Positive Approaches to Phosphorus Balancing in Southwest Missouri

Animal Manure Phosphorus Recycling Initiative

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Introduction

Today we are faced with dwindling high quality domestic phosphorus reserves, higher costs of harvesting lower quality reserves, and higher mining costs due to recognition and incorporation of the indirect environmental costs of mining phosphorus. In the future, more of our phosphorus needs will be met by imported phosphorus from Southeast Asia and North Africa. We continue to export large quantities of fertilizer phosphorus and phosphorus embodied in grain.

Our meat production industries, particularly poultry and swine, have become more integrated and geographically concentrated to produce meat at lower competitive costs. Consumers have benefited from the variety of low cost products produced by these industries. However, the concentration of phosphorus threatens water quality in some of areas of concentrated production.

Opportunities exist to create value added animal waste fertilizer products that can be used in crop production, reducing import demands for phosphorus, and relocating phosphorus from areas of excess supply to areas of need for crop production. This paper focuses on opportunities to recycle poultry litter in southwest Missouri.

Southwest Missouri Background

Southwest Missouri is a supplier of both agricultural products and recreation for Missouri and the surrounding states. Some products are shipped across the entire United States and to other countries. Its recreation developments attract visitors from the entire United States and other countries. Excellent water quality contributes to the success of these industries and must be sustained to keep them viable. Its lakes are key attractions for the recreation and tourism industries that annually bring in over a billion dollars of revenue (Figure 1).

Figure 1. Table Rock Lake

Poultry Background- The poultry industries began vertically integrating in the 1950s and were nearly entirely integrated by the end of the 1960s. Today poultry production is extremely efficient, but also very concentrated geographically. Figure 2 shows the impact of the economic development of the chicken industry on consumer prices of chicken, pork, and beef. Chicken has gone from a meat so expensive that it was consumed only on special occasions in the 1930s and 1940s to a meat that is consumed almost daily in one form or another because it can be produced and marketed efficiently.

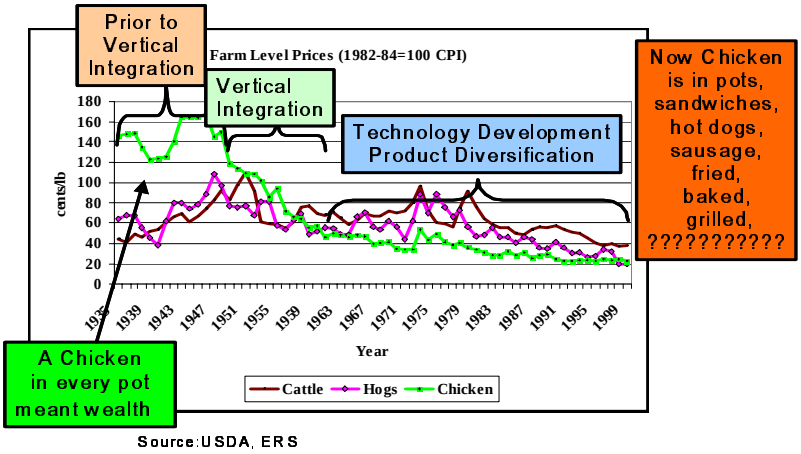

Figure 2. Chicken, cattle, and hog prices during development of current chicken industry

Southwest Missouri Poultry- The poultry industries in 10 southwest Missouri counties produce nearly enough chicken to meet the needs of all Missouri consumers and enough turkey to meet all the needs of Missouri consumers plus some counties in surrounding states (Figures 3 and 4).

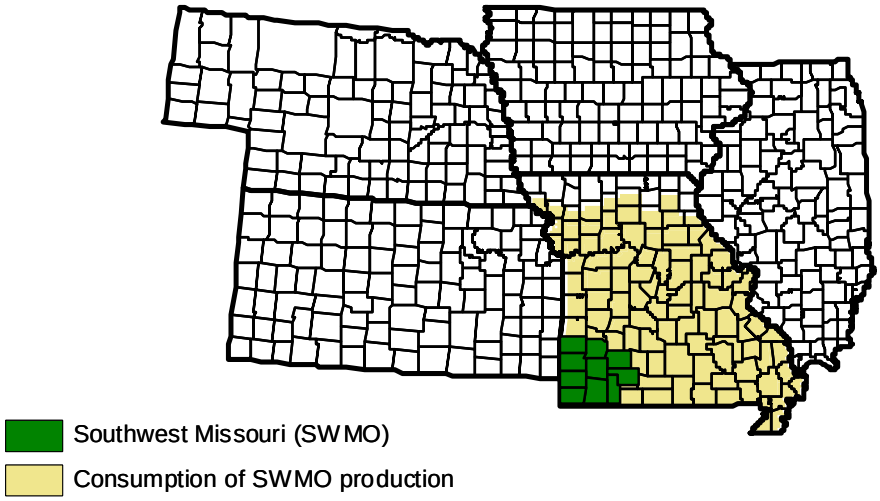

Figure 3. Southwest Missouri 10 county production area and the potential area where consumer needs for chicken could be met

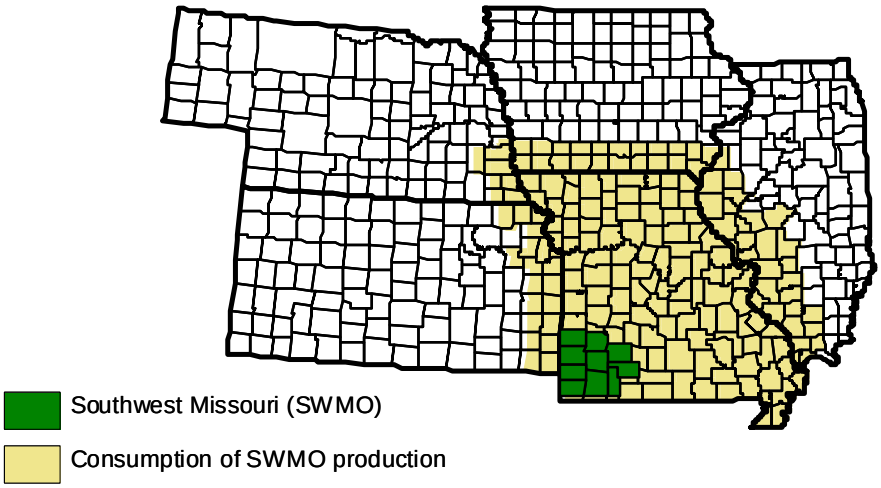

Figure 4. Southwest Missouri 10 county production area and the potential area where consumer needs for turkey could be met

Phosphorus Concentration- Until recent years, scientists had thought that phosphorus bound itself to soil particles and therefore moved primarily with erosion. They have determined that phosphorus can move in relatively high concentrations in solution with runoff water and may even leach through the soil when phosphorus is highly concentrated in surface soil layers. In some geographic areas, like southwest Missouri, the concentration of poultry and other livestock industries has led to high concentrations of phosphorus that pose a potential threat to water quality if manure is spread entirely within those areas. Figure 5 shows how large a part of Missouri would be necessary to balance phosphorus available in manures produced in confined production systems in southwest Missouri. The estimated area needed is based on phosphorus removal in harvested crops and assumes manure phosphorus is used to meet all harvested crop needs. Figure 5 also shows the area needed if only half of the harvested crop needs were met by phosphorus from manures produced in southwest Missouri. In both cases, phosphorus from manure produced in the encompassed counties is assumed to be used before manure phosphorus from southwest Missouri would be used. A companion paper by Joe Slater examines the commercial fertilizer sales in Missouri with detailed county comparisons for southwest Missouri,

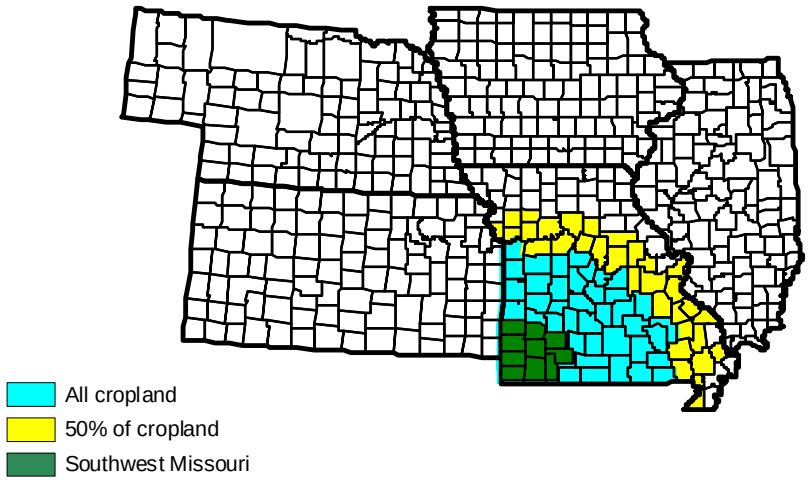

Figure 5. Balancing phosphorus from confined animal production in southwest Missouri with crop production needs in nearby Missouri counties

FAPRI Analyses in Southwest Missouri

The Food and Agricultural Policy Research Institute (FAPRI) began a set of studies in southwest Missouri four years ago as part of the Watershed Water Quality Initiative at the University of Missouri. The initiative began the process of linking economic and environmental modeling, data collection and monitoring, interdisciplinary cooperation, and stakeholder participation in 1995. The current work in the Shoal Creek Watershed continues that effort. The analyses in Shoal Creek and elsewhere in southwest Missouri have brought farm organizations, commodity groups, environmental interest groups, city planners, as well as federal and state agencies together with University scientists.

The studies began with economic and environmental analyses of two representative contract broiler farms. FAPRI is currently conducting watershed level environmental modeling of the upper Shoal Creek watershed; water quality monitoring of nutrients, fecal coliform, and *E. coli*; DNA source tracking of fecal coliform and *E. coli* to identify the most likely sources (i.e. human, chickens, turkeys, cows, horses, deer, dogs, raccoons, etc.); and farm level economic and environmental modeling of cow-calf and dairy farms. The multistep study process used by FAPRI is attached as an appendix.

Southwest Missouri Representative Broiler Farm Analyses

Producer panels were convened in Lawrence and Barry counties, and McDonald and Newton counties. These two panels provided the data needed to develop the "representative" farm models used to evaluate current and alternative litter management systems.

The objectives of these studies follow.

- assess the environmental impacts on surface and ground waters of adopting alternative poultry litter management strategies compared with current practices
-
- assess on-farm financial impacts of adopting alternative poultry litter management strategies compared with current practices

APEX simulations were made to estimate the soil movement and nutrient loading for the following alternatives.

- current management practices
- pasture forage change and commercial fertilizer instead of poultry litter
- alternative changes in grazing management and/or pasture forages
- alternative forages harvested for hay with no grazing

Economic Impacts- The hay production alternative is the only scenario that maintains a positive ending cash reserve throughout the simulation period (1998-2003). This is due to the increase in receipts associated with the sale of hay. The other three scenarios build a large cash reserve deficit the first five years (1998-2002). After the farm pays off the poultry houses in 2002, all four scenarios show a sharp increase in ending cash reserves (Figure 6).

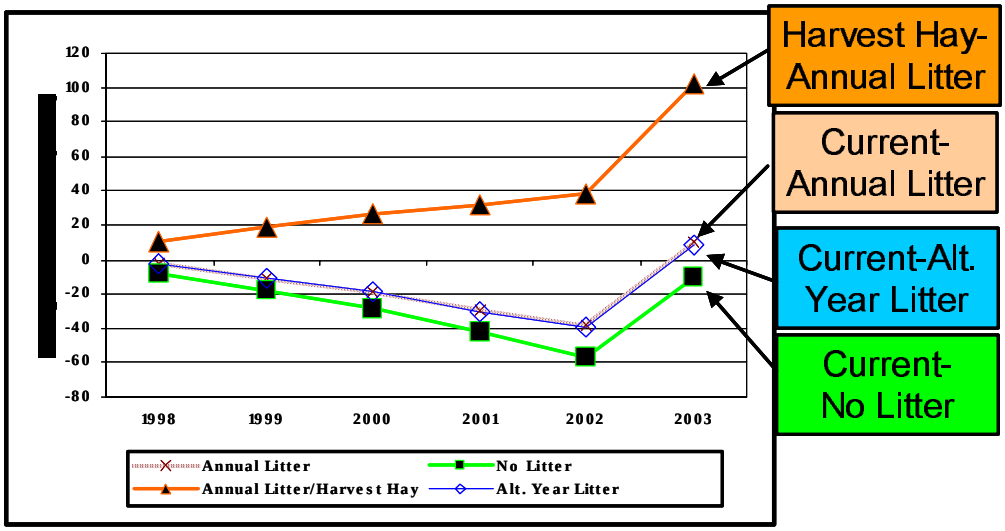

Figure 6. Ending cash reserves for Lawrence and Barry Counties Contract Broiler Representative Farm

Soil Phosphorus Accumulations- The soil phosphorus accumulation in the upper six inches of soil is reduced slightly by the hay production alternative relative to current practices. Soil phosphorus accumulation is reduced to nearly zero by alternate year litter application. The no litter management reduces the soil phosphorus (Figure 7).

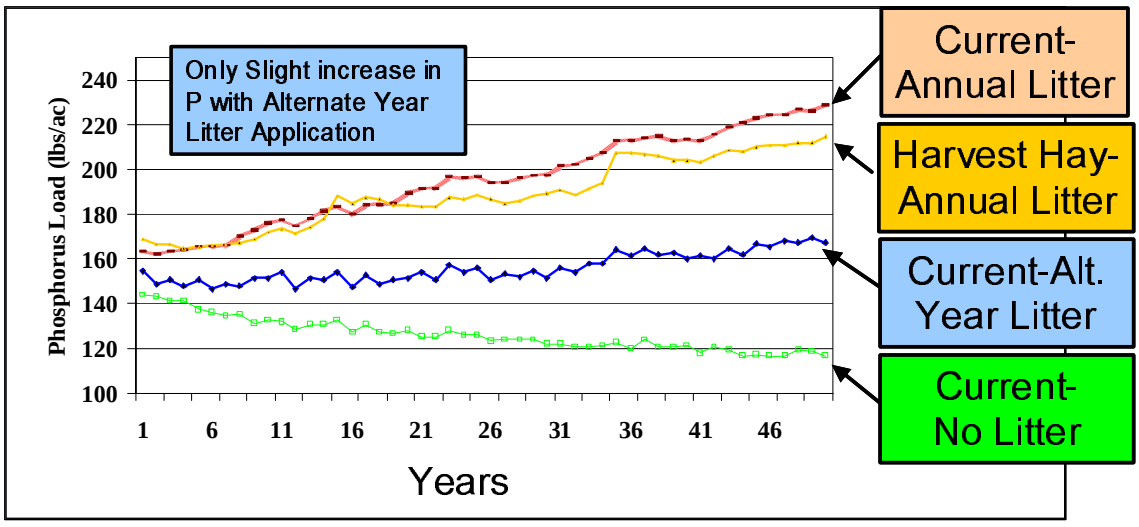

Figure 7. Projected accumulated soil phosphorus in top six inches of soil Lawrence/Barry Counties Representative Broiler Farm

Annual Phosphorus movement- Due to the weather variability, particularly rainfall, the annual phosphorus movement in runoff varies greatly from year to year. There is a response to reduced litter application, particularly in the later years of the 50-year period, because the soil phosphorus available for runoff is much less (Figure 8).

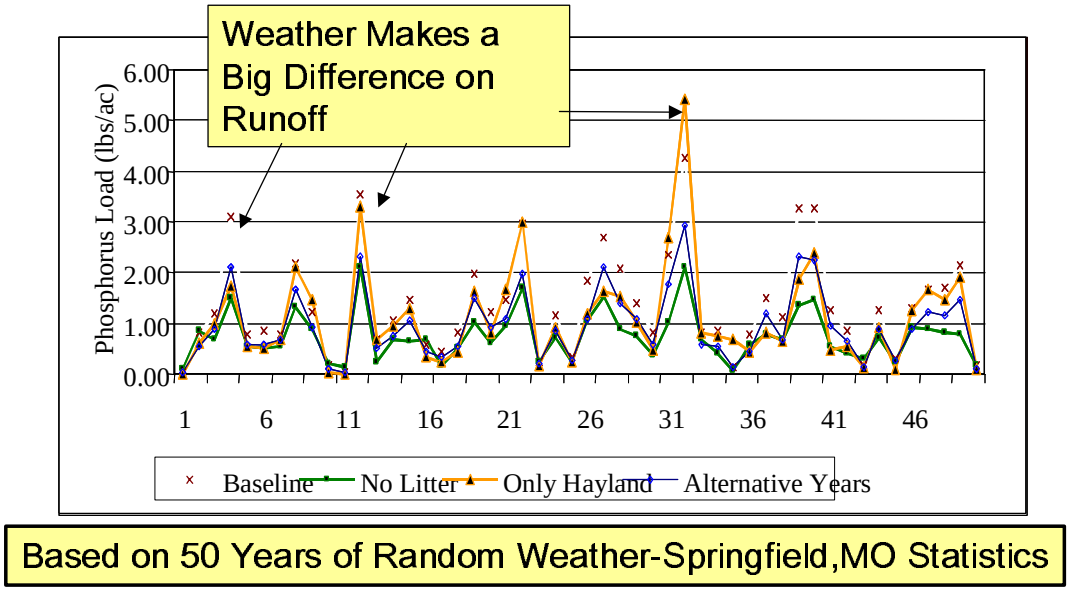

Figure 8. Projected phosphorus loading in runoff Lawrence/Barry Counties Representative Broiler Farm

Conclusions- The Southwest Missouri Representative Broiler Farm Analyses concluded that:

- harvested hay crops recycle more manure P than grazed pasture, but do not utilize all P currently applied in litter
-
- hay sales increased returns
-
- unless litter application is reduced, soil P increased
-
- southwest Missouri broiler farmers may need to export litter

Balancing Economic and Environmental Impacts

To attain stable solutions, economic and environmental impacts should be balanced at many different decision levels. The preceding analysis of the representative broiler farms was limited primarily to farm level decisions. If many farmers chose to adopt the hay production alternative (the highest economic return), it is likely that the local hay market price would drop significantly. If many farmers adopted the no litter or alternative year litter applications (lower phosphorus build up in the soil), it is likely the local market price of litter would drop as more litter was sold. Local merchants would also feel the regional economic impacts of reduced returns to many poultry producers. Ultimately, the increased costs of producing poultry in southwest Missouri must be passed on to consumers. However, it is difficult to pass on regional increases in production costs to a national or international market unless the competing production regions or countries also have similar production cost increases.

The scale in Figure 9 illustrates some of the considerations that should be weighed when making policy decisions like those facing southwest Missouri. Many of these considerations affect people outside southwest Missouri making them stakeholders in the decision making process. The benefits and costs should be considered and the potential to share the costs and arrive at solutions beneficial to all parties should be considered.

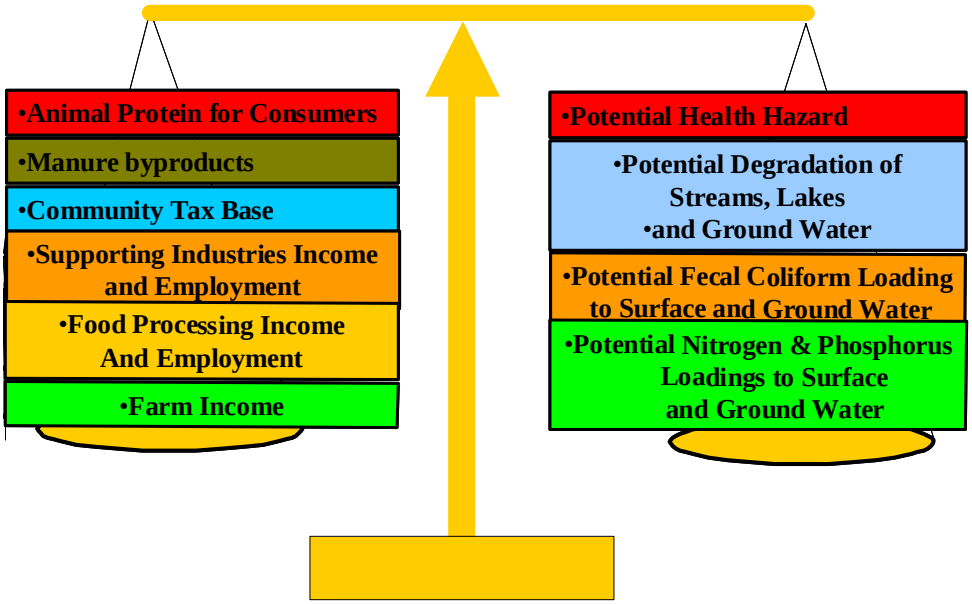

Figure 9. Balancing economic and environmental impacts

Cooperative Roles in Phosphorus Balancing in Southwest Missouri

Balancing phosphorus availability from confined animal production with crop, pasture, forest, and urban needs can be accomplished, but not without many decision-makers working together to find solutions economically and environmental acceptable to all stakeholders. This requires stakeholder cooperation during the formulation of potential solutions that need to be evaluated. The focus of this meeting was to bring members of various stakeholder groups together. The participants were divided into six groups with each group having members from as many different stakeholder groups as possible. Each group was asked to identify potential solutions and present them to all participants. The combined session then identified two or more potential solutions to pilot test. A team was identified for each potential solution with members from as many stakeholder groups as possible to further define the potential solution. These solutions will be pilot tested.

There are many roles that need to be played by the various stakeholders. Figure 10 presents a simplified diagram of the cooperative processes of the various stakeholder groups. Note that cooperation is the main driver with funding, technology, and communication facilitating their cooperative efforts. The following are some of the stakeholder roles identified at the meeting.

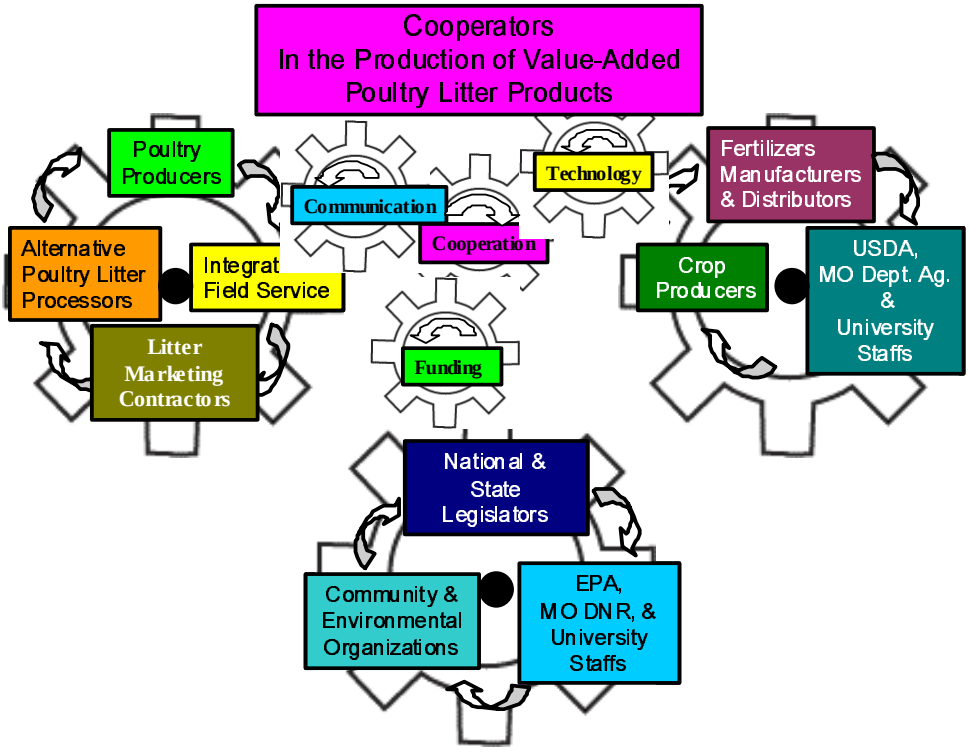

Figure 10. Stakeholder groups functioning in cooperative synchronized roles

Poultry Producers

- select litter material, antibiotics, and chemicals to maximize litter product value in addition to poultry product quantity and quality
- handle litter in a manner that maintains litter value-added product consistency and quality

Poultry Integrators & Field Service Staff

- assist poultry producers in finding and implementing technologies that increase poultry litter value
- make adjustments in feed rations to enhance litter value as well as poultry product value

Litter Marketing Contractors

- establish contracts for future pickup of litter from poultry producers
- deliver litter to users

Alternative Poultry Litter Processing Providers

- compost litter
- produce energy products using digesters
- provide materials for microbial processing or process litter at a central facility
- pellet litter
- burn litter in a central processor or provide equipment for on-farm burning
- do combinations of above

Fertilizers Manufacturers and Distributors

- blend manure with commercial fertilizers
- market the products using existing facilities and marketing channels

Crop Producers

- field test poultry litter products
- cooperate with agency and university scientists to quantify benefits/costs of using value-added poultry litter products

USDA, Missouri Department of Agriculture and University Staffs

- design sampling techniques to estimate benefits and costs of using value-added poultry litter products
- determine cost effectiveness of value-added poultry litter production as a means of reaching phosphorus TMDL goals in watersheds

EPA, Missouri Department of Natural Resources, and University Staffs

- assess analyses and information to determine effectiveness of results relative to water quality rules, regulations and laws; and
- provide suggestions to remedy any remaining issues.

Community and Environmental Organizations

- assess potential economic and environmental benefits to the communities and watersheds
- share information with entire communities and environmental organizations

National and State Legislators

- provide support via new or amended legal authority
- provide new or continuing funding to public and private cooperators as necessary to attain environmental goals and maintain economic stability

Summary

The "Positive Approaches to Phosphorus Balancing in southwest Missouri- Animal Manure Phosphorus Recycling Initiative" will need sustained cooperative efforts by all stakeholders. One key to maintaining the level of cooperation necessary is for stakeholders to understand each other's perspectives. For example, it is easy to look at a large company like Tyson Foods and say they've got deep pockets let them take care of the problem. However, they're publicly owned and that means some of their stock may be owned by a mutual fund you own (part of your own retirement or education fund). It might be your own pocket. The point is not to point your finger at someone else to solve the problem, but to play a role in its solution.

Another key is the perception of cooperator roles. A penny a pound increase in cost is perceived to be easy for a large company to pass on to a buyer. Nearly half of the 30 billion pounds of chicken produced in the United States is sold to food service industries like McDonalds. It is not hard to imagine that these contracts may be as large as 100 million pounds and that makes each penny per pound increase in price an increase of $1 million in the contract bill. Unless all competitors are faced with similar cost increases, the competition within the chicken industry will often preclude passing on the full cost increase.

The cooperative efforts proposed in this meeting were designed to find ways of sharing costs and benefits among stakeholders. It was definitely a challenge that, if met, gave Missouri the opportunity to be the "We'll Show You State".

Results of the Meeting

The meeting successfully started an on-the-ground process of cooperation to respond to phosphorus issues and concerns. Approximately 90 people representing varied interests participated in identifying promising positive approaches. At the end of the day the entire group agreed on two thrusts and established two volunteer teams. The teams will include members of varied interest groups in southwest Missouri. The two thrusts are:

Use of poultry litter for bio-energy production- This alternative consists of burning litter to produce heat or energy. The burning could take place either on-farm or at a regional level. If on-farm, it could be burned in a litter fueled furnace that would heat the poultry barns and the home. Alternatively, the litter could be processed first and mixed with sawdust to produce pellets that could burn in a wood-burning stove. It could also be burned in a small generator that would produce electricity for heating in the winter and cooling in the summer. At a regional level, it would produce electricity. The ash by-product would be recycled, as a fertilizer either as is or by incorporating it with other compounds.

Litter hauling and adding value- This alternative consists of transporting processed litter, and spreading it on crop fields where fertilizers are needed. In many groups, composting and pelleting was viewed as part of this alternative to make the transport easier. EM (Effective Microorganisms) was one of the value-added technologies to be considered. There was a general consensus that for environmental issues to be solved, manure had to be transported to areas where local manure production does not meet fertilizer needs.

These pilot projects are cooperative efforts. The volunteer teams include poultry growers and crop farmers representing the supply and demand. Fertilizer manufacturers have marketing expertise, and production and storage facilities. Animal waste processing companies have a variety of alternative technologies designed to create fertilizer products. Current litter hauling and marketing companies know the potential markets for unprocessed poultry litter. Poultry integrators have both the knowledge gained by their own research into recycling poultry litter and the knowledge necessary to integrate the production of value added poultry litter products with poultry production. For example, technologies like EM may reduce pathogens and residual antibiotics, and enhance nutrient content of poultry litter, but to work most effectively industry field service staff must understand and support the technology.

Production of value-added poultry litter products will not only require cooperation and coordination in production and marketing, they will require researchers to validate the results of the pilot projects, state and federal agency environmental impact assessment, and recognition of successes by local community organizations. Legislative support for this type of cooperative effort is essential. The impacts of these pilot projects will be felt across the entire state in the form of enhanced water quality for the many users of southwest Missouri recreation areas and in the form of continued low-cost poultry products for Missouri and nearby states.

Appendix: FAPRI Models and Analytical Processes

Representative Farm Panel Process- The representative farm is "representative" of the panel members and not the region or the industry with the anonymity of the panel member carefully maintained. FAPRI has been involved in representative farm modeling since 1990. The representative farm system was developed at Texas A&M University by Dr. James Richardson. The representative farm panel is the heart and soul of the system. The panelists provide the input needed to build the representative farm to be analyzed. The panels are interviewed using the consensus building process. The panel members draw on their personal operations and experience to develop a farm that is representative of the members.

At an initial meeting, financial information is obtained from the panel members. The initial data is entered into the Farm Level Income and Policy Simulator (FLIPSIM) model.

Environmental data related to farm management practices is also obtained from the panel members. This data is entered into the EPIC (Environmental Policy Integrated Climate), APEX (Agricultural Policy/Environmental extender), or SWAT (Soil and Water Assessment Tool) models. These models determine the environmental performance at the field, farm, and watershed levels, respectively.

The establishment of farm panels and a watershed steering committee facilitates stakeholder input into the analyses, provides continuing review of the reasonableness of input and output of models, and increases the likelihood that results will be accepted. Their information complements the weather, soil, hydrology, and land use data compiled from databases.

Environmental Models- EPIC is a continuous simulation, process-based model that calculates crop yields and water, sediment, pesticide, and nutrient yields at a uniform field level. The Grassland Soil and Water Research Laboratory, Agricultural Research Service, USDA in cooperation with other government agencies and universities developed EPIC.

APEX is a continuous simulation, process-based model that calculates crop yields and water, sediment, pesticide, and nutrient yields at different locations within a farm or small watershed. The Blackland Research Center, Texas Agricultural Experiment Station in cooperation with other government agencies and universities developed APEX.

SWAT is a continuous simulation process-based watershed model that calculates water, sediment, pesticide, and nutrient yields at different locations within a watershed, as well as crop yields. The Grassland Soil and Water Research Laboratory, Agricultural Research Service, USDA developed SWAT in cooperation with other government agencies and universities.

Economic Models- FLIPSIM is a farm-level economic analysis model that incorporates risk due to yield, cost, and price variability. FLIPSIM was designed for use with farm panels to conduct representative farm analyses.

IMPLAN is an input/output model that uses recent and historic income and employment data to assess area socioeconomic impacts at county, multi-county, state, or regional levels.

The FAPRI Policy Model is a system of econometric equations that capture economic relationships between food and agricultural industries, both domestic and foreign**.**