Environmental Research Agenda for Animal Agriculture, 2006

This document provides a summary of thoughts shared by presenters and participants during the 2006 **John M. Airy Symposium: Visions for Animal Agriculture and the Environment.** *The objective of this symposium was to bring together leading scientists in the field of animal agriculture to define the future course of livestock production and the environment. The list of presenters, their presented paper abstracts as well as their symposium presentations can be accessed at: http://www.iowabeefcenter.org/content/Airy_home.htm.*

Animal agriculture is a significant engine of economic growth throughout much of the world. While animals supply food and power in subsistence economies, commercial livestock and poultry production is an important value-added enterprise in much of the developed world. Feeding grain, forage, and oilseed products to animals creates a higher-quality protein and more nutrient-dense food for consumption.

The conversion of feed to meat, milk, and eggs also creates excretions that if not properly managed can be harmful to the environment. These excretions may have a local effect such as degrading water and air quality, and broader impacts such as green house gases and hypoxia in coastal waters. Tied to the concern about the environmental impact of animal production facilities is the concept of developing environmentally sustainable animal production systems at a regional level. One approach to measuring the sustainability of a given production system type is the concept of its "ecological footprint". Using this concept, the full production costs in terms of resource utilization for raw materials such as water and feed, as well as resources needed to successfully assimilate excretions of production back into the environment without significant environmental damage, must be determined. Using this approach it is clear that systems that import large amounts of feed without the adequate land base to assimilate the resulting excretions, as well as systems that utilize water at rates far in excess of the water source's ability to replenish itself, have a larger ecological footprint than the actual footprint ratio to sustain itself. The largest difficulty in making such determinations however, is identifying the unit of measurement from the standpoint of sustainability. It is very difficult to put a monetary value on environmental degradation. One idea of how to measure the concept of system sustainability is to do so in terms of energy use. Losses from production systems in the form of nutrients or pollutants are in their most basic form a loss of energy. Energy is a far more universal currency than money.

Animal protein production also uses or loses energy during the production of feed, storage and transportation of feed, and in the feed conversion process itself. However, agricultural animals are an important element of nutrient recycling and can utilize other manufacturing byproducts (such as distillers grains from ethanol manufacture) in the production of high-quality food stuffs for human consumption. From a regional perspective, the geographic placement and concentration of these facilities in relation to where resources are imported from and where by-products will be utilized do have an impact on sustainability.

Many aspects of animal production interact with one another and often involve tradeoffs. For example, the practice of incorporating land-applied manure into the soil to reduce odor and emissions can result in increased soil erosion that leads to increased water quality problems. Existing production systems based on historically low water irrigation and fuel prices may not be environmentally or economically efficient under today's prices. As the availability of water for irrigation has diminished, producers in water-deficient areas have had to either use more energy to extract deeper water resources or import feed from areas with greater precipitation. The importation of feed to grain-deficit regions that are sparsely populated may have lower local air and water quality risk, but additional energy is used in moving the feed and the receiving regions have more nutrients than they can recycle through crops.

These integrated plant and livestock systems are complex and have multiple points of interaction with the environment. Historical evaluation methods have relied upon animal inputs and outputs measured in pounds, and occasionally economic returns measured in dollar benefit or cost to producers. Often these measures were made close to the animal and didn't look at broader system costs in terms of nutrients, emissions, and energy.

To more effectively evaluate the environmental impacts of animal agriculture, livestock and poultry research must be evaluated by its impact on the entire production system from plants to animals to excretions and account for inputs, outputs, and leakages. These research issues can be divided into four primary area of investigation: measurement, mitigation, treatment, and incentives.

Measurement

Perhaps the most critical research issue for animal agriculture and the environment is what and how to measure results. Past primary measurements have often been animal performance with some measure of excretions. Environmental performance often measures excretions and emissions and may ignore the animal. Some research has ignored economics and others have used only cost of production economics. Individual research, and more importantly, integrated production systems must measure the broader impacts of the animal, producer economics, and the environment. Specific research needs include:

- Development of a common currency method to compare integrated production systems and individual research projects. This common currency should be grounded in fundamental science and acknowledge that animal production systems result in energy losses, nutrient fluxes, and endproduct enhancement and that system improvements can lead to improvements in these entities. The method should identify how to quantify the environmental footprint of an operation or production system and how it compares to the opportunity production cost in another system or location.
- Development and implementation of models using this common currency to evaluate the environmental footprint of production systems at regional and farm levels so as to inform decision makers about true long term costs and benefits of a particular technology in a given location.
- Identification of what components must be measured and reported from environmental research. These may include the quantity of water, energy used and the amount of nutrients, GHG, and other emissions that are produced.
- Analysis of the environmental costs of integrated and non-integrated production systems on a local, regional, and national basis.
- Development of fast or real-time procedures to determine nutrient composition of animal manures for more effective land application and/or treatment.

Mitigation

The research area with opportunity for win-win results is the reduction of excretions from animal agriculture, or mitigation. This strategy holds promise for the environment by reducing the amount of nutrients and emissions coming from the animal. Mitigation gains will come from improved genetic and nutritional understanding of the animal, better feed processing technology, and advanced management systems that lead to increased efficiency of the animal to utilize the feed inputs. More specifically, priorities for investigation include methods to minimize nitrogen (N) and phosphorous (P) losses including:

- More closely match nutrient inputs with animal needs and utilize more readily available forms of nutrients such that there are less excreted and minimal performance impacts when providing less than recommended N and P levels in feeds.
- Identify animals and/or production systems with lower maintenance requirements as live body maintenance accounts for a large portion of nutrient loss in animals.
- Better understanding of the partitioning of nutrients in animals and their excretion or emission to determine if repartitioning agents that increase protein deposition reduce N and P loss to the environment.
- Understanding of the implications of increased byproduct feeding from an expanding biorenewable fuel industry. Many of the co-products from bio-based energy production will be fed to livestock and often the nutrients are more concentrated than the original feedstock.
- Develop and evaluate production systems that integrate livestock and crop production to enhance enterprise productivity while minimizing damage to water, soil and air resources.

Treatment

Once excretions and emissions are produced by livestock and poultry, best management production decisions must be made for the collection, storage, processing, and application to protect the environment. Currently, producers strive to meet regulatory requirements with an emphasis on short-term economic returns in a globally-competitive marketplace. To be adopted by producers, manure treatment technologies must either be low-cost or add enough value to the manure to encourage adoption. Specific treatment technologies that deserve further inquiry include:

- Understand how the fate and transmission of nutrients, pathogens, endocrine disrupters, and emissions are impacted by alternative treatment systems.
- Determine what collection, storage, and application methods retain the greatest nutrient value for crop production and if these methods be improved upon to enhance manure value to crop producers.
- Determine the energy balance and economic feasibility of producing energy from manure and the impact and value of resulting coproducts.
- Improve land application equipment accuracy to reduce the risk when utilizing manure nutrients for crop production.
- Develop technologies to extract or change the ratio of manure components for improving its economic value or by creating value-added coproducts.
- Develop treatment system technologies that are practical to operate and scale neutral for the production of value-added products from livestock and poultry manure.

Incentives

Regardless of the research innovation, in order for it to have an impact on environment quality it must be adopted. Producers that make decisions respond to economic signals that either increase revenue or minimize cost to achieve a particular product or regulatory standard. Additional research is needed on what policy options are most effective in achieving the desired outcome. Needed research includes:

- Understanding of producer decision-making processes, including cultural and social constraints, short- and long-term economic incentives, and value and source of information.

- Develop and evaluate manure and emission credit markets to provide a private sector market mechanism to value environmental improvements.
- Evaluate cost and effectiveness of policy alternatives regarding local, state, and national agencies.

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