Application for Nomination to the 2010 Experiment Station Section Excellence in Multistate Research Award

Nominating Region: Southern Region
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Project or Committee Number and Title:

S-1032 Improving the Sustainability of Livestock and Poultry Production in the United States

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Situation statement:

From the very founding of this country, the U.S. has enjoyed a diversity of agricultural production systems, including livestock and poultry, affording the population attractive choices of healthy and high value food and fiber. As with all production sectors around the globe, pressures from population growth, migration of population to rural regions, economic competition, and desires to protect the environment have necessitated structural and technological changes in agriculture. For many years, predecessor projects of the S-1032 project brought together scientists and educators representing the Land Grant Universities and Colleges and the USDA/ARS – spanning the nation from the east coast to Hawaii, from Texas to Minnesota – to work on technical challenges surrounding the management and treatment of livestock manure and airborne emissions from livestock operations. From decades of good quality research and reporting, agriculture and society received the benefits of these collaborations. These benefits were usually in the form of distinct components, independent strides taken to solve problems in a piecewise manner.

Now there is an overarching environmental and energy challenge to concentrated animal agriculture, the outcome deciding the future scale and viability of one of the largest but most vulnerable contributors to the agricultural economy. S-1032 unites scientists, engineers, economists, educators, and policy makers from various disciplines to holistically address the environmental and energy issues and concerns facing the North American livestock and poultry industry. The old "tried and true" approach of focused scientific problem-solving still works and has its place in S-1032, but the team has also affirmed that the component-wise objectives of the project, which may appear disparate on the surface, are so interrelated in practice that the experimental work being carried out in any of the areas naturally touches one or more other spheres. Hence, the multistate project requires, and affords by its nature, synergy. That intertwining of problem-solving enterprises led us to a more bold approach in writing the S-1032 project, the approach being to involve economists, ecologists, engineers, and others to participate in developing a new way of describing functions and interactions of livestock and poultry production within the environmental context locally, regionally, and globally. Such a new approach positions S-1032 at the heart of the livestock industry's research needs, while placing science and engineering within the reach of policymakers as they attempt to address questions of sustainability.

Project objectives:

(1) Develop models of each animal industry that describe its cumulative ecological risk, or ecological footprint, as a function of the stocks, flows and transformations of matter and energy in concentrated animal feeding operation systems. This is the "broad context" objective. The other more traditional style objectives, which all provide input to the Objective (1) models, are to invent, research and develop ways to: (2) improve land application of manure, (3) treat manure to meet environmental goals and improve farm profitability, (4) reduce undesirable airborne emissions from livestock and poultry farms, and (5) feed animals differently to reduce excretion of environmentally sensitive nutrients.

Outcomes (typical, not an exhaustive list):

To achieve project objectives, a holistic approach is needed. Included is the consideration of all aspects of livestock production from birth to final marketing including feeding formulations, waste control, waste to a viable resource, and management models. Details are listed below.

Science-enabled refinements of basic animal husbandry processes

- Dramatically reducing excretion of phosphorus by pigs and poultry, by the introduction of synthetic phytase enzyme in the diets – what are the best practices, costs and benefits

Creative approaches to established management practice components

- Design and demonstration of dairy wastewater treatment systems that can clean wastewater to the point of being re-usable in the dairy facility. Such systems combine, in an innovative package, refined versions of known technologies such as constructed wetlands, bark filter mounds, anaerobic digestion, nitrification and denitrification.
- Improvement of vegetative and aquatic systems that "polish" wastewater to sequester nutrients in a harvestable crop.
- Treatment of runoff using management and vegetative filter strips.
- Use of black soldier flies to digest manure and produce a valuable animal feed which can also reduce swine manure odor.
- Development of new standards including ASAE D384.2 Manure Production and Characteristics, a universal methane productivity equation, and air emissions measurement standard equipment and procedures to make comparison of data and systems easier.

New technologies and methods

- Discovery of a newly isolated treatment bacterium for removing ammonia from livestock wastewater promises to reduce wastewater treatment costs for farms and make advanced systems that can discharge or reuse water feasible. Greenhouse gas emissions are reduced at the same time. Field testing of innovative new technologies has provided science-based information on efficacy of using bacterial amendments and solid-liquid separation with synthetic porous tubes to reduce dairy manure and process generated wastewater pollution.
- Development of a continuous thermochemical conversion process for making crude oil product from animal wastes and other agricultural by-products is nearing commercialization.

- Development of protocols to examine synergistic and antagonistic effects of blending manures with other high energy agricultural wastes to maximize energy production by effectively using the abundance of nutrients in manure.
- Mapping of waste biomass and modeling of net energy potential to encourage blending of agricultural residuals, including manure, to maximize the potential of optimized energy production in multiple biomass conversion technologies.

Addressing emerging areas of concern in environment and energy

- Investigation of antibiotic resistant organisms in manure and wastewater, and the fate of endocrine disruptors and pharmaceutical products in water running off manure land application sites. Simulate three commonly used dairy manure management strategies to determine the persistence of several classes of pathogens. Mycobacyterium avium subsp. Paratuberculosis, *E. coli* 0157:H7, Listeria mollocytogenes, and Salmonella spp. were monitored through a series of laboratory experiments to determine the effects of high temperature composting treatment compared to low temperature solid and liquid manure storages.
- Studying fate and transport of livestock and wildlife manure bacteria in rural streams is providing valuable information and comparisons of *E-coli* bacteria shedding by livestock and wildlife in watersheds with pasture settings.
- Pilot-scale testing of on-farm manure to energy conversion using a gasifier has led to scientific and technical data and infor*mation* on production and composition of syngas produced from separated dairy manure solids.
- Initiate modeling efforts on carbon footprint, greenhouse gas emissions, and lifecycle analyses of livestock and poultry production systems.
- Establishment of the Environmental Collaborative on Sustainable Environmental and Agricultural Management (ECOSEAM) that is developing upper level undergraduate, low level graduate classes and continuing educations modules on high priority agricultural watershed management, and rural environmental issues at rural/suburban interfaces, Two classes that are currently being broadly offered are on animal waste management and air emissions from agricultural facilities. All course materials are housed on eXtension. Initiation of a new PhD program in Systems Agriculture developed a conceptual model of the stocks and flows of matter and energy within a nonlinear system involving cattle feedlots, ethanol plants, and cereal-grain production as a platform for evaluating environmental and natural-resource policy scenarios vis-à-vis embodied-energy and life-cycle sustainability considerations.

Applying economics to analyze efficient use of increasingly scarce resources

- Initiate systems modeling efforts on the costs and benefits of inputs consumed and outputs generated by manure management systems, land application methods, and changes in livestock production systems to address environmental and energy concerns.

Impacts:

S-1032 has begun identifying the key collaborators and enabling useful interactions that will build process models and improve and develop management technologies. Modeling results will provide policymakers with the science-based information they need to refine appropriate

local, state and federal regulations. Improved technologies enable the realization of ever changing environmental priorities.

Project members authored most of the chapters and reviewed and pilot tested all of, the Livestock and Poultry Environmental Stewardship national curriculum (www.lpes.org), which is now a widely recognized text defining the current state of the art of livestock manure management and odor control technologies. Various states use the LPES curriculum in Extension training environments. The LPES effort has been augmented and channeled into an eXtension platform for livestock and poultry environmental education, and S-1032 members are the subject matter experts for that effort.

In many states, science-based information resulting from the S-1032 predecessor projects has been shared with community members to help citizens better understand the actual environmental impacts of livestock production. Dialogue within the community among citizens, environmentalists and livestock producers has been initiated – a critical step in acceptance of existing and proposed farming practices.

Results of animal diet changes, based on S-1032 member research, have shown huge reductions – 30-50% -- in the amounts of phosphorus excreted by swine and poultry, with no harm to animal health or performance. Livestock producers and nutrient management planners across the U.S. have improved information and methods for limiting water quality impacts from nutrients and pathogens in manure.

New manure treatment methods, such as thermochemical conversion of swine and dairy manure solids to crude oil, refined manure composting techniques, more efficient anaerobic digestion, and innovative manure treatment package plants, present more options for a livestock industry that is struggling to remain competitive and environmentally responsible. Protocols on modeling and experimental testing of blended waste agricultural residuals are complete and one member has screened over 20 materials looking for synergistic and antagonistic trends. A member state instituted the beta version of a waste biomass inventory that enables the prediction of the quantity of biomass from multiple sources, including manure, and from livestock facilities, that are available from the selected radius around the designated location. The web based resource also models net energy production, including the consideration of resources needed for transportation and energy production, for five biomass conversion technologies.

The S-1032 member-led field manual, 'Managing contaminated animal and plant materials: Field guide on best practices' (http://tammi.tamu.edu/MortalityTSWGguide-2008.pdf) won the American Society of Agricultural and Biological Engineers 2009 Blue Ribbon Educational Award in the comprehensive publication category.

The S-1032 annual meeting has established an excellent venue for the active participation of graduate students researching trans-disciplinary topics related to the ecological sustainability of livestock and poultry production systems. Additionally, S-1032 member-led manure management educational programs such as the 2009 Texas Animal Manure Management Issues Conference in Round Rock, Texas provided several S-1032 members from Texas, Oklahoma and Louisiana an educational venue to provide research-based information and education to producers, scientists, regulators, agriculture business personnel, students and media. Media coverage of animal manure management issues as a result of this conference appeared in the Houston Chronicle (http://www.chron.com/disp/story.mpl/business/energy/6649844.html) and the New York Times (http://www.nytimes.com/2009/12/29/science/29manure.html) reaching national and international audiences.

Newly formed links to Extension:

S-1032 comprises a membership of faculty with research, teaching, and Extension appointments. In addition to exploiting the Extension linkages made readily available by virtue of appointment – for example, citing project research findings in livestock producer meetings -- S-1032 is collaborating with eXtension projects (example: http://www.extension.org/animal manure management) to get information to public stakeholders more quickly and transparently.

Collaborations:

The new project takes a systems approach to incorporate the knowledge of engineers, scientists, educators, policy makers, and economists into a collection of models of each animal industry that describe its cumulative ecological risk, energy flows or ecological footprint as a dynamic, nonlinear function of the stocks, flows and transformations of matter and energy comprising CAFO systems. New collaborations and cooperators are being developed with ecologists, economists, and systems analysts to share and incorporate the detailed process-oriented research of many project members into broad but meaningful models that will aid our understanding of the interactions of the system and will help guide policymakers in decisions regarding the food animal production industries. In addition, there is a history of S-1025 meeting jointly with s-1032 which is providing valuable interaction and collaboration between the two committees benefitting both. There is a sharing of research techniques and results in joint meetings but also each committee conducts separate sessions. Furthermore, these two regional committees have met jointly with the CSREES (NIFA) NRI Air Quality Project Director Meeting, and the eXtension Livestock, Poultry and the Environment Learning Center. Members of S-1032 are now experts for eXtension.

Leveraged Funds:

A partial response last year from the committee with selected other grants attributable to the project demonstrates relevance of the research and demonstration with a total of over $7.4 million in grants with 80% federal, 17% other and 3% commodities from September 2007 to 2010. Details are available upon request.