MAXIMIZING RETURNS FROM STATE INVESTMENTS IN NUTRIENT MANAGEMENT AND MANURE UTILIZATION

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Abstract. Animal operations in Georgia have been placed under increasing regulatory pressure due to their impacts on water quality. This has created an interest at the State level in the development of assistance programs such as cost share to aid the producers in developing environmentally sound solutions. Many programs propose to fund Best Management Practices at the farm level which may offer short term improvements in water quality but may not solve the real problem which is nutrient imbalance. This paper shall propose programs to facilitate nutrient management planning and develop or improve manure markets. These programs could be in the form of grants or low interest loans to encourage composting operations, energy production, expanded markets, or new "crops" dependent on animal manures. Not only will these activities reduce the amount of manure being excessively land applied on the farm, but they should also create more market demand for manure. In addition, the industries these investments could potentially develop will stimulate economic growth in rural areas of Georgia.

INTRODUCTION

Agriculture is one of several industries that face criticism today because of its impact on the environment. On May 5, 1998, Secretary of Agriculture Dan Glickman stated that animal waste is "the biggest conservation issue in agriculture today, bar none" at the National Summit on Animal Waste and the Environment. Agricultural production has been identified by the U.S. Environmental Protection Agency (EPA) as the largest single contributor to water quality impairment for rivers and lakes. A Government Accounting Office (GAO) report (USGAO 1995) to the U.S. Senated suggested that livestock and poultry manure is a major contributor of total nitrogen (N) and phosphorus (P) inputs into U.S. watersheds. Manure nutrient inputs were substantially greater than those associated with more traditional sources of pollution (e.g., municipalities, industry). Studies such as these, and the EPA's increased emphasis on non-point sources of pollution, have lead to increased regulation on animal agriculture. The EPA recently released a National Strategy for regulating confined animal feeding operations and currently is proposing even tougher regulation (http://www.epa.gov/owm/afo.htm). In Georgia, new regulations were passed for both swine and non-swine operations. While these regulations primarily affect the largest operations, both the national strategy and the new Georgia regulations will require most operations to educate and certify an operator and develop a comprehensive nutrient management plan (CNMP).

Manure contains five primary contaminants that impact water quality: nitrate N, ammonia-N, phosphorus, pathogens, and organic solids. In Georgia, nutrients in manure represent the single largest threat to water quality. In addition, many of the practices that control pathogens and organic matter releases are the same as those required for nutrients. Both the EPA and Georgia have recognized this and are using nutrient management as the cornerstone of their regulatory approaches. Both have also recognized that land application and the use of manure as a soil conditioner and fertilizer is the best method of dealing with these nutrients. If managed correctly, manure is an excellent plant nutrient source and soil "builder" resulting in many important environmental benefits. Soils regularly receiving manure require less commercial fertilizer (conserving energy and limited phosphorus reserves), are higher in organic matter contributing to greater soil productivity, and experience less runoff and erosion and better conservation of moisture (Risse and Gilley, 2001). However, an increased risk to water quality will result from excess application of nutrients to a cropping system.

NUTRIENT MANAGEMENT PLANNING

Nutrients are transported along multiple pathways and in a variety of forms on a livestock operation (Figure 1). Nutrients arrive on a livestock operation as purchased products, nitrogen fixed by legume crops, and nitrates in rain and irrigation water. Within the boundaries of the

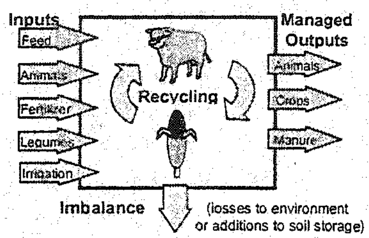

Figure 1. Flow of nutrients on a typical livestock operation (From Koelsch, 2000).

farm, there is a "Recycling" of nutrients between the livestock and crop components. Nutrients exit a livestock operation as "Managed Outputs" including animals and crops sold and possibly other products moved off farm (e.g., manure sold or given away). Some nutrients exit the farm as losses to the environment (nitrates in groundwater, ammonia volatilized into the atmosphere, and nitrogen and phosphorus into surface water). Nutrients (especially phosphorus) also accumulate in large quantities in the soil. Although not a direct loss to the environment, a growing accumulation of nutrients in the soil adds to the risk of future environmental losses.

The "Imbalance" is the difference between the "Inputs" and the "Managed Outputs." This "Imbalance" accounts for the direct environmental loss and the accumulation of nutrients in soil. For the purpose of this discussion, nutrient imbalance will be expressed as a ratio of inputs to outputs. A ratio of 3:1 suggests that for every three pounds of nutrient entering a farm, one pound leaves as a managed product and the remaining two pounds is lost to the environment or added to soil storage reserves. The nutrient balances on typical farms range from less than one to greater than five (Koelsch, 2000). Livestock and poultry operations with a large imbalance (1.5:1 and greater) would expect steadily increasing soil phosphorus levels. Runoff and erosion from land application sites will carry an increasing phosphorus load as soil phosphorus levels increase. Measures to reduce runoff and erosion and other BMP's will partially reduce this risk and provide temporary solutions but the phosphorus imbalance must be corrected before this growing pollution potential will stabilize. These "High Risk" operations are not environmentally sustainable.

The concept of comprehensive nutrient management planning (CNMP) was introduced by EPA and USDA's Natural Resources Conservation Service (NRCS). It is anticipated that CNMP's will serve as the cornerstone of environmental plans assembled by animal feeding operations to address federal and state regulations. NRCS draft guidelines for CNMP's provide some indications of the key issues to be addressed (www.nhq.nrcs.usda.gov/PROGRAMS/ahcwpd/ahCNMP.html).

A CNMP should be more than a regulatory document. It should detail the management practices for minimizing the impact of nutrients and manure on soil, water, and air resources and establish a record-keeping system that will document the degree of implementation and success of the proposed management practices. Both EPA and Georgia will require that CNMP's be developed by "certified nutrient management planners." The University of Georgia, in cooperation with the Georgia Department of Agriculture, has recently developed a program that trained and tested more than 130 county extension agents and 6 private consultants to develop a core group of planners. While this represents a good start on developing the technical expertise necessary for CNMP development, more effort and funding will be needed. At current staffing levels, no single agency in Georgia will be able to develop the number of plans required. The private sector will have to become involved in the planning process. This will require either direct payments from the farmers or some sort of State subsidized planning effort. The state must provide assistance to both develop and implement these plans.

NUTRIENT DISTRIBUTION

Most nutrient-related issues associated with livestock production are a result of poor nutrient "distribution." This distribution issue can be a local or a regional issue. An integrated crop and livestock farm commonly experiences distribution problems within its own boundaries. Some fields, often those closest to the livestock facility, receive excessive manure applications while commercial fertilizer is purchased to meet the needs of more distant fields. Spreading manure based upon convenience and not the crop's nutrient requirements causes water quality problems which are easily corrected through implementation of CNMPs.

Farms focused primarily on livestock production import significant quantities of nutrients as animal feeds. Livestock utilize only 10% to 30% of these nutrients, excreting the remaining as manure. This results in a concentration of nutrients on the livestock farm. The separation of ownership of crop and livestock production can result in a concentration of nutrients on the livestock farms while crop farms import substantial commercial fertilizer nutrients. Such problems are commonly observed in regions where sufficient crop land is available but separation of livestock and crop ownership create nutrient distribution problems. Regional nutrient distribution issues have developed in the last 30 years as livestock/poultry production and feed grain production have concentrated in specific, but separate, regions of the country. The nutrients excreted by these animals can overwhelm the ability of locally grown crops to recycle these nutrients. These regional distribution problems are common in Georgia (Figure 2) and represent the animal feeding industry's most difficult nutrient challenge.

STRATEGIES TO IMPROVE BALANCE

Evaluating a livestock system's nutrient balance during the development of a CNMP provides a complete picture of nutrient-related environmental issues. If problems exist, four management strategies are likely to reduce nutrient imbalances:

Efficient use of manure nutrients in crop production. By accurately crediting manure nutrients in a cropping program, the purchases of commercial fertilizer can be reduced or eliminated and the risk to the environment reduced. This practice is especially important to livestock operations with significant crop production. It can easily be implemented by the farmer with no cost and often improves profitability; however, it will not work on operations with large imbalances

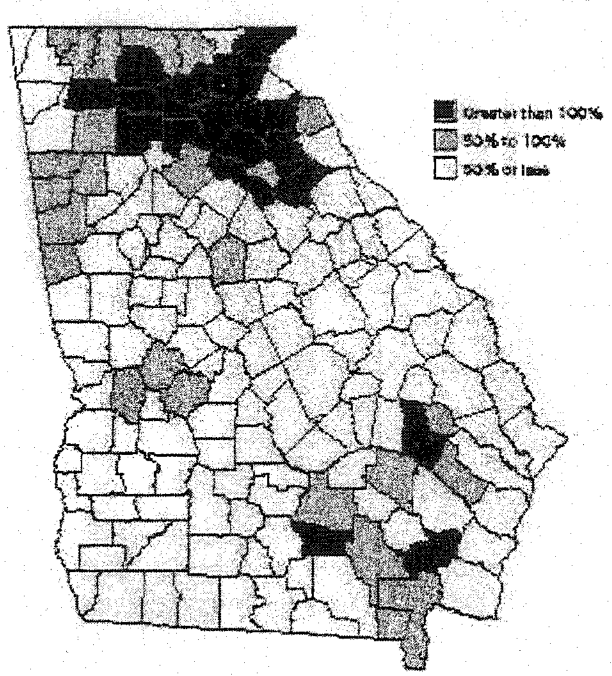

Figure 2. Phosphorus Imbalance in Georgia. In this figure, the nutrient requirements for the total amount of cropland, pastures, and hayfields in a county were calculated. The nutrients generated in animal manure were also calculated by county. The lighter counties can supply less than 50% of the nutrient needs with animal waste, the gray shades supply between 50% and 100%, and the dark counties produce more nutrients than they can use in their county. (From Lander et al., 1998)

Alternative livestock feeding programs. Opportunities are available for reducing both nitrogen and phosphorus inputs by alternative livestock feeding programs. In addition to changes in feed rations, other options include (1) alternative crops or crop rotations that allow a greater on-farm production of livestock protein and phosphorus requirements, (2) harvesting and storage practices that improve the quality of animal feed and reduce losses, and (3) feed additives that improve feed conversion of nutrients such as phytase. This strategy does hold some promise but will require more research. Ideally, programs that encourage the use of more animal feed grown in Georgia would provide the greatest benefit.

Marketing of manure nutrients. Marketing of manure creates an additional managed output, similar to the sale of crops or livestock products. This strategy has excellent potential in that it could improve on-farm profitability as well as stimulating new industries that use animal by-products. It will be discussed in more detail below.

Manure treatment. In some situations, it may be necessary to consider manure treatment technologies similar to municipal and industrial waste treatment systems. Many manure treatment systems focus on disposal of nutrients with modest environmental impact. For example, treatment systems such as anaerobic lagoons commonly dispose of wastewater nitrogen as nitrogen gas (no environmental impact) or ammonia (some environmental impact). This is a preferable alternative to nitrogen losses to surface or ground water. Other treatment systems enhance the value of manure (e.g., solids separation or odor stabilization) to allow alternative uses of the nutrients. For example, some producers are successfully combining composting (for odor control and volume reduction) with marketing of manure to crop farms and urban clients.

A single strategy will likely not fit all situations. For systems with sufficient land base, a strategy that utilizes manure nutrients effectively and reduces commercial fertilizer inputs will be most appropriate. When the land base becomes insufficient for utilizing nutrients, livestock dietary options for reducing manure nutrients should be considered. In Georgia, many dairy farms that grow their own feeds could theoretically use this strategy to correct nutrient imbalances; however, a large number of poultry farms with limited land base will have to resort to off-farm marketing of their litter to obtain a nutrient balance.

Off-farm Marketing of Manure

All the cropland and pasture in Georgia could easily assimilate the animal manure produced in Georgia significantly reducing the use of imported commercial fertilizer and improving our soils in the process. Georgia farmers have recognized the value of manure. The Georgia Poultry Federation recently established a poultry litter matching service to help market excess litter. They found that the number of requests from those that wanted poultry litter were about seven times greater than those that had it to sell. The current market for poultry litter values it at $5 to $20 per ton depending on location; however, studies have indicated that its value as a fertilizer and soil amendment should be much greater than this (Carpenter, 2000). Their database also contains more than twenty poultry litter "brokers" that currently buy and sell poultry litter in Georgia. Although land application is the most common utilization method, it is not used to its potential. Obstacles include substantial energy and labor costs associated with handling and storage of waste, high transportation costs, problems encountered in collecting representative manure samples for nutrient analysis, odor and fly concerns, and determination of application rates that give the crop sufficient nutrients without having adverse environmental effects. This is especially true on operations that manage their manure using liquid systems.

Bosch and Napit, 1992, found that the export of poultry litter from surplus to deficit areas for use as a fertilizer in Virginia is often economically viable at larger scales, but large scale transfers of poultry litter were not occurring. They suggested that the use of government subsidies to crop producers who purchase litter for use as a fertilizer would encourage more research in transport and increase the incentives for commercial firms to provide litter transfer services. Goodwin et al., 2000, recently conducted a study that concluded "large-scale, off farm, centralized and regionally coordinated enterprises that process poultry litter into value added products could provide solutions to poultry nutrient issues." Many European governments do provide subsidized transport cost for manure and these programs have generally resulted in greater use of animal waste (Conway and Pretty, 1991). Separation, screening, condensing, pelleting and dewatering technologies could also be used to produce more transportable products; however, these practices are currently not widely used in Georgia. With some encouragement through low interest loans, grants, subsidies for transport from high concentration areas or start-up assistance, entrepeneurs could easily develop a business plan around marketing raw or value added manure off the farm.

Composted manure offers several advantages over raw manure. Composting converts the nutrients in manure into more stable organic forms that release slowly and are less susceptible to leaching. It also has better handling properties that make it easier to apply, transport, or bag for sale. These improved handling capabilities and the reduced odor offer many opportunities to move large quantities of manure into nontraditional market places. In addition, composting offers an opportunity to utilize yard wastes and other organic material that traditionally goes to landfills. Here, composting may give off-farm interests a waste disposal option and provide additional revenue sources through "tipping" fees to on-farm composters. Municipalities, food processors, and paper industries are examples of off-farm clients that have paid farmers to compost their usable waste resources. Through the University of Georgia Bioconversion Research and Education Center, several new composting facilities have already been established in Georgia and more are considering it. The main obstacles appear to be start-up capital, market uncertainty, and regulations on non-manure waste streams. State programs could easily be developed to overcome these barriers and encourage the development of new industries in this area.

Livestock waste also has value as a potential source of energy. Processes for utilizing manure as an energy source include direct combustion, gasification, or conversion to a gaseous fuel through biological means such as anaerobic digestion or thermochemical processes. At larger scales, efficient systems to use the energy in biomass resources have already been developed. A $35 million power station that uses 11,000 tons of poultry litter per year was recently established in Sulfolk, England. In the United States, large scale power plants that directly combust dry manure or gasified manure are currently being built in Maryland and Minnesota, while smaller scale units have been used to supplement on-farm energy systems for many years. These types of systems not only decrease the stresses currently being placed on the world's oil reserves, but they also can present appealing options for alternative uses of manure resources. Numerous projects have proved that manure to energy systems are technically feasible, but high initial costs and low energy prices have hindered further developments.

The use of livestock waste as feed for fish has occurred for many centuries. Manure serves as an indirect food by enhancing the production of natural aquatic food. Considerable research emphasis has been placed on using poultry manure as a feedstock for cattle and several operational feed mills using poultry litter exist throughout the country including one in Georgia. Currently, about 4.2% of the poultry litter produced in the United States is fed to cattle and much lesser amounts of other wastes are used as feed (Moore et al., 1995). Most of this litter is either deep stacked and fed to wintering cattle or ensiled in combination with other forage or grain feeds. While this does represent some acceptance, manure as an animal feed has the potential for more widespread use. Potential barriers include public acceptance as well as start-up and marketing costs.

Biological treatment of waste can be cheaper than other methods of treating waste and may yield additional value added products. It encompasses the use of various forms of aquatic and non-aquatic vegetation as well as the conversion of waste by bacterial or insect action. The use of animal waste as a substrate for protein production from algae, yeasts, fungi, bacteria, fly larvae or earthworms shows promise but further evaluation is necessary. Algal production from nutrient laden waste water may be a promising alternative to produce feed supplements for fish, poultry and swine. Other potential protein sources that can be produced using manure include soldier fly larvae and duckweed and the University of Georgia has active research in these areas. These types of systems are currently underutilized, but additional research and start-up funding could improve them.

CONCLUSIONS

Animal feeding operations in Georgia are under increasing regulatory pressure primarily due to non-sustainable nutrient management practices that impact water quality. The EPA, USDA, and State of Georgia have recognized this and will be requiring comprehensive nutrient management plans on most Georgia animal feeding operations. To provide these operations with the support they need and the citizens of Georgia with improved water quality and a sustainable food system, the State should implement a two step approach. First, assistance will be needed to develop certified CNMP's throughout the state. This can be accomplished by increasing the technical assistance available in the public sector as well as developing capability in the private sector. Several states have developed programs to cost share the development of CNMP's and this should serve as a model for involving the private sector. While CNMP's will help many operations manage their nutrients in an environmentally sound manner, many will not have the land base necessary to balance incoming and outgoing nutrients. These farms will have to develop methods of marketing manure off the farm. To assist them and to stimulate rural economies, the State should investigate the development of low interest loans, grant programs, manure transport subsidies, or other methods to encourage the development of new industries. Potential areas for these new industries include composting ventures, energy production facilities, animal feed manufacturers, new biological based products, and other practices that add value to animal by-products.

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