock production is a more complex business model, we have built a curriculum that guides producers through all the business planning considerations necessary to start and operate a profitable livestock operation: from acquiring poultry, sheep or goats,

to health and environmental issues, to processing and creating a unique market niche. Following the classroom portion, producers are eligible to apply for a mentorship or internship, where they can work directly with an experienced producer to address production issues (water use, pasture management, crop planning), or business development issues (managing a CSA, or gearing up for farmers' market or on-farm sales). Some of our producers become classroom instructors or mentors for new program graduates. We will discuss how CSU Extension's educational materials and services provide ongoing technical assistance and an agricultural community that support the inherently complex production and marketing systems in which smaller-scale producers operate. <http://www.extension.org/67732>

## **Ammonia Emissions from Anaerobically Digested Manure**

Fei (Figo) Sun, Washington State University

Joe Harrison, [jhharrison@wsu.edu](mailto:jhharrison@wsu.edu) Liz Whitefield, Pius Ndegwa, Hung Soo Joo, Washington State University

Data will be presented on the effect of manure source (anaerobically digested (AD) and non-AD manure), fiber, and manure additive. <http://www.extension.org/67705>

## **Drying and Rewetting Effects on Gas Emissions from Dairy Manure in Semi-arid Regions**

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Enzhu Hu, Utah State University, Rhonda Miller, Utah State University, Markus Tuller, University of Arizona, Scott B. Jones, Utah State University

The major source of emissions in animal production sites is from animal waste (manure), which can be in solid, slurry, or liquid states, exhibiting varying physical properties. Once manure is excreted from an animal, processes of biological decomposition and formation of gaseous compounds continue, but diminish as the manure cools and dries. However, increases in gas emissions following rewetting, particularly from precipitation, have been observed in various agricultural lands. Our study investigates changes of gaseous emissions through manure drying and rewetting processes to identify the effects of climatic conditions and manure management on gaseous emissions.

We carried out drying and rewetting processes of dairy manure in a greenhouse to maintain moderate wintertime temperatures (20 - 40 C) while monitoring gaseous emissions through these processes. Closed dynamic chambers (CDC) coupled with a multiplexed Fourier Transformed Infrared (FTIR) spectroscopy gas analyzer provided gas flux estimates. The analyzer was capable of monitoring 15 pre-programmed gases simultaneously including typical gaseous compounds and greenhouse gases emitted from manure sources; namely, ammonia, carbon dioxide, methane, nitrous oxide, oxides of nitrogen, and volatile organic compounds. Magnitude of dairy manure gas emissions resulting from variations in moisture and temperature provide insight toward enhancing manure management decisions.

Results from our study should further understanding of manure gas emission temporal dynamics that are largely dictated by heat and by drying and rewetting processes that impact the generation and

delivery of gasses to the atmosphere. Our overall goal is to advance development of appropriate best management practices to reduce gas emissions for dairy operations in semi-arid regions.

<http://www.extension.org/67670>

## **Nutrient Management Regulations and the Equine Industry**

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A.M. Swinker\*, C.A. Williams, K. Anderson, C. Skelly, A.O. Burk, M. Westendorf

State and federal agencies are implementing stronger nutrient regulatory laws including equine operations. Nationwide, equine has increased by 77% since 1997; and there are 9.5 million horses in the United States (AHC, 2005). All horse farms are covered under the Federal Animal Feeding Operation (AFO) these laws are regulated through the Environmental Protection Agency (EPA); state requirements may be more stringent than federal. Pennsylvania requires any farm housing animals write a Manure Management Plan, regulated by Department of Environmental Protection, and kept on file at the farm and doesn't need to be approved, unless it is a Concentrated Animal Operation (CAO) or Concentrated Animal Feeding Operation (CAFO). New Jersey requires facilities with as few as 8 animal units (AU) to develop animal waste management plans. The rule is tiered with larger farms (> 300 AU) having to complete a certified nutrient management plan, farms of 8-299 AU complete a self-certified plan the smallest farms (< 8 AU) complete no plan. In Delaware one horse equals 1.25 AU; properties with seven or more horses must comply. The Virginia Department of Conservation and Recreation manages agricultural nutrients found in fertilizers, manure, and focus on BMPs, P-Index management. VA defines AFOs as 150 horses, kept in confinement for 45 days/yr. In 2010, West Virginia Department of Agriculture established the nutrient management certification program for equine. Maryland's Water Quality Improvement Act, affect horses in 2004; horse operation making \$2,500 gross annual income or houses 8 AU's must file plans. North Carolina developed a permitting program through the Division of Water Quality, and Department of Environmental & Natural Resources. Farms with 75 horses are subject to state permits. Kentucky's 1998 Act requires operation with 14 contiguous acres develop a plan. Twenty-five states administer a state NPDES, CAFO Program with other state permit program.

<http://www.extension.org/67710>

## **Process for Recovery of Phosphorus from Solid Manure**

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Matias Vanotti, Patrick Hunt, USDA-ARS Coastal Plains, Soil, Water, & Plant Research Center

Land application of manure in regions with intense confined livestock and poultry production is an environmental concern when land is limiting because it promotes soil phosphorus (P) surplus and potential pollution of water resources. Although manure can be moved off the farm, its transportation becomes less economical with increasing distances from the farm. Thus, management alternatives to land application are needed to recycle manure P. A treatment process, called "quick wash", was developed for extraction and recovery of P from poultry litter and animal manure solids. In the quick wash process, P is selectively extracted from solid manure or poultry litter by using mineral or organic

acid solutions. Following, P is recovered by addition of liquid lime and an organic poly-electrolyte to the liquid extract to form a calcium-containing P precipitate. The quick wash process generates two products: 1) washed solid residue, and 2) concentrated recovered P material. The washed solid residue has a more balanced N to P (N:P) ratio that is more environmentally safe for land application. The use of recovered P can provide a recycled P source for use as crop fertilizer while minimizing manure P losses into the environment from confined animal production. <http://www.extension.org/67702>

## **Ammonia Emissions and Emission Factors: A Summary of Investigations at Beef Cattle Feedyards on the Southern High Plains**

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N. Andy Cole, USDA-ARS Conservation and Production Research Laboratory, Heidi M. Waldrip, USDA-ARS Conservation and Production Research Laboratory

Ammonia volatilization is a major component of the nitrogen balance of a feedyard, and the effects of ammonia loss range from the economic (loss of manure fertilizer value) to the environmental (air quality degradation, overfertilization of ecosystems). Seven years of research at the USDA-ARS Conservation and Production Research Laboratory have greatly increased our understanding of ammonia emissions from southern High Plains beef cattle feedyards. We summarize results of our ammonia investigations and report emission rates, discuss major factors that influence emissions, and recommend a whole-farm emission factor. Ammonia emissions were quantified at three commercial feedyards in the Texas Panhandle from 2002 to 2008 using micrometeorological methods. Ammonia emissions followed a distinct annual pattern. Emissions during summer were about twice those during winter, while spring and autumn emissions were intermediate. Annualized ammonia emissions ranged from 0.20 to 0.37 lb NH<sub>3</sub>/head/day, and averaged 0.26 lb NH<sub>3</sub>/head/day over all studies. Ammonia loss as a fraction of nitrogen fed to cattle averaged 41% during winter and 69% during summer; on an annual basis, 54% of fed nitrogen was lost as ammonia. Greatest emissions were observed when crude protein in cattle rations exceeded the NRC (2000) nutrient requirements of beef cattle. Mean monthly ammonia emissions were strongly correlated with mean monthly temperature, and the relationship could be used to predict ammonia emissions from southern High Plains feedyards. Cattle feeders that meet recommended crude protein in rations can expect to lose 50% of fed N as ammonia. We recommend an annual emission factor of 88 lb/head for beef cattle feedyards based on one-time capacity, or 39 lb/head fed, based on a 150-d feeding period. <http://www.extension.org/67711>

## **Exploring Chicken Manure to Increase Concentrations of Organic Sulfur Compounds in Onions**

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Regina R. Hill, and George F. Antonious - Kentucky State University-Division of Environmental Studies

Onions are valued as food and medicine primarily for the flavor and medicinal properties of their sulfur compounds. A field study was conducted at KSU Research Farm. The soil in five plots was mixed with sewage sludge, five plots were mixed with yard waste compost, five plots were mixed with laying hen

manure each at 15t acre<sup>-1</sup>, and five unamended plots that never received soil amendments were used for comparison purposes. Plots were planted with onion, *Allium cepa* L. var. Super Star-F1. The objectives of this investigation were to: i) determine the concentrations of organosulfur compounds (dipropyl disulfide and dipropyl trisulfide) in onion bulbs and ii) investigate the effect of mixing soil with three amendments (sewage sludge, yard waste, and chicken manure) on the concentration of sulfur compounds in onion bulbs. Gas chromatographic/mass spectrometric (GC/MS) analyses of onion oil in chloroform extracts revealed the presence of two major fragment ions that correspond to dipropyl disulfide and -trisulfide. Concentration of these two organic sulfur compounds was greatest (1.5 and 0.8 mg 100 g<sup>-1</sup> fresh weight, respectively) in onion bulbs of plants grown in chicken manure and lowest (0.4 and 0.07 mg 100 g<sup>-1</sup> fresh weight, respectively) in onion bulbs of plants grown in yard waste compost treatments. We concluded that chicken manure could be exploited in growing onions with health-promoting properties. <http://www.extension.org/67712>

## **The Role of Computer Models in Environmental Phosphorus Management**

Peter Vadas, Dairy Systems Scientist, USDA-ARS Dairy Forage Research Center, [peter.vadas@ars.usda.gov](mailto:peter.vadas@ars.usda.gov)

Computer models are excellent ways to integrate years of scientific research into decision tools that producers and policy makers can use to reduce the environmental impact of agricultural phosphorus. Models are playing more important roles in efforts to manage phosphorus at the farm and watershed scales, so it is increasingly important to make sure models are well developed to meet the needs of users, give reliable predictions, and are consistently updated to keep pace with scientific knowledge. <http://www.extension.org/67713>

## **Predicting Nutrient Application at CAFO Land Application Fields using CAFOweb™**

Tara Vander Dussen, Glorieta Geoscience, Inc. [tbone@glorietageo.com](mailto:tbone@glorietageo.com)

Reddy Ganta, Jay Lazarus\*

Current Best Management Practices (BMPs) only measure past land application of nutrients at Animal Feeding Operations (AFO) and Concentrated Animal Feeding Operations (CAFO). Because the current BMP calculates nutrient application at the end of the year, the CAFO operator finds out if they have over applied CAFO-generated nutrients, when it is too late to adjust nutrient applications. Over application of nutrients in land application fields limits a CAFO operator's ability to reuse his/her green water or manure solids as nutrients. Green water, manure solids, and chemical fertilizers are fungible assets and should be managed as resources, not wastes. Over application can result in high (>30 ppm) or very high (>50 ppm) soil nitrate concentrations beneath land application fields that must be mined from the soil. Where there is sufficient hydraulic head in the land application fields, excess nitrate can leach through the soils and root zone to groundwater. When ground water quality standards are exceeded, the nutrients are being disposed of as wastes rather than reused as a resource and EPA or other regulatory agencies can require costly soils and ground water investigations and abatement/remediation. To prevent turning the manure and green water resources into an environmental liability and financial

burden, we developed the online CAFOWeb software to allow CAFOs to manage their nutrients in real time from the fields. Real time forecasting works best when all nutrient and water contributions are quantified using chemical analyses of soil and plant tissue coupled with and the meter readings that allow the operator to determine if he is operating at peak efficiency. The CAFOWeb data management and interpretations allow CAFO operators to make informed real time decisions on land application of nutrients at agronomic rates, insuring “wastes” are converted to assets or worth. Real time management of dairy-generated nutrients retains the value of the CAFO facility for future generations. <http://www.extension.org/67714>

## **Refining a Pork Production Carbon Footprint Mitigation Tool: A Case Study of an Integrated Research/Extension/Education Project**

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Swine production systems in the U.S. have long been guided by efforts to increase productivity, decrease costs of production and minimize environmental impacts. Public policy is currently considering the impacts of these production systems on regional greenhouse gas (GHG) emissions and their potential impact on global climate change. There is a gap between our understanding of these impacts and our ability to make informed decisions to guide changes in breeding, feeding, waste management and other production practices. Therefore, a USDA NIFA project was funded to experimentally evaluate mitigation technologies to support development of a robust and accurate process-based Life Cycle Analysis (LCA) model of GHG emission from swine production systems; to couple this model with Life Cycle Cost Analysis; and utilize this model as an education and outreach tool for evaluating the environmental footprint of swine production facilities. The project objectives are:

- 1) Perform experimental validation of the effectiveness of selected mitigation strategies, including dietary feeding strategies (reduced nitrogen, growth enhancers), health status, barn and manure management options (solids separation, algal nutrient removal, gasification).
- 2) Integrate process models of swine production with coupled LCA and economic model to create a decision support tool to identify economical swine production system options which minimize GHG emissions and increase sustainability of swine production systems.
- 3) Develop and implement education and outreach programs utilizing the interaction between climate and swine science to introduce life cycle thinking and systems analysis into the national sustainable agriculture conversation.

This presentation provides the opportunity to review the structure and content overview of a successfully funded integrated Research/Extension/Education project. Opportunity will also be provided for Q&A interaction with a panel of project participants regarding various aspects of the project, from basic concepts to implementation approaches. <http://www.extension.org/67626>

## **Treatment Technologies for Ammonia in Liquid Manure: Nitrification/Denitrification and Anammox Based Deammonification**

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Biological treatment is regarded as the most efficient and economically feasible method available for removal of ammonia from wastewater. Its use for animal wastewater required development of new systems and methods that could handle the higher-strength characteristics of liquid manure. The discovery of a high-performing nitrifying bacterial sludge (HPNS) adapted to high ammonia concentrations (> 3,000 mg N/L) and low water temperatures (5 oC) significantly reduced biological nitrogen removal (BNR) plant footprint and costs. Nitrification of fresh flushed manure was most effective after solid-liquid separation treatment, using a pre-denitrification configuration. Farmers that would like to implement biological ammonia removal from the effluent of anaerobic digesters (AD) are often limited by the low amount of endogenous carbon available for traditional denitrification, since the carbon is consumed in the biogas production. The deammonification process is a completely autotrophic nitrogen removal approach that eliminates the carbon needs for denitrification. Thus, it can be a promising approach for the biological removal of ammonia from anaerobic digester effluents that are low in carbon and high in ammonia concentration. We obtained rapid deammonification reaction by mixing nitrifying sludge HPNS with anammox bacteria, *Brocadia caroliniensis* in a single, aerated reactors. The single-tank reactors were tested with digested swine wastewater. Compared with traditional N removal, the deammonification process reduced 57% of the aeration. Therefore, deammonification is a key technology for development of more economical and energy efficient biological ammonia removal systems in the near future. <http://www.extension.org/67627>

## **Ammonia Recovery from Livestock Wastewater with Gas Permeable Membranes**

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This presentation shows new methods and systems being developed for reducing ammonia emissions from livestock waste and recovering concentrated liquid nitrogen that could be sold as fertilizer. These systems use gas-permeable membranes as components of new processes to capture and recover the ammonia in liquid manures. The process includes the passage of gaseous ammonia contained in the liquid manure through a microporous hydrophobic membrane and capture and concentration with circulating diluted acid on the other side of the membrane. The membranes can be assembled in modules or manifolds. For liquid manure applications, the membrane manifolds are submerged in the liquid and the ammonia is removed from the liquid matrix in barn pits or storage tanks before it goes

into the air. The concept was successfully tested using concentrated swine and dairy manure effluents. The results obtained showed that the new technology could be an effective approach to recover ammonia from livestock wastewater. The new technology could help change on-farm nitrogen management: Livestock producers could use the technology to help meet air-quality regulations, save fuel, protect the health of livestock and their human caretakers, improve livestock productivity, and recover concentrated liquid nitrogen that can be sold for fertilizer. <http://www.extension.org/67628>

## **Farm-system modeling to evaluate environmental losses, profitability, and Best Management Practice Cost-Effectiveness**

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To meet Chesapeake Bay Total Maximum Daily Load requirements for agricultural pollution, conservation districts and farmers are tasked with implementing best management practices (BMPs) that reduce farm losses of nutrients and sediment. The importance of the agricultural industry to the regional economy highlights the need for determining cost-effective BMP solutions given the geographical and operational characteristics of these farms. This study evaluated both the environmental risk and farm profitability of common farm-level management practices for three major farm types in the region: crop, tractor-based (“English”) dairy, and horse-drawn (“Amish”) dairy. Whole-farm simulations were conducted with the Integrated Farm System Model, a multi-year, process-based simulation model, to facilitate a broader understanding of the challenges for the farmers in finding financially feasible and environmentally sustainable solutions. Strip cropping, conservation tillage, cover cropping, and nutrient management BMPs generally reduced nutrient and sediments losses from all three farm types. However, scenarios that reduced phosphorus and sediment losses generally promoted more leaching of nitrogen. Double cropping corn with winter wheat combined with improved nutrient management was the most profitable practice for the crop farm, increasing average farm profitability by 92% over the baseline condition, while reducing combined nitrogen and total phosphorus losses by 13% and 23%, respectively. Net profitability of the dairy farm was increased only by decreasing manure storage or using improved nutrient management. For the horse-drawn dairy, cover-cropping and harvest of rye silage combined with increased nutrient management provided the greatest increase in farm profit (+8%) and also reduced phosphorus and nitrogen losses. <http://www.extension.org/67629>

## **Managing Creek Pastures for Improved Water Quality**

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Runoff of E. coli and other fecal indicator bacteria from grazing lands has been identified as a significant source of bacterial contamination in need of reductions to improve water quality. Improved management of creek pastures and implementation of on-farm best management practices to address these bacterial issues is critical to the success of watershed restoration efforts. To address this, the impacts of grazing management and providing alternative off-stream water in creek pastures were evaluated to assess their effectiveness for reducing E. coli loading.

Study results showed that there was no difference in runoff E. coli concentrations from ungrazed, properly grazed and heavily grazed pastures and no correlation between stocking rate and E. coli concentrations. It is suspected that the observed rapid decline in E. coli concentrations following rotation and significant contributions by wildlife resulted in this lack of correlation. However, rotational grazing, when timed appropriately, was found to be a very effective practice for reducing E. coli concentrations in runoff. As a result of these findings, it was recommended that, where feasible, creek pastures and other hydrologically connected pastures be grazed during periods when runoff is less likely and that upland sites be grazed during rainy seasons when runoff is more likely to occur.

The study also found that when alternative off-stream water was provided, cattle spent 43% less time in the creek. Despite this significant reduction in the amount of time cattle spent in the creek, the study was not able to document statistically significant E. coli loading reductions from providing alternative water. Nevertheless, providing off-stream water in creek pastures was highly recommended practice for improving water quality due to the reduction in the amount of time cattle spend in the creek documented by this study and the finding of other studies demonstrating reductions in sediment, nutrients and bacteria. <http://www.extension.org/67631>

### **Estimation of Ammonia Emissions from Two Commercial Beef Cattle Feedyards in the Southern High Plains with Process-Based Models**

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Ammonia (NH<sub>3</sub>) emissions from beef cattle feedyards result in loss of nitrogen that could be useful for crop production, and this emission can have negative environmental consequences. Both empirical and

process-based models have been developed to estimate NH<sub>3</sub> emissions from various livestock production systems; however, little work has been conducted to assess their accuracy for large open-lot feedyards. To validate two process-based models, Manure-DNDC and the Integrated Farm System Model (IFSM), model-simulated NH<sub>3</sub> emissions were compared to data collected from two commercial feedyards in the Texas High Plains from 2007 to 2009. Predictions made by Manure-DNDC and IFSM were within 66 to 74% agreement with observed feedyard emissions ( $p < 0.001$ ), and were sensitive to seasonal variations in air temperature and dietary crude protein concentration. Manure-DNDC predicted mean daily NH<sub>3</sub> flux densities for the two feedyards of 43.6 and 55.7 kg NH<sub>3</sub>/ha/d, and regression analysis showed good agreement with observed data ( $p < 0.001$ ). With the addition of an open-lot emission routine, IFSM predicted mean per capita emission rates of 72.8 and 60.7 g NH<sub>3</sub>/head/d for the two feedyards, which also agreed well with observations ( $p < 0.001$ ). Despite differences in the core models, daily Manure-DNDC and IFSM predictions were highly correlated ( $r = 0.74$ ,  $p < 0.001$ ). When model predictions for annual feedyard NH<sub>3</sub> emissions were compared to predictions made with a constant emission factor that is currently used by the EPA, IFSM and Manure-DNDC estimates were within 19% to 13% of observations, respectively; whereas, the constant emission factor underestimated annual feedyard emissions by 54%. This evaluation indicates that both IFSM and Manure-DNDC are useful tools for predicting NH<sub>3</sub> emissions from commercial feedyards, offering accurate information for policy makers and producers and methods for evaluating the effects of specific management practices and mitigation strategies. <http://www.extension.org/67632>

## Anaerobic Digestion of Finishing Cattle Manure

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Continuously stirred anaerobic digesters ( $n = 7$ , 1 L capacity) were used to compare degradation of manure from 2 cattle diets (Trial 1) and 2 cattle housing methods (Trial 2). Manure was collected from confinement cattle on a CONT diet with 82.5% dry rolled corn (DRC) or WDGS diet with wet distillers grains plus solubles replacing 40% of DRC (Trial 1). Organic matter degradation (OMD) was 51.0% for CONT and 52.9% for WDGS ( $P = 0.10$ ). Methane production was 0.551 L/d for CONT and 0.634 L/d for WDGS ( $P = 0.10$ ), equal to 0.116 and 0.137 L/g OM fed ( $P = 0.05$ ). Manure was collected from cattle in complete confinement (CONF) or soil-based, open feedlot pens (FDLT; Trial 2). Manure OM was 88% for CONF and 26% for FDLT. During the trial, 3 digesters on FDLT treatment failed due to ash buildup. For remaining digesters, OMD was 46.7% for CONF and 24.8% for FDLT ( $P < 0.01$ ). Methane production was 0.478 L/d for CONF and 0.229 L/d for FDLT ( $P < 0.01$ ), equal to 0.103 and 0.189 L/g OM fed ( $P = 0.01$ ). Open lot manure can be a viable feedstock if ash buildup is avoided. Microbial communities (Eubacterial and Archaeal) were identified using 454-pyrosequencing and revealed structuring of the microbial community based on diet ( $P < 0.001$ ; Trial 1). Bacteria prevalent in WDGS digesters belonged to phylum Chloroflexi (61.42%) and Bacteroidetes (19.57%) while archaea belonged to classes Methanobacteria (97.63%) and Methanomicrobia (1.98%). Within CONT digesters, bacteria consisted of phylum Bacteroidetes (57.36%) and Chloroflexi (35.48%) while classes Methanobacteria (89.90%) and Methanomicrobia (9.62%) dominated archaea. These results suggest the microbial food chain that contributes to methane production is greatly influenced by the diet fed to cattle, and dietary

manipulation may provide opportunities to increase or decrease methane production from cattle manure. <http://www.extension.org/67633>

## **BFNMP\$: A Tool for Estimating Feedlot Manure Economics**

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The Beef Feed Nutrient Management Planning Economics (BFNMP\$) computer program (available at <http://water.unl.edu/web/manure/software>) can assist producers in understanding the impacts manure handling changes could have on their operation. The BFNMP\$ program calculates manure management economics based on animal nutrient intake, manure nutrient availability, land requirement for spreading, operating costs and fertilizer value. This program was used to determine 1) impact of dietary N and P from traditional grain based diets compared to diets including 40% distillers grains (DG) 2) effect of different N volatilization (VOL) rates 3) impact of changing manure application rates from N to P based and from 1 to 4 yr rates. These scenarios fed out 5000 cattle per yr in 100 hd pens from 750 to 1300 kg with 144 d on feed. Increasing dietary N and P increases nutrient excretion. Capturing these nutrients in manure increases costs, but increases value at a greater rate. Manure from cattle fed a traditional feedlot diet with 50% N VOL has a value of \$21.53/animal (\$13.11/ton) based on inorganic fertilizer values. Feeding a 40% DG ration results in manure worth \$29.70/animal (\$18.09/ton). Decreasing N VOL to 20% increases value of the manure to \$26.55/animal and \$37.11/animal for the grain based and DG diet, respectively. Spreading enough manure in 1 yr to meet crop P requirements for 4 yrs costs approximately the same as spreading manure every yr to meet N requirements. Phosphorus based applications, whether 1 or 4 yrs, require about 3 times the acres of N based applications. Spreading on a 1-year P basis is expensive and unnecessary. Spreading on a N basis results in excess P buildup. Fertilizer prices have increased dramatically in recent yrs which has renewed interest in manure fertilizer and enhanced the value of manure. <http://www.extension.org/67634>

## **Nutrient Management on Small Farms**

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The USDA defines a small farm as any operation with gross sales less than \$250,000 per year. A small farm might have 50-100 dairy cows in the Midwest or Northeast, it could be a 30-ewe flock of pasture raised sheep, or a 100 head sow herd or 10 head of beef cows and calves on a retirement farm; or even a flock of laying hens in a residential area. This definition includes both commercial and hobby farms. Many small farm owners do not realize the value of the manure produced on their farms. Manure is often disposed offsite or stored indefinitely on the farm, if manure is spread on farm a nutrient management plan may or may not be in place. Small farms have fewer animals and often several animal species on the same farm. There may be limited acreage and/or a lack of equipment for spreading manure. Financial resources may be lacking, but lower cost solutions for manure management may exist. Small farmers may not be aware of potential critical areas on the farm (sensitive water bodies,

erosion, neighbor concerns, manure storage), and they may not understand the idea of nutrient balance. The following principles may help small farmers who develop nutrient management programs: 1) Appropriate manure storage should be located at least 100 feet from water bodies, wetlands, etc.; 2) Animal access to water bodies, wetlands, etc. should be controlled; 3. Manure should be applied according to a nutrient management plan that balances nutrient content in the manure with crop nutrient requirements and uptake and optimizes beneficial use of nutrients from manure and bedding; and 4) Minimize odors from manure storage and application areas. The Livestock Poultry Environmental Learning Center has a series of Small Farms fact sheets; for more information please go to: <http://www.extension.org/pages/8890/lpes-curriculum-small-farm-fact-sheet>.

<http://www.extension.org/67636>

### **Inhibition of Total Gas Production, Methane, Hydrogen Sulfide, and Sulfate-Reducing Bacteria From In Vitro Stored Swine Manure Using Condensed Tannins**

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Management practices from large-scale swine production facilities have resulted in the increased collection and storage of manure for off-season fertilization use. Odor produced during storage has increased the tension among rural neighbors and among urban and rural residents, and greenhouse gas emissions may contribute to climate change. Production of these compounds from stored manure is the result of microbial activity of the anaerobic bacterial populations present during storage. We have been studying the bacterial populations of stored manure to develop methods to reduce bacterial metabolic activity and production of gaseous emissions, including the toxic odorant hydrogen sulfide produced by sulfate-reducing bacteria. Quebracho and other condensed tannins were tested for effects on total gas, hydrogen sulfide, and methane production and levels of sulfate-reducing bacteria in in vitro swine manure slurries. Quebracho condensed tannins were found to be most effective of tannins tested, and total gas, hydrogen sulfide, and methane production were all inhibited by greater than 90% from in vitro manure slurries. The inhibition was maintained for at least 28 days. Total bacterial numbers in the manure were reduced significantly following addition of quebracho tannins, as were sulfate-reducing bacteria. These results indicate that the condensed tannins are eliciting a collective effect on the bacterial population, and the addition of quebracho tannins to stored swine manure may reduce odorous and greenhouse gas emissions. <http://www.extension.org/67635>

### **Combination of Borax and Quebracho Condensed Tannins Treatment to Reduce Hydrogen Sulfide, Ammonia and Greenhouse Gas Emissions from Stored Swine Manure**

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Livestock producers are acutely aware for the need to reduce gaseous emissions from stored livestock waste and have been trying to identify new technologies to address the chronic problem. Besides the malodor issue, toxic gases emitted from stored livestock manure, especially hydrogen sulfide (H<sub>2</sub>S) and ammonia (NH<sub>3</sub>) are environmental and health hazards for humans and animals and under scrutiny by the Environmental Protection Agency for regulatory control of concentrated animal farm operations (CAFOs). These odorous and toxic gases are produced by bacteria during the fermentation of the stored manure. Sulfate reducing bacteria convert sulfate (SO<sub>4</sub>) to sulfide (H<sub>2</sub>S) during the fermentation. During storage of swine manure, about 60% of NH<sub>3</sub> nitrogen is also loss. If NH<sub>3</sub> loss can be prevented, the fertilizer value of swine manure would improve and reduce the need for additional commercial nitrogen fertilizer. There are very few technologies available to reduce H<sub>2</sub>S, NH<sub>3</sub> and greenhouse gas emissions from stored livestock manure, which meet the criteria of being: inexpensive, safe for farmers and animals, and environmentally sustainable. Previous research has shown that borax and quebracho condensed tannin are effective in inhibiting H<sub>2</sub>S production in stored swine manure. The present research demonstrates that a combination of borax and quebracho condensed tannin is highly effective in reducing all gaseous emissions (H<sub>2</sub>S, NH<sub>3</sub>, CO<sub>2</sub>, CO, N<sub>2</sub>O and CH<sub>4</sub>) and in retaining more nitrogen in swine manure. Lesser amounts of borax and quebracho condensed tannin are needed when combined to achieve a similar reduction in H<sub>2</sub>S production to using much larger amounts of either product alone. Phytotoxicity studies show that the level of tolerance of crops to borax-tannin combination treated swine manure is: alfalfa > corn > wheat > soybean >> dry beans. Quebracho condensed tannin does not appear to be toxic to crops. <http://www.extension.org/67637>

## **The Discovery Farms Model: The Impact of Helping Farmers Take Control of Water Quality Management**

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Many states conduct water quality monitoring projects and within the past decade, sub-watershed and whole farm water quality monitoring has gained more traction as a preferred method to understand runoff and nutrient loading behavior. The one aspect of these projects that has evolved is the level of partnering. Partnering not just with technical and academic groups but fully partnering and involving the landowner or resource manager. The Discovery Farms model is a great example of a fully partnered, adaptive management water quality monitoring project that began in Wisconsin and has grown to formally include North Dakota, Minnesota and Arkansas. The main objective of the Discovery Farms projects is to fully engage producers in the identification and if necessary the reduction of nutrient and

sediment losses from a variety of agriculture farming systems by collecting runoff data from real, working farms. The program is founded on the belief that farmers who are engaged, educated and empowered with actual on-farm information will use the data to address water quality concerns. The concept has demonstrated successes and is gaining interest around the country from producers and their commodity organizations.

This workshop will share experiences, successes, the principals of operation and key tasks needed to develop and implement Discovery Farms programs. Among the four states; edge of field, tile drainage and feedlot monitoring is being conducted for a diverse set of agricultural production systems. The purpose of the workshop is two-fold: 1) to provide guidance and advice to help other States develop plans and partnerships with stakeholder groups to build Discovery Farms programs in their respective States, and 2) allow participating farmers the opportunity to share what they have learned from the monitoring done on their farms and how they have reacted to that new knowledge.

<http://www.extension.org/67638>

## Currently Used Manure Management Practices of Equine Operations

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Adoption of manure management best management practices (BMPs) by horse farm operators is critical for the prevention of nutrient losses into water and air resources. Our objective was to summarize the use of the manure management BMPs in North Eastern states as determined by three independent mailed surveys.

Removal of horse manure appears to be practiced more in New Jersey (58%; 1) than in Maryland (29.5%; 2) or Pennsylvania (20.9%; 3). While NJ found that 74% horse farms had designated manure storage facilities, MD and PA found that 71.4% and 52.3%, respectively of horse owners stored manure on unprepared sites. The New Jersey study found that operations with a designated area for storage were more likely to clean stalls daily, dispose of manure off-site and use a dry lot or sacrifice area. In the other studies, 57.0% of MD and 44.1% of PA farms sometimes or never removed manure from sacrifice lots. Very few operators in any state stored manure within 50 ft of a water source (MD: 1.9%, NJ: 1.1%, and PA: 2.2%). Slightly less than half of operations composted manure (MD: no data, NJ: 47%, and PA: 41.8 %). A higher use of spreading of manure was found in NJ (54%) compared to PA (10.6%). Those spreading manure in NJ study were also more likely to store some manure off-site and credit manure as crop fertilizer.

Results indicate the majority of horse farms store and manage manure on their property. Low adoption rates of proper manure management BMPs indicate educational programming and cost share funding is needed to increase adoption rates and lower environmental impact.

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<http://www.extension.org/67737>

## **Diet and Tillage Effects on VOC Emissions Following Land Application of Beef Cattle Manure**

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Little information is currently available concerning odor emissions following land application of beef cattle manure. This study was conducted to measure the effects of diet, tillage, and time following land application of beef cattle manure on the emission of volatile organic compounds (VOC). Each of the experimental treatments which included tillage (broadcast or disked) and diet (0, 10, or 30% wet distillers grain (WDGS)) were replicated twice. A 5-m tandem finishing disc was used to incorporate the manure to a depth of approximately 8 cm. Small plots (0.75 m x 2.0 m) were constructed using 20 cm-wide sheet metal frames. A flux chamber was used to obtain air samples within the small plots at 0, 1, 2, 6, and 23 hours following manure application. The flux of fifteen VOC including fatty acids, aromatic compounds, and sulfur containing compounds were measured. Based on odor threshold, isovaleric acid, butyric acid, and 4-methylphenol provided 28.9%, 18.0%, and 17.7%, respectively, of the total measured odor activity. Heptanic acid, acetic acid, skatole, 4-methylphenol, and phenol each contributed less than 1% of the total odor activity. Dimethyl disulfide (DMDS) and dimethyl trisulfide were the only measured constituents that were significantly influenced by diet. DMDS values were significantly greater for the manure derived from the 30% WDGS diet than the other manure sources. No significant differences in DMDS values were found for manure derived from diets containing 0% and 10% WDGS. Tillage did not significantly affect any of the measured VOC compounds. Each of the VOC was significantly influenced by the length of time that had expired following land application. In general, the smallest VOC measurements were obtained at the 23 hour sampling interval. Diet, tillage, and time following application should each be considered when estimating VOC emissions following land application of beef cattle manure. <http://www.extension.org/67640>

## **Affecting Change Through Collaboration: An Industry-Driven Approach**

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Identifying every source of nitrogen that contributes to deposition in the park is a daunting task, but is critical in order to fairly and equitably develop a plan to reduce nitrogen levels in the park. As a result,

starting in 2006 various stakeholder groups came together to analyze air quality data related to the park and to provide recommendations on how to best address nitrogen deposition concerns from sources of oxides of nitrogen and ammonia in Colorado. The presentation will highlight some of the actions taken, or being planned, by the agricultural stakeholder group, in particular, to address atmospheric deposition of nitrogen in the park.

Even though it is too early to make any conclusions as to the success of the proactive approach (i.e., voluntary measures versus regulatory controls) or to the extent that current state air quality plans or best management practices are having on nitrogen deposition in the park, the presentation is intended to share some of the challenges and achievements, to date, of this particular stakeholder-driven approach. <http://www.extension.org/67641>

### **Dissipation of Fine Particulates Downwind of Poultry Houses**

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Air emissions from animal feeding operations have become a growing concern for producers and their neighbors. Much work has been done to quantify emission rates; however, little information has been provided about air quality downwind from these facilities. This study investigates PM<sub>2.5</sub> (particulate matter  $\leq 2.5 \mu\text{m}$  in diameter) levels as they dissipate from the exhaust fans of selected commercial, tunnel-ventilated, broiler houses in Northeast Georgia. PM<sub>2.5</sub> was measured in real time using aerosol monitors and from a time-integrated basis using cyclone samplers. Data were taken over the last 4-weeks of a summer flock (considered a worst-case-scenario) and filtered to insure enough data was present at each distance and time. Results indicate a rapid reduction in fine particulate concentration as the distance from the source increases. When compared to nearby monitoring data, particulate levels appear to be near background levels at distances greater than 30 m (100 ft) from the exhaust fans.

<http://www.extension.org/67642>

### **Impacts of Changing Climate in the Northeast on Manure Storage**

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Manure storage design and operation are influenced by climate and weather. The Northeast United States has been identified as likely to experience more frequent and larger precipitation events in climate change models. The Northeast Regional Climate Center (NRCC) predicts that particularly in New York and New England where the frequency of 2 inch rainfall events has increased since the 1950s and storms once considered a 1 in 100 year event have become more frequent. Such storms are now likely to occur almost twice as often. In consultation with Natural Resource Conservation Service (NRCS) the NRCC has put together a website [www.precip.net](http://www.precip.net) that includes estimates of extreme rainfall for various durations (from 5 minutes to 10 days) and recurrence intervals (1 year to 500 years). Although the public website remains static, providing design criteria, updated data is continually collected. It is anticipated

that this will show a continual shift in extreme rainfall amounts. Monthly and yearly rainfall also impact manure storage design. The impacts of both changing extreme rainfall and monthly rainfall amounts on manure storage design are explored. Higher freeboard amounts to protect from overtopping and more total storage to provide flexibility in abnormally wet weather are recommended to be incorporated in manure storage facility designs. <http://www.extension.org/67643>

## **Enhancing The Productivity Of Livestock Production Through Improved Feeding: Empirical Evidence From Highland Of Ethiopia**

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The Feed Assessment Tool (FEAST) was used to characterize the farming and livestock system in Limu-Bibilo district in Ethiopia. Prior to data collection, a Sustainable Livelihoods Framework (SLF) was conducted in August 2012. The quantitative data from individual interviews of 18 farmers were entered and analyzed using FEAST. Livestock production is an integral component of the farming system of the study area. Cattle are kept for food, cash, draught power and manure production. For the above average group grazing, crop residues, and cultivated fodder contributes 49%, 25% and 12% to the dry matter (DM) content of the total diet respectively. Similarly, grazing, crop residue, and purchased feeds contributes 33%, 23% and 20% of the DM respectively as to the below average groups. Grazing, crop residues and cultivated fodders are the major feed resources that are contributing 49%, 20%, and 14% of the metabolizable energy (ME) respectively as to the above average group and 32%, 17% and 14% respectively to the below average group. For above average group Grazing, cultivated fodder, purchased feeds, and crop residues contribute 42%, 17%, 16%, and 15% crude protein (CP) content respectively whereas purchased feeds, grazing, and cultivated fodders contribute 35%, 25%, and 15% of CP in the total diet in the case of below average groups. The problems that were raised by the farmers encompass, shortage of feed, scarcity of water, unavailability of cash or credit services, shortage of veterinary service, lack AI service, awareness and communication gap. In light of the problems the study recommends the development of herbaceous forage legumes and fodder trees species which can mitigate the constraints of feed scarcity. Training on cost effective livestock ration formulation techniques to reduce the feed shortages observed must be part of a strategy which requires attention to improve the production of the sector. <http://www.extension.org/67644>

## **Dairy Manure Digestion Influenced By Wasted Milk From Milking Operations**

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It is not uncommon that a significant amount of milk from milking operations is discharged to manure digesters on dairy farms. To understand the impact of milk on the digester performance, experiments

using batch digesters (500 mL flasks) were carried out in this study to co-digest milk and dairy manure at different milk levels for biogas production and pollutants reduction, and a total of eight treatments were examined, i.e., control (without milk), 1, 3, 5, 7, 9, 14, and 19% milk additions. The temperature for all digesters was maintained at  $37\pm 0.5^{\circ}\text{C}$  throughout the experimental period, which was 28 days. The results showed that co-digesting milk with dairy manure could increase biogas productivity, with the percent cumulative biogas volume increased by 5.6, 16.3, 26.5, 40.8, 50.2, 79.9, and 103.8%, as compared to the control, for milk addition of 1, 3, 5, 7, 9, 14, and 19% (v/v), respectively. However, the  $\text{CH}_4$  content in the biogas decreased slightly as the milk content increased (from 66.5% for the control to 63.5% for 19% milk treatment), implying that the added milk could promote  $\text{CO}_2$  production. To avoid that, the milk content in the manure should be controlled below 3%. A linear relationship for the total biogas volume produced with the milk content in the manure was revealed, with a correlation coefficient of 0.9993. An improved removal efficiency of chemical oxygen demand (COD) was observed for milk treated digesters. Good linear regressions between the total biogas production and the percent COD reductions and the substrate carbon/nitrogen ratio were also obtained (correlation coefficients: 0.9266 and 0.9992, respectively). Besides, co-digestion of dairy manure and milk was found to improve substrate solids breakdown, but had little impact on percent volatile fatty acid (VFA) reductions. In summary, the wasted milk co-digested with dairy manure may not cause negative impact on anaerobic digester performance. <http://www.extension.org/67645>

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