Protecting Water Quality with Incentives for Litter Transfer in Georgia

Final Report

Principal Investigators

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INTRODUCTION

Nutrient over-enrichment in North Georgia watersheds threatens water quality and the use of water resources for drinking water, fishing, and recreation. Animal operations are estimated to be one of several important contributors of phosphorus loadings in this region. To address this concern, the Natural Resources Conservation Service and the Georgia Soil and Water Conservation Commission are interested in the use of litter transfer incentives to facilitate the movement of animal waste nutrients out of nutrient-stressed watersheds in North Georgia to watersheds elsewhere in Georgia with nutrient-poor soils. Incentives for litter transfer are an innovative approach to water quality protection that have been implemented recently in a several other states and piloted in Georgia.

This project was created to evaluate and make recommendations concerning the use of litter transfer incentives in Georgia. The project was funded through the U.S. Department of Agricultural Natural Resources Conservation Service Conservation Partnership Initiative and the Georgia Soil and Water Conservation Commission. The project was implemented by a team of researchers and outreach specialists at the University of Georgia and the Georgia Water Planning and Policy Center.

The objectives of this project were to: (1) Develop partnership to implement a litter transfer incentive program in Georgia; (2) Compile environmental and economic information to support program implementation; and (3) Conduct outreach to build support for litter transfer program implementation.

The first objective of this project sought to build a foundation to support a litter transfer program in Georgia. Therefore, a primary focus of the project was the development of a partnership of stakeholders, government agencies, and nongovernmental organizations to support the program's development and implementation. The partnership was initiated through the formation of a workgroup with members representing these various constituencies that were critical to program success.

The second major focus of the project was to provide the research and analysis needed to ensure effective program design. In 2005, the Natural Resources Conservation Service created a pilot litter transfer program in Georgia. This project evaluated the results of the pilot program and conducted additional research to support recommendations for improvement. The project focused on the Upper Chattahoochee River basin as the primary nutrient source. An important focus of this research was potential linkages between nutrient trading and litter transfer.

Building public support for and participation in the nutrient litter transfer program required reaching beyond the project workgroup. Therefore, the third major focus of the project was outreach to a broader audience – those who participated in, were affected by, or had an interest in the litter transfer program. The outreach component of the project used educational materials and watershed meetings to inform the public about the program.

1.1 Benefits of Poultry litter use

Poultry litter is a combination of bedding material and poultry manure that accumulates on the poultry house floor where the birds are raised. The nutrients in feed stuffs used in poultry feed formulations are not fully digested and utilized by the bird. The nutrients not absorbed by the bird are contained in the manure which accumulates in the litter. Many poultry producers also raise cattle and use the nutrients in the litter to fertilize their pastures and fields to grow forage for their cattle. With the high cost of inorganic fertilizer, access to free poultry litter has a great economic benefit to the poultry/cattle producer.

Poultry litter is a great source of the major nutrients, nitrogen (N), phosphorus (P), and potassium (K), along with all of the micronutrients required for plant growth (Brady and Weil, 1996). Poultry litter also acts as a slow release fertilizer, some of the N and P is water soluble and immediately available for plant uptake while the rest is bound to organic compounds in the litter and is made available to the plant slowly over time (Brady and Weil, 1996). This is not only an agronomic benefit but also an environmental benefit since the insoluble nutrients will not dissolve into rainwater and runoff during storm events. Poultry litter also has a soil liming effect (Sharpley et al., 1993; Kingery et al., 1994; Boman et al., 1996). This effect occurs due to minerals such as calcium and magnesium in the litter (Risse et al., 2001). This allows for better nutrient availability on acidic soils and decreases or eliminates to need for lime application.

Organic matter has many soil benefits. Poultry litter application increases soil organic matter in two ways, through the organic matter contained in the litter itself and through increased below ground and above ground biomass from improved plant growth (Haynes and Naidu, 1998; Risse et al., 2001). Organic matter helps in the conversion of nutrients from unavailable to available forms by providing a food source for the microbial soil populations that break down those nutrients. Organic matter also improves soil structure, water infiltration, and water holding capacity. Improvement in these soil properties along with increased ground cover through crop growth reduces runoff volume and soil loss (Rousseva, 1989; Oades and Waters, 1991; Gilley and Risse, 2000).

1.2 Limitations of poultry litter use

While the use of poultry litter has proven to have great benefits, improper use can have negative economic, agronomic, and environmental impacts. Poultry litter is a bulky material that is difficult to handle, expensive to transport, and requires special equipment to apply. Unlike inorganic fertilizer, the nutrient concentration and availability is highly variable in poultry litter (Edwards and Daniel, 1994; Brady and Weil, 1996; Wood et al., 1999; Kleinman and Sharpley, 2003), which is an important property that row crop producers must consider. This can have both an agronomic and economic impact if application rates are too low to meet the crop needs.

When considering environmental impacts of poultry litter application, the main concern is eutrophication or nutrient enrichment of surface water. Phosphorus is the primary nutrient that causes fresh water eutrophication (Schindler, 1977; Carpenter et al., 1998)). The risk of P from land applied poultry litter reaching surface water is based on application rate, timing, and location (Lemunyon and Gilbert, 1993).

Rate: Research has shown that P concentrations in runoff increase as P application rates increase (Edwards and Daniel, 1992,1993; Kleinman and Sharpley, 2003). This is not only true for poultry litter application but also inorganic fertilizer application. In fact, research has shown that runoff from plots receiving inorganic triple super phosphate had much higher P concentrations in runoff than plots receiving the same amount of total P from poultry litter; this is due the higher P solubility in the inorganic fertilizer (DeLaune et al, 2004). Rate of application can also impact water quality by increasing the concentration of P in the soil. It is common to see high soil test P levels in pastures that have historically received poultry litter as their main source of fertilizer. Poultry producers have a free source of nutrients and for many years have applied poultry litter to their pastures based on the nitrogen needs of forage. On average, forage crops uptake 3-4 times more N than P_2O_5 per ton of forage produced, but poultry litter contains approximately the same amount of N and P_2O_5. Therefore, when poultry litter is applied based on the N needs, 2-3 times more P_2O_5 is applied than the forage can utilize. Over time, this can cause a build-up of P in the soil. Research has indicated, as soil test P increases, P concentrations in runoff also increase (Edwards et al., 1993; Pote et al., 1999).

Timing: The timing of application is also very important; research has shown that the shorter the length time between land application and the first runoff producing rainfall event the higher P concentrations in the runoff (Edwards and Daniel, 1993; Heathman et al., 1995; Sharpley, 1997; Schroeder et al., 2004). Also, the intensity of the rainfall event is an important factor when determining the risk of P loss (Edwards and Daniel, 1993). Therefore, the risk of P runoff is greater during the winter and spring when more frequent and higher intensity rainfall events occur compared to summer.

Location: Placement of poultry litter within a field is another limitation to consider. Research has shown that P concentrations decrease as flowpath length increases (McDowell and Sharpley, 2002). Therefore, it is important to observe recommended setbacks from environmentally sensitive areas such as streams, well heads, sink holes, etc. Additional practices such as buffers can add to the protection of our natural resources.

Metals: Approximate concentrations of copper and zinc in the fresh broiler litter are 320 and 265 ppm respectively (reference). These metals usually do not create any environmental concern however, they should be monitored over time because continued application will result in accumulation of these elements in soil. Peanuts are particularly sensitive to high levels of soil zinc. When soil pH is maintained at the recommended level of pH 6, soil test zinc levels of 20 lb per acre are the critical level, above which there may be some toxicity to peanuts with a possible reduction in yield. In recent field studies carried out over four years by Dr. Gary Gascho and colleagues at the Coastal Plain Experiment Station in Tifton, a total of 40 tons of litter were applied to crops and the crop performance and soil test levels were measured. The litter applied in this study contained an average of 216 ppm zinc. At this concentration, 17 lb zinc per acre was applied in the 40 tons of litter. They found that the soil test zinc increased by 11 lb zinc per acre from this litter application. The soil at the test site was a Tifton loamy fine sand, typical of many soils in the Coastal Plain region of Georgia. Based on this result of 17 lb zinc raising the soil test zinc by 11 lb, this gives a ratio of 17/11= 1.6 lb of zinc added to raise the soil test zinc by l lb per acre. At lower rates of litter application, they found that 2.3 and 2.8 lb of zinc raised the soil test zinc by one lb per acre.

If we consider a typical crop rotation of two years of cotton followed by one year of peanuts (no litter is applied to peanuts), and if the maximum recommended rate of application of 2 tons of litter per acre is followed for the cotton, then an average application would be 1.3 tons per year (4 tons every 3 years). If litter has 265 ppm zinc, then 1.3 tons of litter would contain 0.7 lb of zinc. Over a period of 20 years, 14 lb of zinc would be applied. If we assume that 2 lb of zinc would be needed to raise the soil test 1 lb per acre, then the 14 pounds contained in the litter would raise the soil test by 7 lb per acre. Even over a forty year period this should not be a problem with these application rates if the soil test zinc started at a low level. However, with heavier applications in double cropping and/or on some soils sandier than those in the Tifton study, the soil test may build more quickly, so caution should be exercised to avoid excessive applications of litter, especially if peanuts will be grown in the future. Land receiving litter should be monitored for its available nutrient levels by regular soil testing, at least every two or three years.

In addition to these limitations, public perception can sometimes be an issue with poultry litter use (Ritz, 1995). Nuisance complaints due to odor and insects by neighbors are common with poultry litter is application. Animal agriculture has received negative publicity in recent years and many in the general public feel land application of poultry litter is a human health risk. Although these popular opinions are not based on science, it is public perception that drives the regulatory processes. Therefore, it is import for producers who utilize poultry litter, to build good relationships with their neighbors work with them to determine the best time for application. It is also critical to educate those neighbors and the public on the benefits of poultry litter use and the processes producers use to properly utilize this nutrient source.

1.3 Nutrient Balance issues in Georgia

Georgia is the top broiler producer in the nation producing 1.3 billion birds in 2007 (NASS). Georgia's poultry production is concentrated in mountains and hills of North Georgia where more P and N is produced than surrounding crops can utilize, leading to nutrient surpluses in that region. This research was conducted to quantify the nutrient balance spatial distribution of N and P contained in poultry litter.

The following datasets were obtained for each county from the Farm Gate Report:

- Row crop yields in 2005
- Number of cows in 2005
- Total area of row crops and pasture lands in 2002
- Total house size and number of birds for breeder, pullet, broiler, and layer poultry in 2005

Average percentage of N and P in different types of poultry litter were based on analysis of 7122 litter samples received by the Agricultural and Environmental Services Laboratories between 2005 and 2007. GIS datasets, including county and watershed boundaries, were obtained from Georgia GIS data clearinghouse. The removal of P by 13 crops was estimated based on the 2005 crop yields for these crops. The removal of P from pasture land was estimated based on number of cows. The total removal of P for each county was the sum of the removal from all crops including pasture. The removal of N was equal to a typical N fertilization rate. The total removal of N for each county was the sum of the removal from all crops including pasture.

To calculate generated P and available N, four types of litter were considered; breeder and pullet, broiler, and layer litter. For each type, the amount of generated P was calculated as follows:

$$\mathbf{Mp_i = a_i \times Nbi} \qquad \mathbf{Mp = \sum Mp_i}$$

where **i** represents each different type of poultry litter: breeder & pullet, broiler, or layer;
$\mathbf{Mp_i}$ is the amount of P generated from poultry litter i;
$\mathbf{a_i}$ is a coefficient representing the pounds of generated P per bird per year for poultry litter i;
$\mathbf{Nb_i}$ is the number of bird spaces for generating poultry litter i;
Mp is the sum of the amount of P generated from different types of poultry litter.

To calculate generated available N, the amount of poultry litter for each type of bird was calculated using the amount of generated P and the percentage of P contained in the poultry litter. Then the amount of available N was calculated based on the amount of generated poultry litter and the percentage of available N contained in each poultry litter. The total amount of available N was the sum of available N generated from different types of poultry litter. The excess N and P balance for each county was calculated by subtracting the total amount of nutrients removed by crops from the total amount of nutrients generated from poultry litter. The calculation was based on the assumption that the amount of generated N and P in each county was applied to agricultural lands in the same county. The net N and P balance for HUC10 watersheds was also calculated according to the area percentage of HUC10 watersheds located in counties.

The amounts of P and available N generated from different types of poultry litter are shown in Table 1.3-1. A map distribution of generated P from poultry in Georgia is shown in Fig. 1.3-1. The distribution of generated N is not shown but had a similar distribution to P.

Poultry litter	P_GENERATED		N_GENERATED	
	Amount (ton)	Percent (%)	Amount (ton)	Percent (%)
Breeder & Pullet	1,982	4.5	1,562	3.6
Broiler	26,631	60.7	30,849	70.3
Layer	15,265	34.8	11,474	26.1
Total	**43,878**	**100**	**43,885**	**100**

Table 1.3-1. Amount of P and available N generated from poultry

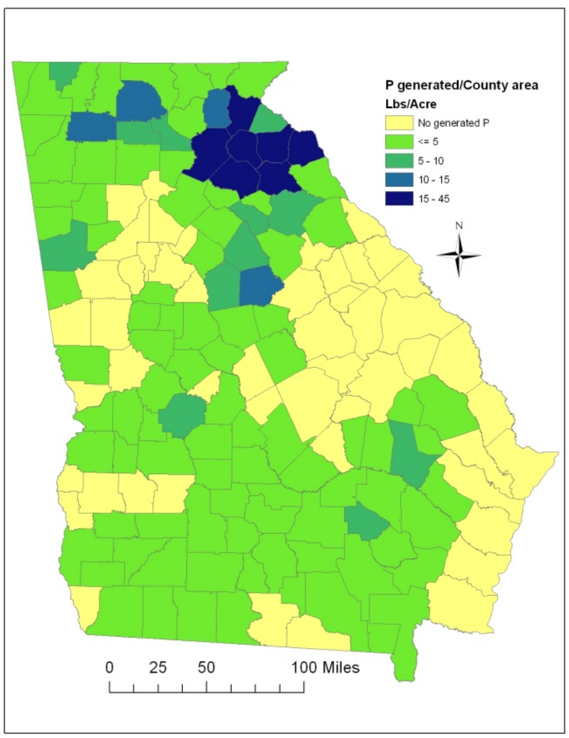

Fig 1.3-1. Amount of generated P per acre of county area

The amounts of N and P removed by crops are shown in Table 1.3-2. Pasture and hay lands removed 64% of total crop P removal. Peanut, corn, and cotton removed about 26% of total P removal. The amounts of N removed by pasture, hay, and cotton lands were 35%, 25%, and 24%, respectively. The spatial distributions of P and N removed are shown in Fig. 1.3-2 and Fig. 1.3-3. A much higher amount of both P and N per unit of crop area was removed in the northeast region of Georgia.

Crop	P_REMOVED		N_REMOVED	
	Amount (ton)	Percent (%)	Amount (ton)	Percent (%)
CORN	2,847	8.6	16,457	7.2
COTTON	2,184	6.6	55,023	23.9
HAY	6,370	19.2	57,142	24.9
PASTURE	14,814	44.6	80,801	35.2
PEANUTS	3,468	10.4	0	0.0
OTHERS	3,527	10.6	20,385	8.8
Total	**33,210**	**100**	**229,808**	**100**

Table 1.3-2. Amount of P and N consumed by crops

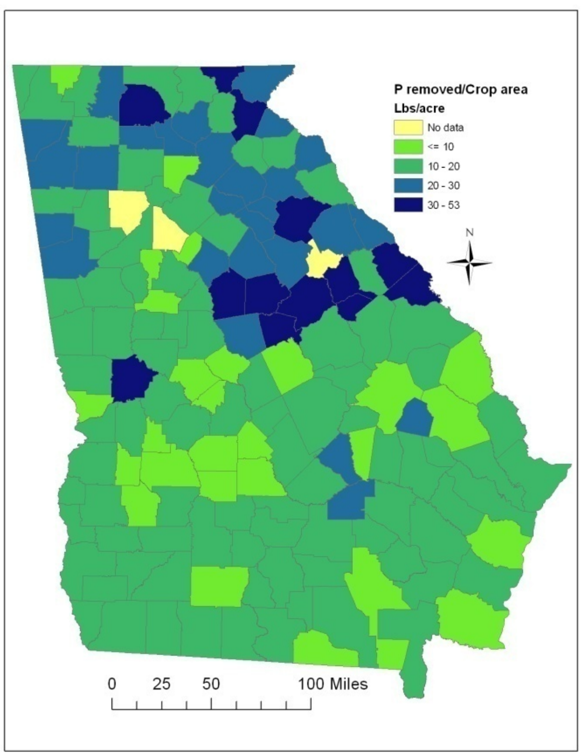

Fig 1.3-2. Amount of P removed by crops per crop area

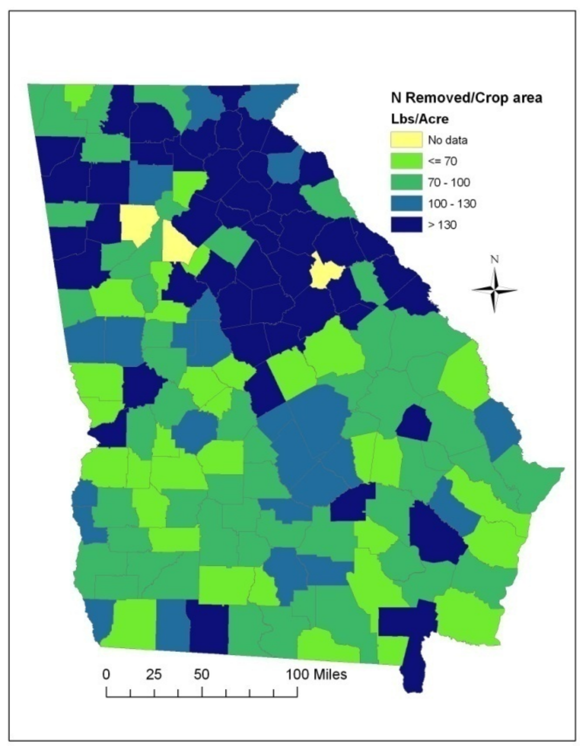

Fig 1.3-3. Amount of N removed by crops per crop area

The comparison of number of counties with excess P and soil test P > 450 lbs/acre in >10% of collected soil samples is shown in Table 1.3-3. The comparison might lead us to pay specific attention to the counties with excess P of >50 lbs/acre of crop area for future studies of water quality. The distributions of excess P and N are shown in Fig. 1.3-4 and Fig. 1.3-5. Small amounts of excess P existed in northwest, middle, and southeast GA, but the excess was the greatest in northeast counties. Excess N only existed in a few northeast counties.

Excessive P from poultry litter (lb / acre)	**Number of counties**	**Number of counties with soil test P > 450 lb / acre in > 10% samples (1990-2002)**
> 50	21	11
20 - 50	15	1
0 - 20	22	0
0 or less	101	1
Total	**159**	**13**

Table 1.3-3. Comparison of excess P with soil test P

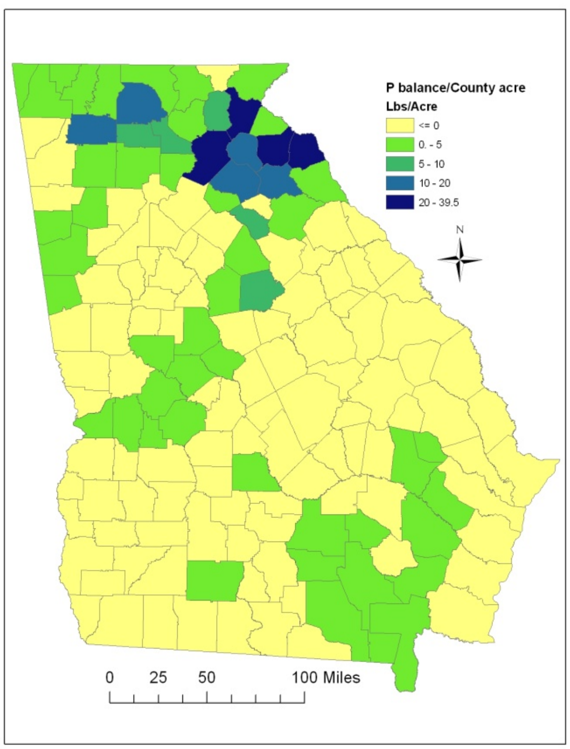

Fig 1.3-4. Spatial distribution of excess P per county area

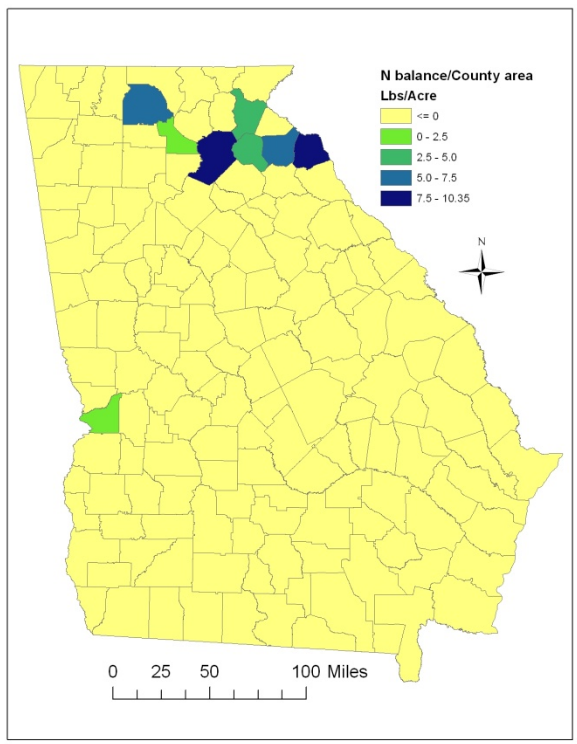

Fig 1.3-5. Spatial distribution of excess N per county area

The Upper Chattahoochee Watershed, and the Etowah River Watershed included several sub-watersheds that had greater than 5 pounds per acre of excess phosphorus. We draw attention to these watersheds, because they are particularly sensitive watersheds with regard to phosphorus loading due to large downstream reservoirs that supply much of Atlanta's drinking water. However, they are impacted to a lesser degree than the upper reaches of the Savannah Watershed, but it is a less sensitive watershed from a water quality standpoint. Within the Upper Chattahoochee watershed, there were some sub-watersheds with excess phosphorus greater than 15 pounds per acre. As can be noted in figure 1-3-6, the upper Chattahoochee River Watershed is impacted to a greater degree than the Etowah River Watershed with regard to excess phosphorus.

With regard to nitrogen in these watersheds, there is very limited excess nitrogen. Within the Etowah River watershed, only one sub-watershed had excess nitrogen, and it was at a level of less than two pounds of nitrogen per acre. The Upper Chattahoochee River Watershed had relatively low excess nitrogen loadings. The largest loading in one sub-watersheds was just six to seven pounds of excess nitrogen per acre, an extremely low amount relative to crop use of nitrogen by pastures and hay crops, which will frequently exceed 100 pounds of nitrogen removed per acre.

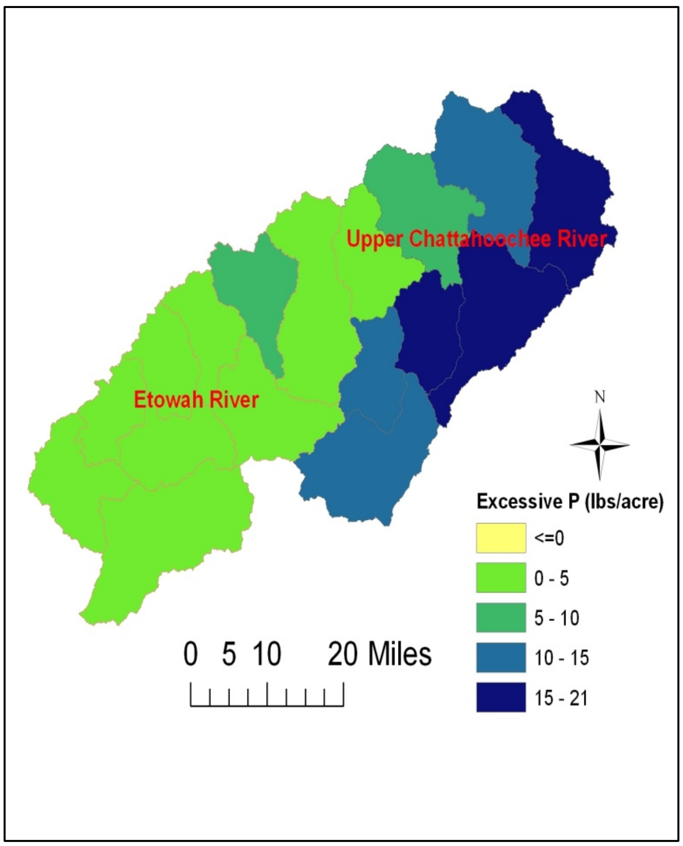

Fig 1.3-6. Spatial distribution of excess P per county area

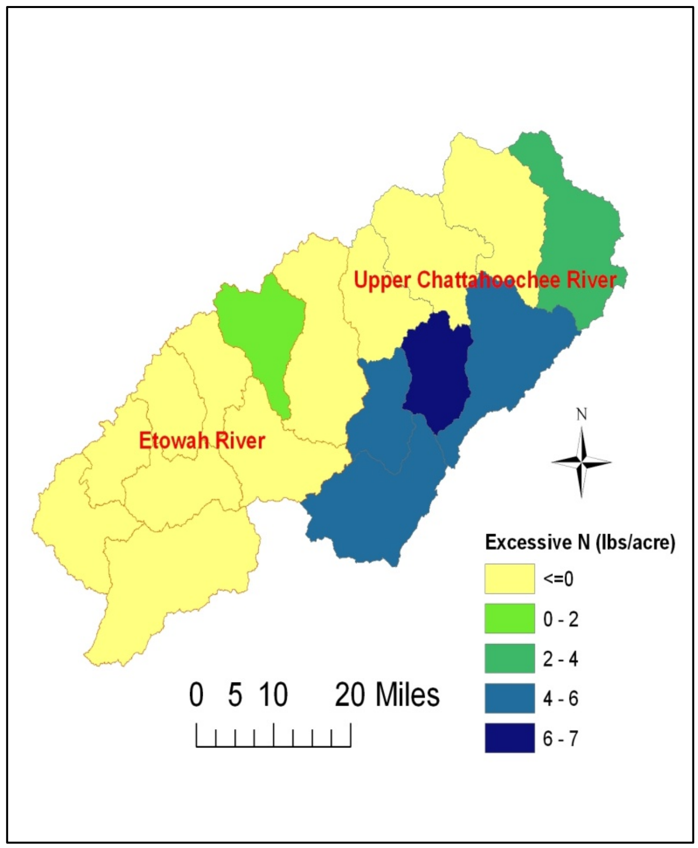

Fig 1.3-7. Spatial distribution of excess P per county area

There are over 3 million tons of poultry litter generated in Georgia each year. This litter contains a total of 44 thousand tons of both P and available N. Excess poultry litter is found in the northeast, middle, and southeast regions of the state based on the spatial distribution of P. However when considering the N distribution, excess poultry litter is located in fewer counties located mainly the northeast region of the state. The valuable data generated from this research indicated the need for the facilitation of litter transfer project in the state of Georgia where poultry litter in counties with excessive nutrient production could be transferred to other areas that can better utilize this resource.

PARTNERSHIP DEVELOPMENT

A key element of this study was to gather a group of people from various aspects of the poultry and farming community to gather their insights, have them talk to each other, and record some of this interaction so that we could identify what is working and what needs improvement in the transport of litter in Georgia. The combination of poultry growers, litter haulers, policy makers, and conservation professionals, and farmers who use litter was a very productive mix that engaged in stimulating conversations. All discussions were in the context of the full path of litter from the chicken house to the farm.

The Workgroup also heard presentations from researchers and extension professionals, and their input was invaluable. The Workgroup allowed us to place the data that was being produced into the context of what takes place on the ground, and this was very helpful as well.

The Workgroup held four meetings over the course of ten months. The four meetings were held on October 10, 2007, December 12, 2007, January 30, 2008 and July 22, 2008, all in Gainesville/Oakwood area. Many Workgroup members also attended one or more of the three Outreach meetings and frequently offered information and feedback in these meetings, as well. Workgroup members also provided input through additional conversations between meetings and personal conversations during the public Outreach meetings. Agendas for the workgroup meetings can be found in Appendix B. A total of 28 people participated in the Workgroup as stakeholders or presenters. A roster of Workgroup participants is given in Table 2-1.

Name	Affiliation
Anderson, Chris	UGA
Asbill, Sandy	Loggins' Rocky Ridge Farm
Belflower, Buddy	NRCS/Soil & Water
Brinson, Steve	GA Poultry Lab
Cahill, Stephanie	GA EPD
Caudell, Billy	GA Dept of Ag Livestock/Poultry Industry
Chen, Feng	UGA
Collier, Sam	GWPPC
Cooper, Otis	Grower
Dangler, Jim	NRCS
Edington, Barry	grower, Wayne Farms
Edwards, Bob	Triple E Poultry
Eigenberg, Dave	GSWCC
Fowler, Carrie	GSWCC
Fulmer, Bob	GSWCC
Giles, Mike	GA Poultry Federation
Horne, Frank	Poultry Plantation, Inc.
Kissell, Dave	UGA Ag & Enviro. Services Labs
Loggins, Tim	Loggins Farm
Mullen, Jeff	UGA Dept. of Applied & Agricultural Economics
Nolan, Maxcy	CNMP
Page, Andy	NRCS
Risse, Mark	UGA
Ritz, Casey	UGA
Rowles, Kristin	GA Water Planning & Policy Center
Seabolt, Wayne	Natural Growth, Inc.
Smith, Tim	Dawson, Lumpkin & Hall Poultry Agent
Tyson, Clelland	Earthsafe Inc.
Walker, Page	A&B Litter

Table 2-1. Roster of workgroup participants

Workgroup presentations

The following presentations were made to the Working Group or during the larger Outreach meetings. These presentations will be available on the project website at www.galitter.org.

December 12, 2007 Working Group Meeting – Gainesville, GA

Risse, Mark – UGA Pollution Prevention Specialist "Educational Resources: Poultry Litter"

Kissel, Dave & Feng Chen – UGA Agricultural & Environmental Services Laboratories
"Poultry Litter for Transport: Lanier & Etowah Basins"

January 30, 2008 Working Group Meeting – Gainesville, GA

Rowles, Kristin – Georgia Water Planning & Policy Center of Albany State University
"Introduction to Water Quality Trading"

July 22, 2008 Working Group Meeting – Gainesville, GA

Mullen, Jeff – UGA Dept. of Applied & Agricultural Economics "Poultry Litter Survey"

Mullen, Jeff – UGA Dept. of Applied & Agricultural Economics "Transport Model"

The Workgroup was very involved and offered several suggestions that the project team implemented. For example, the Workgroup discussed the fact that an impediment to greater litter transport was a lack of understanding of the value of poultry litter among farmers that had not used litter in the past. Workgroup members suggested that a fact sheet on the value of poultry litter would be an asset to encourage greater litter transport, In response, Dave Kissel prepared a factsheet on the Replacement Value of Litter (Appendix A). Dave drafted the sheet for the meeting after it was requested, the Workgroup made comments, and Dave incorporated the feedback into a revised draft. Workgroup feedback made the fact sheet more usable, an example of having real-time input into a needed piece of information and feedback on that information from practitioners in the field. This factsheet is now in review and will become an official UGA Extension Bulletin.

2.1 What we learned from the Workgroup *(Summary of Feedback from Our Partnership & Outreach Efforts)*

We drafted a list of key points we had been hearing from the Workgroup, and then discussed that list at our final Workgroup meeting in July 2008. The following is the list as revised from Workgroup comments and revisions:

- Talk of moving P out of a watershed implies that litter is the problem. This seems to place more blame on agriculture than is due. Agricultural contributions to excessive P levels in some watersheds are much smaller than residential runoff, yet everybody looks to the farmer for the solution. Conversations on nutrient load reductions need to account for all sources and not focus on one individual sector.

- Farmers and poultry growers are the focus because they may represent the fastest and easiest way to reduce excess P in affected watersheds. It is very important to turn this into an opportunity for the farmers to benefit by being the easiest source of P removal ***whether or not*** they are the ***main*** source of P. Education on the relative percent of P from each source, including residential, commercial and industrial activities, will help. Communicating a clear message on how agriculture is stepping up to the plate to bring about reductions is important, as well.

- When a farmer is managing land application for Nitrogen, excess Phosphorus can build up in the soil. This is especially true for plants such as forage, which do not need as much P as they need N. Similarly, soils with a history of land application need more N than P.

- Cotton needs NPK in a much closer ratio to that supplied by litter and has historically received less litter application, and thus all of the replacement value of litter is of benefit to cotton.

- Providing incentive to poultry producers in P surplus areas to purchase N to apply to their pastures/hayfields might be more effective to address surplus P than paying for transport. This is particularly true in times where the cost of commercial fertilizer is high. It would also free litter up for transport. There are not enough incentives to keep poultry producers from over-applying P on their own land.

- For a poultry grower with pasture lands, the cost difference of using litter vs. nitrogen is the cost of the nitrogen alternative (be it commercial N or legume cover crops) so this is the cost needed to free up nitrogen for them.

- For a poultry grower's neighbor who has pasture land, it is usually cheaper to apply litter with excess P than to purchase just the nitrogen needed. If that pasture owner is paying the full replacement value of all the nutrients in that litter, but does not need the P, then paying for the P value is wasted, and in fact is *buying a problem.* So, it would seem that education on the replacement value of litter, coupled with education on managing pastureland for P would show NE Georgia pasture owners without litter than it is not economical (if somewhere close to the full replacement value of litter is paid everywhere).

- Another alternative to address surplus P would be incentives to plant legumes in their pastures and hayfields. There are some excellent, recently developed clovers and grazing type alfalfas that could boost forage production without poultry litter application to supply N. The reason that litter is so valuable to those poultry producers who also have cows and pastureland is that the biggest benefit from applying the litter to their fields is the plant available nitrogen they get from the litter. Commercial nitrogen fertilizer is very expensive now, and litter is a cheap substitute, but legumes can eliminate the need to apply nitrogen to these pastures.

- Feedback from farmers in this group was that they have lots of trouble maintaining the clovers and are less accepting of this alternative. They find that it is tough to maintain clovers in a grazed pasture – it requires intensive management. Perhaps this highlights a need for education and demonstration of how can be accomplished.

- Georgia has good subsidies such as $4 soil test, free litter analysis, and free technical assistance to support litter use, and proper nutrient management. Poultry producers and other farmers should use nutrient management plans to manage the P balance of their soils.

- Potential litter buyers need to know the replacement value of litter to be able to compare it to commercial fertilizer. Litter buyers and sellers perceive litter from different perspectives:
    - Poultry producers who know the replacement value of litter sometimes want to sell litter for higher prices.
    - Then again, when litter buyers know there is a need to move litter out of certain areas, they sometimes do not want to pay much (or anything) for it. Their perception is: 'I will take the litter off your hands for you.'

- Litter delivers the nutrient equivalent of 3-3-2 commercial fertilizer. As of Spring, 2008, the replacement value for litter is $53/ton, based on the N-P-K content of the litter Under this analysis, there are additional benefits with litter such as limeing value, improved Soil Moisture retention, Micro-nutrients, and organic matter.

- Mileage costs rise along with increases in the price of oil, but probably not as much as commercial fertilizer prices rise, since commercial fertilizers have much more embedded petroleum costs in them. **Every $.10 increase in fuel results in an added cost of $.50**. [assuming a base case of a 300-mile haul of litter, only a 175-mile "dead-haul" (empty truck that is then able to back-haul a load of sand, peanut hulls, etc. the remaining 125 miles back). Truck gets 4 Miles/Gallon, litter load is 25 tons => $.475/ton in fuel costs with a diesel price of $4.70/gallon]

- Growers cannot expect to receive this full replacement value, as the costs of clean-out, loading, hauling and spreading (and possibly storage) must be factored in.

- Litter cost components (per ton)

	Fall, 2007	Summer, 2008
Clean-out costs	$5	$8-11
Hauling costs	$20-30	$25-40 Distance/Fuel dependent
Un-load & spread	$7-12	$12-13

- It is expensive to haul litter and manage its transport as well as land-apply it. Each time litter is moved from one place to another (such as from truck to stackhouse, or from stackhouse to farm) there is a $3/ton in addition to mileage costs.

- Storage in community stackhouses adds a cost of $3/ton for another handling, and this can be significant. On-site storage avoids this added cost, however, covered in-field storage can lead to covers blowing off the pile and/or getting caught and shredded up in spreading equipment.

- Litter is bulkier than the same nutrients in commercial fertilizer form. This creates a challenge in terms of storage. It also increases need for a spreader, which can run $15,000-25,000 as a cost of entry to use of litter. Equipment costs for a loader are $40-50,000.

- Litter smells like what it is. It is more difficult to apply uniformly than fertilizer. But advance notice and a neighborly visit help. Stopping by a neighbors' house a few days in advance of spreading, and telling them that litter will be applied, while giving them a "pound of pecans" can greatly reduce complaints, because then they know what the smell is, and that it won't last. When new folks move into the area (especially from more urban areas), they are sometimes less used to occasional odors, and often complain louder. When neighbors are used to rural life, they are more comfortable with these temporary inconveniences. But never spread around holidays, birthdays, weddings or Sundays near a church.

- Connecting litter sellers and buyers in a timely manner is difficult. Large scale transport from watersheds with excess P would benefit from facilitation at the watershed level. In Georgia, this is mainly done by the brokers but could be provided by other private or public entities.

- Timing of litter application is a substantial barrier to increased litter transfer. The large quantity buyers (row crop in Middle and South Georgia) all want litter in the spring to put out before planting. Infrastructure for storage and transport is not in place at this time to support this time-sensitive demand. A system for improved storage that would allow year-round transport and storage where it is needed would help.

- The availability of back-hauls is important to keeping transport costs low. Cost of transport is much higher when there are "dead back-hauls" from the litter receiving area. Availability of back-hauls near litter receiving depends on season (peanut hulls are free when available).

- A disease outbreak such as LT/VLT (Laryngotracheitis/Vaccinal Laryngotracheitis) can stop litter transport cold. The stigma of LT goes far beyond the LT Zone. Some farmers are worried that using litter may make them a target for disease control regulation. Even among the highly-informed members of the Workgroup, the presentation on disease control was extremely informative. It provided so many answers as to what the actual threat posed by LT is, what the state's response is and why and that the time frame for quarantine and vaccination is used. This information should be easily accessible to all who are interested, since a vacuum of information breeds unfounded fear and suspicion.

- A Sherri Heron-type of one-stop shop (Sherri is director of BMPs, Inc. in Arkansas) for brokering and transporting litter would be great. Sherri plays the role of Leader, Visionary and Manager. At present, the brokers in Georgia are serving that role but they are not viewed as non-biased and are not a single point of contact.

- Some Georgians are composting litter for use as a soil amendment. In this form, most of the concerns – such as odor and pathogens– are not a problem, however, much of the N is lost during the composting process. This is one of the value-added products that could create new markets for litter transport in Georgia by reducing some of the impediments posed by uncomposted litter.

- There are a variety of other value-added products and processes that may rapidly change the situation for litter. Energy production from litter in a variety of forms could compete with litter as a fertilizer, reducing the supply of litter nutrients and/or raising the price of litter.

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ENVIRONMENTAL AND ECONOMIC INFORMATION

The second component of this project was to compile the information needed to support the evaluation, design, and implementation of a nutrient transfer program. The information needs were primarily economic, but also related to assessment of policy approaches and options. The component included several analyses, including the investigation of litter transfer programs in other states, a survey of participants in the NRCS pilot litter transfer incentive program in Georgia, the development of an economic transportation model for litter transfer, an exploration of potential linkages between nutrient trading and litter transfer, and a literature review of alternative uses of poultry litter. An annotated bibliography of research relevant to litter transfer is included in Appendix C to provide additional background on this topic.

3.1 Investigation of litter transfer programs in other states:

The production of poultry has creates a waste product that can be quite beneficial if managed properly, but mismanagement can lead to costly, adverse consequences. As a result, many states with substantial poultry production in their farm sectors have created programs to support the poultry litter management, including best management practice cost-share incentives, poultry litter marketing support, and support for development of value-added industries. This project is focused specifically on incentives designed to stimulate transport of poultry litter from areas where there are concerns about nutrient effects on water quality. In this section of the report, we review existing poultry litter transfer incentive programs in the U.S. We start by providing an overview of the pilot program in Georgia as a reference for comparison to other states. Then, we summarize other programs state-by-state. Finally, we analyze the programs' primary features and identify common themes and approaches.

Georgia Litter Transfer Incentive Pilot Program

Georgia is the top broiler producing state in the U.S. The state produces over 1.3 billion broilers annually – about 15% of U.S. broiler production in total. In Georgia, poultry production accounts for more than half of agricultural cash receipts. This industry generates approximately 1.5 million tons of poultry litter annually, and a substantial amount of this litter is generated in nutrient sensitive watersheds in North Georgia. To address nutrient loading concerns in North Georgia watersheds, the U.S.D.A. Natural Resources Conservation Service (NRCS) in Georgia developed a pilot litter transfer incentive program in 2005. Implementation began in 2006. The pilot program had three objectives: (1) to create an incentive to distribute poultry litter to areas of the state that have historically not used poultry litter as a fertilizer, (2) to promote a long-term market for animal manure as a fertilizer around the state, and (3) to reduce over-application of poultry litter in areas where it has been traditionally over applied. The program operated as follows:

- Farmers interested in using litter could apply for an incentive intended to offset transportation costs.
- Litter had to originate in a "targeted removal" county and be applied in a "targeted application" county. These counties were identified based on an assessment of the phosphorus balance in each county. Surplus counties were identified as removal counties, and other counties were application counties. Within each category, counties received a priority ranking, also based on the phosphorus balance.
- The incentive payment was $10.00/ton, but an applicant could receive a higher ranking if willing to receive a lower payment rate (e.g., $6 or $8 per ton).
- Applications were ranked on several criteria, including: priority level of removal county, priority level of application county, willingness to accept a lower payment rate, receiving crop, P-index for receiving land, use of conservation tillage, availability of appropriate storage facilities, and litter application rate.
- The maximum incentive payment per farmer was $10,000.00 per year.
- Litter must be hauled by a Georgia licensed Animal Manure Hauler.

- Waste must be transported according to Georgia Department of Agriculture, Animal Industry Division Manure Handlers rules (Chapter 40-13-8).

- The receiver must have litter storage available that meets NRCS Waste Field Storage Standard (749).

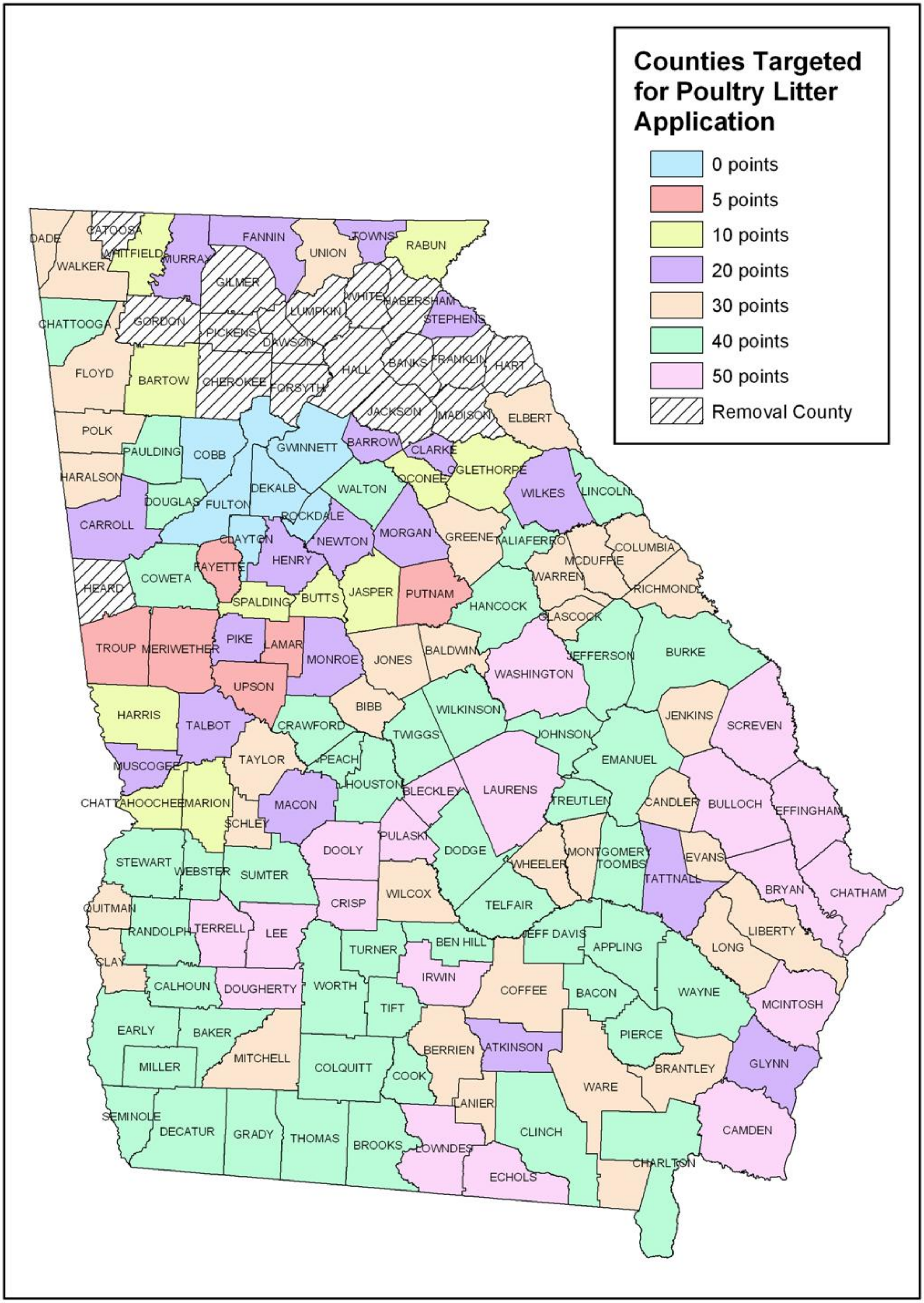
- Litter application must be set back more than 100 feet from water bodies or have a 35 foot vegetative buffer.

- Litter application should be based on "P" Index and follow NRCS Nutrient Management Standards (590).

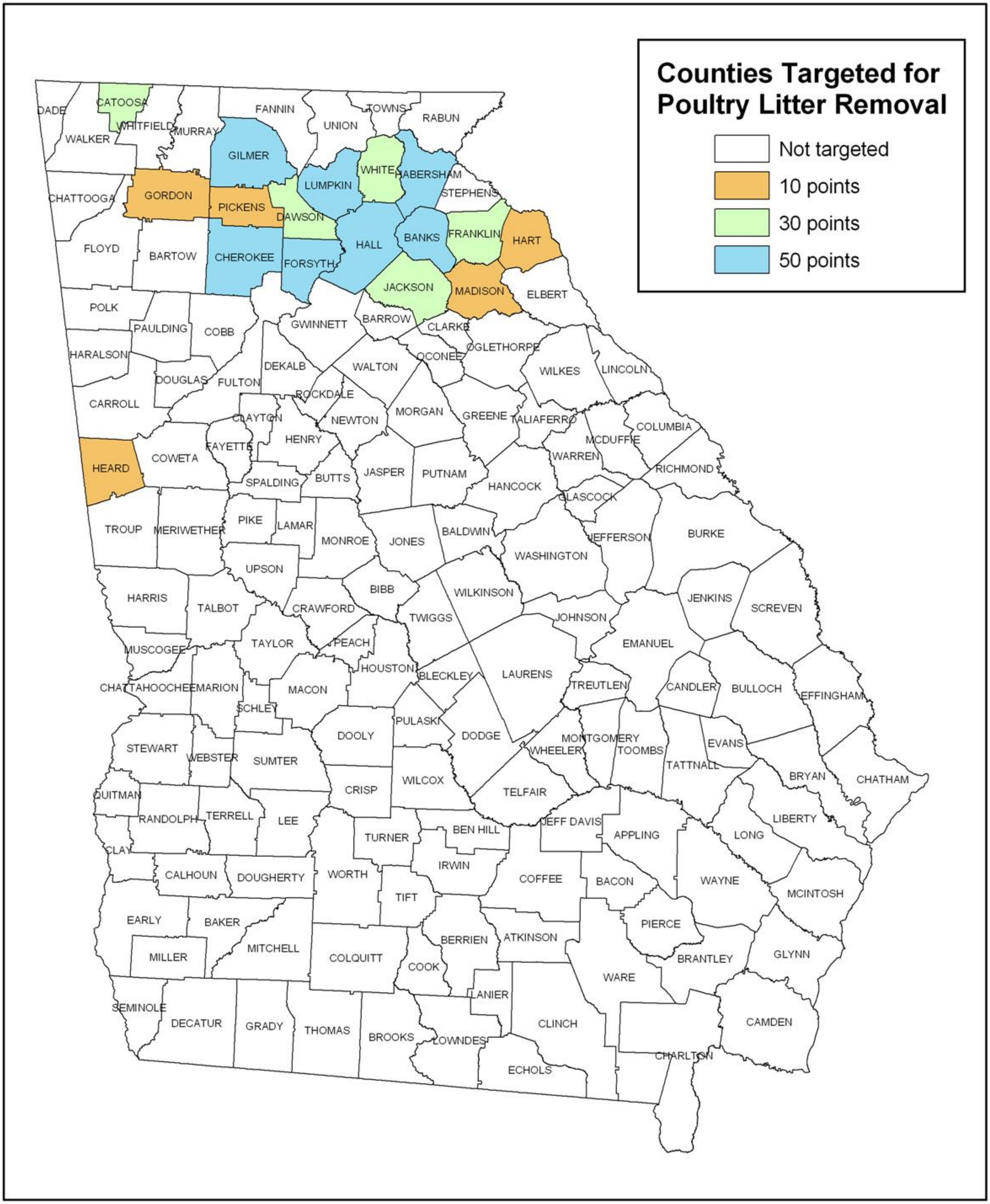
- No application sites with a "P" Index >75 will be approved for litter application.

The pilot program awarded 53 contracts in 2006 for a total of $248,000 from an earmarked pool of funds made available by NRCS for the incentive at the state level. In 2007, specific funding was not set aside at the state level, but local units could fund the incentive using regular EQIP dollars. In 2007, the pilot program awarded 14 two-year contracts for a total of $340,000. The program was offered in the same way in 2008. Farmer perceptions of the pilot program are reviewed in Section 2.1 of this document.

2006 Poultry Litter Transfer



2006 Poultry Litter Transfer



Transfer Programs in Other States

Alabama

Alabama is the third largest producer of broilers among poultry producing states in the U.S. Similar to Georgia, Alabama has a strong concentration of poultry production in the northern part of the state and a strong concentration of row crop production in the southern part of the state. A poultry litter transfer incentive program was created in Alabama in 2003. The program's creation was stimulated by a new regulation that prohibited litter spreading from November 15 to February 15 of each year in the Northern half of the State. The program has been funded by EPA 319 and EQIP. The program is operated by the NRCS in Alabama.

The program pays an incentive to litter applicators that will use litter on land that has not received litter in the past three years. Requirements include covered storage of litter, hauling by a certified handler, nutrient management planning, and soil testing by the applicator. Litter must be from Alabama, and it must be hauled at least 50 miles. Producers in counties with a high concentration of litter are ineligible to participate (the NRCS lists these counties). Poultry producers are ineligible to participate. The incentive payment is 10 cents per loaded mile based on distances between sending and receiving counties, and the incentive is doubled from Nov 15 to Feb 15. Payments are based on mileage estimates for each county set by the NRCS, and while litter may be hauled more than 150 miles, payments are limited to 150 miles.

The amount spent in the program has decreased from $573,000 in 2004 to $140,000 in 2007. Program administrators report that fewer producers are available to participate now because of the limitations on participation per producer. In 2008, no special project funds will be made available for the incentive, but local EQIP funds can be used to pay for the practice. The incentive payment counts toward the $450,000 limit on EQIP funds that a landowner can receive.

One official involved with this program reported to our stakeholder group that poultry litter use is greater than commercial fertilizer use in Alabama and that poultry litter use is increasing while commercial fertilizer use is flat. He also noted an interest in back-hauling litter on barges that transport grain to Alabama on the Tennessee River (Charlie Mitchell, Auburn University, personal communication, October 10, 2007).

Virginia

A large part of Virginia is within the Chesapeake Bay watershed, where nutrient over-enrichment is a significant concern. All of the Chesapeake Bay watershed states have committed to reducing nutrient inputs to the watershed. See Figure 3.1-1 for a map of the Chesapeake Bay watershed. In Virginia, poultry production is concentrated in the Shenandoah River Basin, which is a tributary to the Chesapeake Bay. Nutrient pollution concerns have led to the creation of several programs that address poultry litter management, including two transport incentive programs.

Virginia created a poultry waste management program in 1999. This program sets requirements for poultry producers that address storage and nutrient management planning. Through this program, the state tracks poultry litter that is exported from poultry operations. The program supports producers in creating and complying with nutrient management plans, and it provides incentives ($6 per acre) to technical service providers to assist farmers in creating nutrient management plans. This program is administered by the Virginia Department of Conservation and Recreation (DCR).

The DCR and the Virginia Poultry Federation, a non-profit organization, jointly fund the Virginia Poultry Litter Transport Incentive program to support the transport of poultry litter from areas of high concentration to farmlands lacking in nutrients. The program offers $5 to $12 per ton for litter transfer (rate is based on receiving county). Incentives are paid to poultry litter brokers and end-users. To be eligible, litter must come from either Page or Rockingham counties, and it cannot be transferred to Accomack, Augusta, Northampton, Page, Rockingham, or Shenandoah County. The incentive is limited to 500 tons per end-user per request. Litter end-users must have a nutrient management plan in place. The program budget for this year is $600,000. For more information on this program, see: http://www.dcr.virginia.gov/soil_&_water/nmlitter.shtml (accessed July 14, 2008). This program was created in the fall of 2007.

The Natural Resources Conservation Service also supports poultry litter transfer through EQIP in Virginia. This program began in 2004, and the program budget was $115,708 in 2005, $350,513 in 2006, and $342,000 in 2007. In 2007, the program had 64 poultry litter transfer contracts. The incentive payment averages $15 per acre, the payments can last for up to three years, and payments cannot exceed $3000 per year. An incentive of $6 per acre is available for nutrient management planning. Requirements include nutrient management planning by the recipient, soil test phosphorus at "Medium +" or below, covered storage (if kept more than 14 days), and record keeping. Litter must come from an identified source county. The incentive payment counts toward the $450,000 limit on EQIP funds that a landowner can receive.

Interest in poultry litter management led to the creation of a Waste Solutions Forum, which received a Chesapeake Bay Targeted Watersheds grant for $1 million in 2006. The grant project is seeking to increase off-site uses of poultry litter through (1) bioenergy production, (2) nutrient concentration to decrease the cost of transport, and (3) manure markets support. Part of the grant is used to support a full-time market maker in organic by-products at the Shenandoah RC&D. For more information, see http://www.valleyorganicresources.com/ (accessed July 14, 2008). The market maker operates a website and hotline (hotline co-sponsored by the Virginia Poultry Federation) to support poultry litter transfer and supports the development of markets for off-site use of manure.

In another effort to address nutrient concerns associated with poultry operations, the six largest poultry integrators in the state signed an agreement in November 2007 to optimize the use of phytase in poultry feed in an effort to attain a 30% reduction in poultry litter phosphorus. The agreement is voluntary and it builds on recent grants to the integrators from the state that supported the use of phytase in feed preparation.

Maryland

In Maryland, interest in poultry litter transfer arose in response to the outbreak of a toxic dinoflagellate (*Pfiesteria*) in the Chesapeake Bay watershed in 1997. The organism was believed to be stimulated by nutrient pollution. In 1998, Maryland passed the Water Quality Improvement Act. To address nutrient loading from poultry operations on the Delmarva peninsula, the Act created new animal waste management requirements, supported the development of a poultry litter transfer program, and funded pilot studies on various alternative uses of poultry litter, including pelletization, composting, energy production, and forest fertilization.

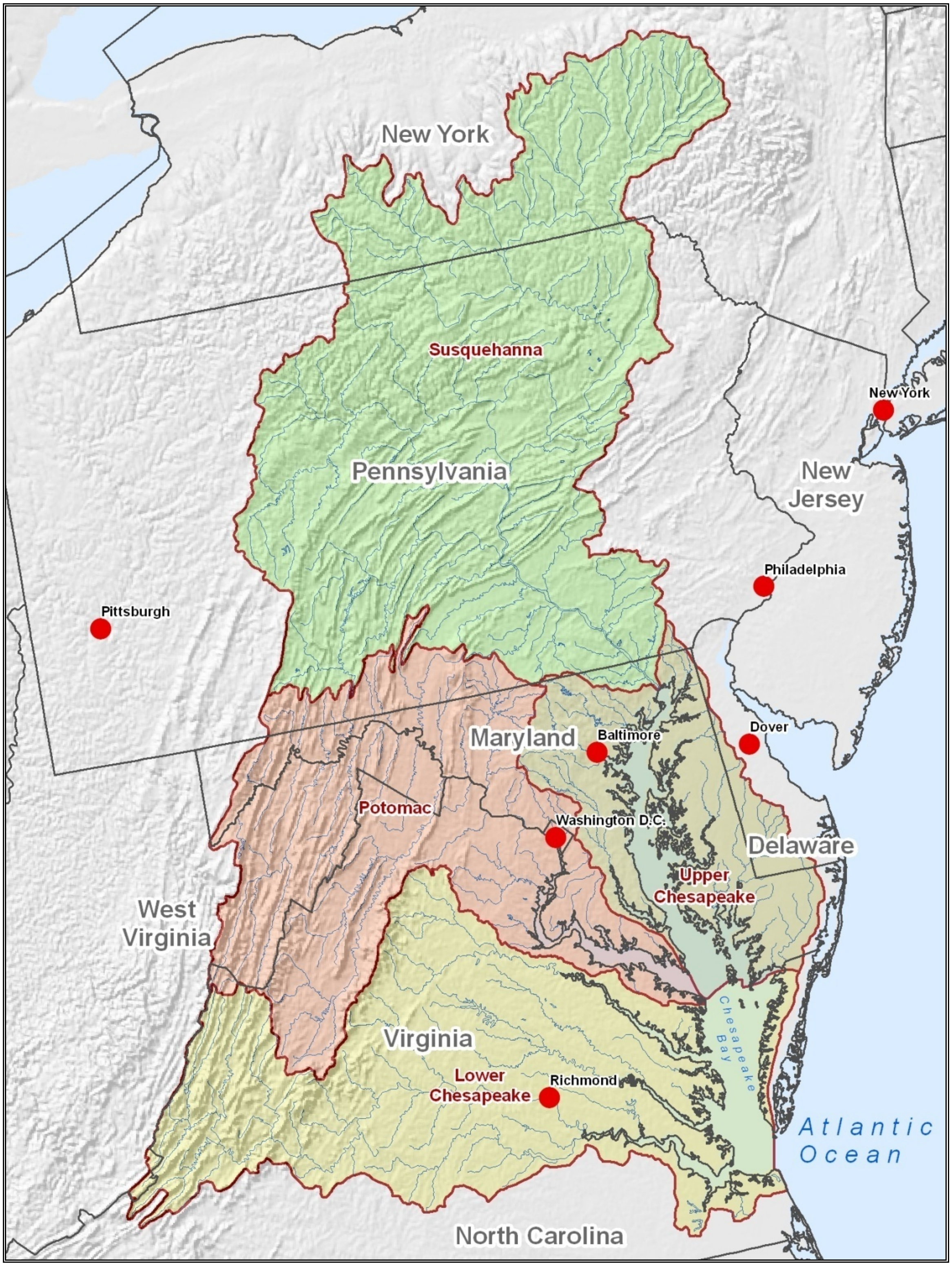
The Maryland Manure Transport Project is administered by the Maryland Department of Agriculture. Funding is provided 50% by the state (annual appropriations) and 50% by poultry integrators. The program also received some funding for use in certain watersheds from an EPA 319 grant (now expired). Project funding has fluctuated between $500,000 and $1,500,000 over the past eight years. The program is not limited to poultry manure; dairy, beef, and other animal waste is also eligible. The project is supported with substantial funding from the poultry integrators, and the integrators are legally prohibited from passing these costs onto their contracted growers.

From 2005-2007, the project averaged payments in support of the transport of almost 36,000 tons of poultry litter per year. The average payment was about $16 per ton of litter. The incentive is paid based on the county of origin, and additional payment is made for manure loading. The incentive is higher for manure that originates in one of four Lower Shore counties, where nutrient pollution concerns are particularly pronounced.

Program requirements include that the manure producers must have insufficient land for manure application or land identified as high in phosphorus. Sending farms must be contracted with an integrator. The amount of excess litter at a sending farm is determined based on the farm's nutrient management plan. The project administrator reports that most of the sending farms have a "no land" nutrient management plan, which means that they have no land available for application of litter at agronomic rates (Norman Astle, Maryland Department of Agriculture, personal communication, October 10, 2007). Receiving land must have a nutrient management plan and a soil test within the past three years. The sending farm must provide a manure analysis. The project sets limits for land application by the recipient based on a "fertility index value". Covered storage of litter is not required in Maryland. The program administrator noted that receivers said that they would not participate if covered storage was required. Incentives can be paid for litter transferred within the same farm operation if the litter is transported at least seven miles and meets other project requirements. All participants must be in compliance with nutrient management regulation and in good standing with the Maryland Agricultural Cost-Share Program. Other requirements address biosecurity, trucking, stockpiling, and delivery. The project includes inspections for compliance, and the project administrator believes that the inspections have provided credibility to the project.

The incentive can be paid for transport for litter for alternative uses, such as pelletization and composting. In one alternative use, the project has supported the transport of poultry litter to provide a substrate for mushroom production.

Figure 3.1-1: Chesapeake Bay Watershed



Arkansas/Oklahoma

Poultry production is heavily concentrated in eastern Oklahoma and northwestern Arkansas. This region generates about 1.5 million tons of poultry litter annually. Poultry production in this region is focused in some nutrient sensitive watersheds, including the Eucha-Spavinaw Figure 3.1-2 and the Illinois River Basin 3.1-3. Poultry litter export is a primary tool for addressing nutrient loading from poultry operations in this region. The Oklahoma Cooperative Extension Service has estimated that the nutrient replacement value of poultry litter is $137/ton.

Much of the poultry litter export in northwestern Arkansas and eastern Oklahoma is administered by BMPs Inc., a nonprofit organization set up by five integrators from northwest Arkansas to export litter under legal settlement with the City of Tulsa in 2003. The legal agreement requires that the integrators export 25% of litter from the Eucha-Spavinaw sub-watershed in order to address phosphorus pollution. BMPs Inc. provides a turnkey service that coordinates the litter export process. A farmer that wishes to apply litter as fertilizer can call BMPs Inc. to purchase litter, often at costs subsidized with environmental incentive funds. BMPs Inc. owns loading and transporting equipment and maintains three clean-out and trucking crews. BMPs Inc. transports litter across four states: Arkansas, Missouri, Oklahoma, and Kansas.

BMPs Inc. charges litter recipients for litter deliveries ($28.50 per ton for 100 miles transported), but they also apply subsidies to this amount that can reduce the price. A variety of subsidies are available for the program depending on the source of the litter. BMPs sources litter in both Arkansas and Oklahoma. Subsidy funding sources include EPA 319, EQIP, Oklahoma Conservation Commission, and the Oklahoma tax code. See Table 3.1-1 for a summary of the available incentives. BMPs Inc. coordinates the incentives for participants. Support from poultry integrators provides about 40% of the program funding.

BMPs Inc. reported the following as the organization costs in the litter export process in October 2007: $6 per ton paid for clean-out, $5 per ton paid to poultry producer for litter, $3.50 per mile for transport for a 25 ton load, and $2 per ton for coordination. BMPs Inc. uses trucks with belted floors to transport litter. They have found that these work better for them than end-dump trucks. They load litter by conveyor. Equipment costs were reported as $25,000 for a conveyor and $60,000 for a belted floor truck (Sherri Herron, BMPs Inc., personal communication, October 10, 2007).

BMPs Inc. estimates that it has reduced land application of litter in the Eucha-Spavinaw sub-watershed by 75%. The organization has been successful in promoting litter export in the region, and the program administrator believes that demand exceeds supply. The organization moved 150,000 tons of litter in its first two years. The program administrator asserts the importance of selling exported litter based on its fertilizer value. She notes that subsidies have been a part of the program, but is concerned about how subsidies affect the sustainability of such a program. She believes that the program could operate without subsidies within a 100 mile radius (Sherri Herron, BMPs Inc., personal communication, October 10, 2007).[1]

Litter transfer is also supported by a litter market website operated by Oklahoma State University Cooperative Extension (see: www.ok-littermarket.org accessed September 8, 2008). The director of BMPs Inc. does not believe that matching websites and hotlines are adequate to support an active litter market. She asserts that a "one-stop shop" (like BMPs Inc.) is necessary. The litter marketing website replaced a litter telephone hotline. The telephone-based approach was not heavily utilized, but the web-based approach is receiving a substantial amount of Internet traffic. Organizers reports that buyers interested in litter outnumber sellers with litter for sale. Membership on the site is free, and membership is not required to view the site. The web-based approach supports the delivery of relevant education material to potential litter producers, handlers, and users (Payne and Smolen, 2006).

The Oklahoma Cooperative Extension Service reports that several alternative uses of poultry litter have been considered, including composting, pelletizing, power generation, bio-gas, and long-distance rail shipping. After years of research, studies have found no definitive results on alternatives. To date, none of these alternatives has proven a viable alternative to poultry litter transfer by truck to nutrient deficient lands.[2]

Land application of poultry litter in this region has been the source of substantial controversy in Oklahoma and Arkansas. Oklahoma and the City of Tulsa have put substantial pressure on wastewater plants and agricultural producers in northwest Arkansas to reduce phosphorus loading in this region. The City of Tulsa uses the Eucha-Spavinaw for water supply. In 2001, Tulsa sued poultry producers and the city of Decatur (Arkansas) over phosphorus loading in the Eucha-Spavinaw. Settlement of the litigation included a payment of $7.5 million to Tulsa and new limits on poultry litter application, including the use of a P-index to govern litter management and the use of Nutrient Management Plans by applicators. A temporary moratorium on litter spreading was implemented while the P-index was developed. Also as a result of the litigation, BMPs Inc. was created by the poultry integrators.

In 2002, Oklahoma approved a strict phosphorus water quality standard (0.037 mg/l) for six scenic streams, including four Illinois River watershed streams that begin in Arkansas, which is required to meet the limit at the state line. The Oklahoma Attorney General has asserted that Arkansas is not adequately controlling nonpoint pollution, including phosphorus and fecal coliform, from poultry operations in these watersheds. He filed a lawsuit against poultry companies in 2005 over the pollution in the watersheds under the federal Superfund law. As a

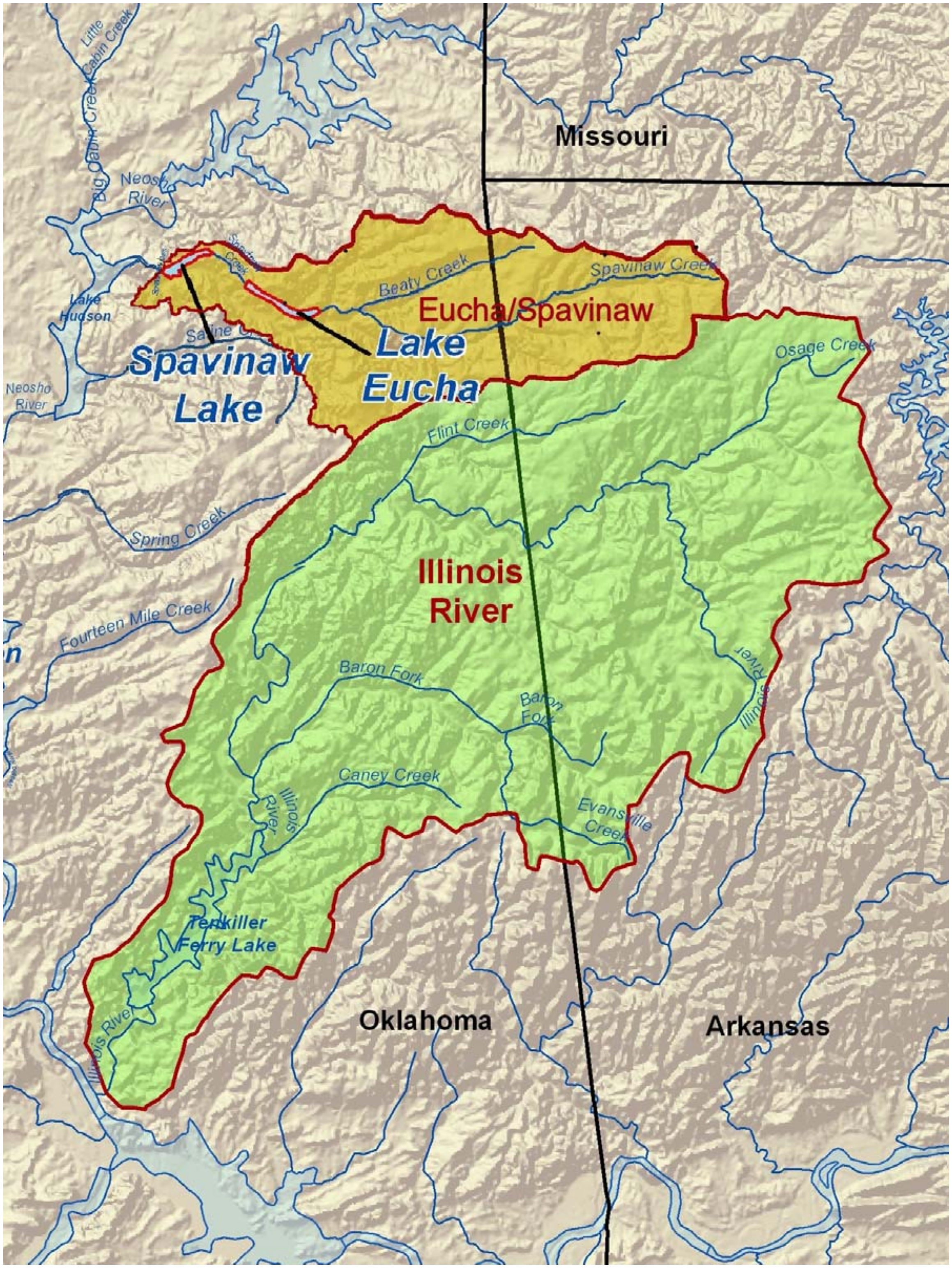
[1] Note that these estimates were based on fuel prices in Fall 2007. Recent increases in fuel prices have likely increased the importance of transport subsidies.

[2] Joshua Payne, Oklahoma Cooperative Extension Service, August 20, 2008, presentation at a project workshop in Athens GA.

part of the legal proceedings, the state of Oklahoma is seeking a preliminary injunction to ban poultry litter spreading in the watersheds until the case is decided.

The litigation over poultry litter management in this region raises a number of issues that could have significant consequences for the management of animal waste in general. Concerned about the potential ramifications of the case, a number of agricultural organizations, including cattle producers, are seeking to file *amicus curiae* briefs in the case. In general, these briefs contend that animal manure is a natural fertilizer and that an adverse decision in the case could lead to bans across the country on land application of manure. The Oklahoma Attorney General has noted that the case does not seek to ban land application that is consistent with environmental regulations and guidelines. However, in the Illinois River watershed, an injunction would halt, at least temporarily, all litter spreading until the case is decided. Central issues in the case include whether manure is a hazardous waste, how to track the source of nonpoint pollution, and interstate watershed management. Animal producers will watch this case closely, and with the case still undecided, the outcome looms over the future of animal waste management programs, including litter transfer. It seems unlikely that the case would lead to a complete ban on litter spreading, but it may lead to substantially more restrictive scrutiny of animal waste management in general.

Figure 3.1-2: Illinois River and Eucha/Spavinaw Watersheds in Arkansas and Oklahoma



West Virginia

Litter transfer incentives in West Virginia started in 2004, with funding from the NRCS Agricultural Management Assistance program. The West Virginia Conservation Agency, the West Virginia Department of Agriculture, and the West Virginia University Cooperative Extension Service supported the program with coordination and education. The program has ended because the practice is no longer receiving funding in West Virginia. Representatives of the NRCS and West Virginia Department of Agriculture believe that the program was ended because of perceived concerns about biosecurity. However, a Department of Agriculture representative believes that biosecurity concerns were unfounded. She reports that haulers were provided with education and guidelines to provide adequately for biosecurity. The Department of Agriculture representative believes that the program was a success and that demand for litter outstripped supply. She said that with the current costs of commercial fertilizer, there is great demand for litter as a substitute. Currently, the Department of Agriculture tries to match interested buyers and sellers (C. Richmond, WV Department of Agriculture, personal communication, July 15, 2008).

When the NRCS program was active, it was focused on the reduction of nutrient loading in the Potomac River Basin of the Chesapeake Bay watershed. The incentive subsidized the cost of broiler and turkey litter from counties within the Chesapeake Bay watershed to counties outside of the watershed. The program was also intended to promote extended livestock grazing to reduce animal confinement and manure storage and handling needs.

The program required that eligible receiving lands meet stream, well, spring, and property line setback requirements. Receiving lands could not be in the Chesapeake Bay watershed or within certain biosecurity zones. Litter transport was limited to April through September. Litter application had to follow a current nutrient management plan. Priority was given to receivers with a Prescribed Grazing System or an extended grazing plan. Litter that was not spread within three days of receipt had to be covered. The sending operation was required to supply a litter analysis. The incentive payment was $2.50 per loaded mile for loads of 15 tons or more. For loads of 10 to 14.9 tons, the incentive payment was $1.70 per loaded mile. The incentive payment was limited to 200 miles.

Texas

In the Brazos Valley in Texas, the NRCS recently introduced a new incentive program in to subsidize off-site litter use by non-poultry producers. The incentive uses EQIP funds to pay $25 per acre per year to use litter as fertilizer. Applicators must have a current soil test, and fields with high P soil tests are ineligible. This is a new program.

The Texas State Soil and Water Conservation Board operates a Texas Poultry Litter Hotline as a matching service for poultry litter in East Texas. The hotline has received support from an EPA 319 grant. (See: http://www.litterhotline.com)

Texas has had two successful programs that have supported the export of dairy manure in the North Bosque and Leon River watersheds. The Texas State Soil and Water Conservation Board Dairy Manure Export Support project paid an incentive to manure haulers to transport manure from dairy farms to commercial composting operations. The Texas Commission on Environmental Quality Composted Manure Incentive Program paid an incentive to government entities to purchase composted manure. This program also provided technical and marketing support to manure composters. Both of these programs have recently ceased incentive payments, but in 2007, the five commercial manure composters that participated in the programs were still actively operating. However, more time is probably needed to assess the viability of the operations without subsidies. During its operation, the DMES program reports that over 1 million tons of manure were transported to commercial composting facilities. The CMIP reports that in most years, it met its goal of removing 50% of solid cattle manure from the watershed. Both programs received substantial support from EPA 319 grants. The Texas Department of Transportation supported the composting programs by using the compost on roadsides to control highway nonpoint source pollution.

Pennsylvania

Pennsylvania does not currently have an incentive initiative to support litter transfer directly. However, its new nutrient trading initiative has been used to support litter transfer. A primary actor in these transfers has been the Red Barn Trading Company. In the Pennsylvania Nutrient Trading initiative, 22 of the 29 contracts that have been approved as nutrient trading credits were based on nutrient reduction through poultry litter transfers out of the Chesapeake Bay watershed (see Figure 3.1-1). These credits generated through litter transfer total 415,409 pounds of N and 51, 928 pounds of P. These amounts account for 63% and 65% of the total credits generated for N and P to date, respectively. Clearly, poultry litter transfer is an attractive option for generating tradable nutrient credits. This initiative is discussed further in Section 3.3 of this report.

Vermont and Iowa: An Alternative Approach

These states do not have poultry litter transfer incentives, nor do they have substantial poultry production, but they have piloted an innovative approach to nutrient pollutant controls from farms that is an alternative to traditional subsidies for specific farm practices. In several watersheds in these states, farmers are eligible for subsidies that are based on environmental performance, not the use a particular practice. This approach could be a viable alternative to subsidies that are directly tied to poultry litter transport.

In the pilot areas, for phosphorus, the performance- based approach pays an incentive based on the whole- farm P index or an estimate of P loss. For example, in one pilot, farmers receive an incentive payment when their P- index is a particular level or less. Bonus incentive payments are available for certain levels of improvement in their P- index and when soil tests are at optimum levels. In another pilot, an incentive is paid per estimated pound of P loss reduced. In Iowa, the rate is $10 per pound P loss reduced, and in Vermont, the rate is $25 per pound P loss reduced.

The performance- based approach gives farmers the flexibility to design their own approach to reducing nutrient loading. Because performance-based incentives are not tied to the completion of a particular action, they can support the use of a broad range of practices, as long as they deliver environmental results. This approach offers benefits of increasing flexibility, inducing innovation, lowering costs, and increasing farm income. This approach is information- intensive, and at this time, it is not yet widely used. However, because of the advantages it could offer, this approach can be an alternative to traditional practice based subsidies, such as poultry litter transport subsidies.

In Georgia, focusing incentives on reducing P loss, as measured by the P-index, would encourage poultry producers to manage litter application to achieve the desired environmental outcomes. A farmer that typically applies litter at N rates would have an incentive to manage litter application for P. He might choose to export poultry litter and to substitute commercial N fertilizer or to plant legumes to provide N for crops. The end result would be a focus on the environmental outcome. This approach also can integrate with nutrient trading, which is discussed in Section 3.3. For more information on performance- based incentives for agricultural pollution control, see the presentation by Chad Ingels from Iowa State University. This presentation was given at the final workshop for this project.

Information Sources

The summaries in this section are based in part on research summaries prepared by Lauren Smith and David Harper, graduate students in the Department of Agricultural and Applied Economics at the University of Georgia. The material herein was also drawn from presentations from the project's October 10, 2007 workshop. Additionally, the following list includes information sources consulted in preparing this section:

Virginia Poultry Litter Transport Incentive Program website:
http://www.dcr.virginia.gov/soil_&_water/nmlitter.shtml (accessed July 15, 2008)

Valley Organic Resources website (Shenandoah watershed manure market maker): http://www.valleyorganicresources.com/ (accessed July 15, 2008)

BMPs Inc. website: http://www.litterlink.com/index.html (accessed July 15, 2008)

Oklahoma State University Cooperative Extension Service Litter Market Website: http://www.ok-littermarket.org/index.asp (accessed July 15, 2008)

Texas Poultry Litter Hotline: http://www.litterhotline.com/index.html (accessed July 15, 2008)

Texas Commission on Environmental Quality Composted Manure Incentive Project: http://www.tceq.state.tx.us/compliance/monitoring/nps/projects/compost.html (accessed July 15, 2008)

Texas State Soil and Water Conservation Board Dairy Manure Export Support Project: http://www.tsswcb.state.tx.us/managementprogram/initiatives/bosqueleon (accessed on July 15, 2008)

Performance-Based Incentives for Agricultural Pollution Control: www.flexincentives.com (accessed September 10, 2008)

Analysis of Litter Transfer Initiatives in Other States

The following provides an over-arching analysis of the main characteristics of a poultry litter transfer incentive program and compares and contrasts the various programs reviewed above.

Impetus

All of the litter transfer incentive programs have started in the past decade, with Maryland starting the earliest (1998). In the other states that have litter transfer incentive programs, regulatory and legal pressures led to the creation and funding of the litter transfer incentive programs. Several states in the Chesapeake Bay Region implemented litter transfer incentives as a part of their efforts to meet their goals for nutrient reduction under the Chesapeake Bay Program. In Maryland, the outbreak of the toxic dinoflagellate *Pfiesteria* also was a factor. In Oklahoma and Arkansas, litter transfer incentives were created as a result of litigation.

Funding

The primary sources for litter transfer incentive programs have been NRCS EQIP funding and EPA 319 (Nonpoint Source) grants. Another federal source in one state was the NRCS Agricultural Management Assistance program (West Virginia). State appropriations are an important source of funding in some states, especially Maryland. In some states, poultry integrators have contributed substantially to program funding (i.e., Maryland and Arkansas). Program budgets range from a few hundred thousand dollars per year to as high as $1.5 million per year.

Program Structure

Most programs are administered by a government agency at the state level, such as the state NRCS office, the state soil and water conservation commission, the state department of agriculture, or the state environmental agency. These agencies work to coordinate the multiple entities involved in the market. Several have marketing websites and/or hotlines to support litter matching between buyers and sellers. In Oklahoma and Arkansas, BMPs Inc. provides for coordination and marketing by a non-profit entity.

Incentive Payments

The structure of incentive payments varies across the programs. Most programs pay the incentive to the end-user of the litter. However some pay the hauler or the sending operation. Most payments are directly tied to transport costs, with a rate based on mileage and load. However, some pay a per acre rate for the use of the litter to the end-user (e.g., Virginia). Table 1 summarizes the incentive payments from the programs reviewed.

Discussions with stakeholders and other program leaders reveal some cautiousness toward creating a dependence on subsidies. Clearly, the availability of subsidies helps programs to get off the ground and to support and extend regular operations. However, the concern about dependence on outside funding is valid. While the subsidy may be seen by some as providing a public good that would not otherwise be provided (i.e., increased water quality protection), others will argue that the water quality outcome should have been provided at no cost to taxpayers. The administrator of BMPs Inc. believes that her program could operate without subsidies, though within a limited range. However, her assessment may have changed with the recent increase in fuel costs.

It appears that subsidies are necessary at least to help these programs get started. Continued operations in most states appear, however, to depend at least in part, on public funds. Litter transfer in Pennsylvania is unique in that it is supported by nutrient trading. This initiative is reviewed in more detail in Section 3.3. This approach provides a sustainable, non-subsidy based funding for litter transfer.

Requirements

Nutrient management plans are commonly required for the litter recipient. Several states also have setback requirements for litter application from streams and property lines. Several also have soil testing requirements for applicators. Many states require that the sending farm provide a litter analysis.

Storage requirements are common, and most states require covered storage of litter that is held for more than a few days. Maryland is a notable exception. In Maryland, covered storage is not required, and the program administrator believes that this is important to the program's success. He said that Maryland's requirements for storage focus on location to prevent run-off.

Summary of Project Findings

Most litter transport subsidy programs in other states have been created in response to an event that stirs public concern (e.g., lawsuit, environmental issue). They are targeted toward water quality concerns. They seek to increase nutrient export from nutrient sensitive watersheds. Although these programs vary in the details of their design, they are all directed toward subsidizing transport costs and encouraging off-site use of poultry litter to address water quality concerns. Not all states with an interest in poultry litter export have transport subsidies. Some are focused solely on facilitating exchanges through telephone or web-based market makers.

All of the poultry litter transport subsidy programs are dependent upon public funds for their operation. The funding sources for other state subsidy transport programs vary, but federal funds are a part of the financing in all states with transport subsidies. The only state litter transport initiative that exists without direct public funding is in Pennsylvania, where a litter transport subsidy program does not exist, but instead, litter transport is supported through the state's nutrient trading initiative.

The programs in other states provide a model for a standard poultry litter transfer incentive. Program design is likely to focus on rate per ton per mile, limits on total payments, and requirements for litter handling, storage, and application. If fuel prices maintain current high levels or increase, many programs may need to increase incentive rates to maintain current levels of litter transfer. However, increased prices for commercial fertilizer may increase demand for litter as fertilizer and lessen the need for increased incentives.

Traditional litter transport subsidy programs provide for water quality, but it is unclear that they create a self-sustaining market. Alternative designs might be better able to provide for a self-sustaining market. The nutrient trading program in Pennsylvania, the dairy manure composting program in Texas, and the performance-based incentives in Vermont and Iowa should be considered as alternatives.

TABLE 3.1-1: Poultry Litter Transfer Incentives in Other States

Program	Incentive Payment	Conditions	Funding	Comments
Georgia Pilot Program (administered by NRCS)	$10 per ton (or farmer could opt for lower rate)	Incentive paid to farmer using litter; removal and application counties are identified and prioritized; storage and setback requirements for litter application; litter application based on P-index; litter must be hauled by state licensed Animal Manure Hauler	$248,000 from a specified state-level pool in 2006, $340,000 from local funds in 2007 (2-year contracts in 2007)	Practice still eligible for funding but no state-level funds are specified for this purpose. Local units can use regular EQIP funds for this incentive.
Alabama (administered by NRCS)	$2 per loaded mile	Mileage based on standard amounts set by county based on distance from general sending area (e.g., 50, 100, 150 miles); counties with surplus litter are excluded from subsidy as litter recipients.	$140,000 from EQIP in 2007	Program no longer receives specific funds but practice is an eligible for EQIP funding at local level.
Maryland Manure Transport Project (administered by Maryland	12 cents per mile per ton; 15 cents per mile per ton if litter originates in Lower Shore counties; $1.50 per	Maximum rate of $18.00 per ton	Varies $500,000 to $1,500,000 annually; funded by state appropriations, poultry integrators; previously funded in part by EPA	

Department of Agriculture)	ton for loading		319 grant	
West Virginia (administered by NRCS)	$2.50 per loaded mile for load of 15 tons or more; $1.70 per loaded mile for loads of 10 to 14.9 tons	Payment limited to 200 miles; must export from Shenandoah River watershed.	N/A	Program has ended
Virginia (administered by Virginia Department of Conservation and Recreation)	$5 to $12 per ton based on receiving county	Paid to broker or end-user; payment limited to 500 tons per request; Chesapeake Bay watershed counties cannot receive litter; sending counties are specified Chesapeake Bay watershed counties.	$600,000; funded by Virginia Department of Conservation and Recreation and Virginia Poultry Federation	
Virginia (administered by NRCS)	Average payment of $15 per acre on which litter is applied	Payments cannot exceed $3,000 per year; payment can extend up to three years		
Oklahoma State Tax Credit	$5 per ton of litter purchased and transported		$375,000 per year	
Oklahoma NRCS (EQIP)	Up to 13 cents per mile	Litter must originate in Scenic or Nutrient Limited watershed in AR or OK; must be applied in OK	$332,000 in FY2008	

		outside of those watersheds.		
Oklahoma Conservation Commission	3 cents per ton per mile	Maximum $8 per ton; must originate in Eucha-Spavinaw or Illinois River watersheds; can originate in AR or OK but mileage paid only from OK border; apply only outside of specified watersheds.	$300,000 in 2008	Expect rate to drop next year; overwhelming response in 2008; seeking additional federal funds.
Arkansas Surplus Nutrient Removal Incentive	5 cents per ton per mile	Maximum $15 per ton; paid to end-user; apply outside of specified watersheds.	Funding sources have included integrators, state, and EPA 319 funds.	
Arkansas NRCS Manure Transfer Program	$4 - $16 per ton based on mileage			

3.2 ECONOMIC ANALYSIS

The economic section of the project was designed to examine whether state intervention would be necessary to prevent over-application of poultry litter in counties with high phosphorous soils. A farmer survey was designed and administered to elicit information about poultry litter use and attitudes toward the Poultry Litter Transfer Pilot Program. In addition, a transportation model was developed to analyze market conditions for poultry litter used as a fertilizer.

Farmer Survey

The farmer survey addressed four general topics: experience with past poultry litter use; expectations about future poultry litter use; attitudes toward the Pilot Program; and perceptions about the attributes of poultry litter. Twenty attendees of the Perry Workshop completed the survey. In addition, 200 questionnaires were mailed to a randomly selected sample of farmers throughout the state. Of those, 53 were returned as undeliverable. Forty-seven completed questionnaires were returned, for a response rate of 32%. A copy of the questionnaire is provided in Appendix D.

Because the Perry workshop respondents were not a statistically random sample, their responses cannot be used in strict statistical analysis. Nonetheless, they are informative. Considering this, the results of the survey were compiled in two ways. First, the entire sample – both the Perry Workshop respondents and the mail respondents – were analyzed. Then the analysis was done with the mail respondents only. The results for each question are presented. In the tables below, FS is for the full sample, and MS is for the mail sample.

<u>Question 1: Past poultry litter use</u>

The first question addressed past poultry litter use. Those that have used litter in the past were also asked to provide information about the crops to which litter was applied, the application rate, the acreage to which litter was applied, and the timing of their litter acquisition. As expected, the Full Sample has a higher percentage of users of poultry litter, because nearly all of the attendees at the Perry Workshop had experience with poultry litter.

Used Poultry Litter?	Full Sample	Mail Sample Only
Yes	70%	64%
No	30%	36%

Table 3.2-1: Percent of respondents who have used litter in the past

Crop	% Using Litter		Mean Application Rate (tons/acre)		Mean Acreage	
	FS	MS	FS	MS	FS	MS
Corn	55%	62%	2.2	2.1	256	275
Cotton	38%	48%	2.1	2.1	837	657
Peanut	19%	28%	1.9	2	156	112
Soybean	9%	0%	2.1	0	324	0
Hay	51%	45%	2.3	2.2	88	79
Other	19%	14%	2.1	2	290	123

Table 3.2-2: Percent of respondents who applied litter, Average application rate, Average acreage receiving litter, by crop

Table 3.2-2 shows, for those who use litter, the percentage of respondents that apply litter to a particular crop. It also shows the mean application rate and the mean acreage for each sample. In general, the workshop attendees applied poultry litter at higher application rates and to larger acreages than the mail respondents. In both samples, corn, cotton, and hay were the primary crops to which litter was applied.

Table 3.2-3 addresses poultry litter timing. The data refer to the percentage of respondents who apply poultry litter to a given crop and acquire their litter for that crop in a given month. The final column shows the percentage of respondents who acquire litter in a given month, regardless of the crop to which it is applied. Figure 3.2-1 presents the all crops data visually.

What is evident from the data is that very few producers are acquiring litter in the summer months, and that is strictly for hay application. The first four months of the year is when most producers are acquiring their litter, although 10-17% are also acquiring litter in May and June as well as October through December.

Month	Corn		Cotton		Peanut		Soybean		Hay		Other		All Crops	
	FS	MS	FS	MS	FS	MS	FS	MS	FS	MS	FS	MS	FS	MS
January	15%	25%	39%	31%	11%	0%	33%	0%	8%	7%	0%	0%	21%	28%
February	46%	45%	33%	38%	33%	25%	33%	0%	29%	33%	22%	33%	34%	38%
March	38%	35%	22%	25%	33%	25%	33%	0%	38%	47%	0%	0%	36%	45%
April	12%	10%	50%	50%	11%	0%	33%	0%	25%	27%	0%	0%	26%	34%
May	12%	10%	28%	25%	11%	0%	33%	0%	17%	20%	0%	0%	13%	17%
June	12%	10%	28%	25%	11%	0%	67%	0%	21%	20%	0%	0%	17%	17%
July	4%	0%	6%	0%	11%	0%	33%	0%	17%	7%	0%	0%	9%	3%
August	4%	0%	6%	0%	11%	0%	33%	0%	8%	7%	0%	0%	6%	3%
September	4%	0%	6%	0%	11%	0%	67%	0%	8%	7%	11%	0%	9%	3%
October	12%	10%	11%	6%	33%	25%	67%	0%	8%	7%	44%	33%	15%	10%
November	12%	10%	17%	13%	11%	0%	67%	0%	13%	13%	33%	33%	15%	17%
December	12%	10%	28%	13%	33%	25%	33%	0%	13%	7%	0%	0%	15%	17%

Table 3.2-3: Percent of respondents acquiring poultry litter, by month and crop

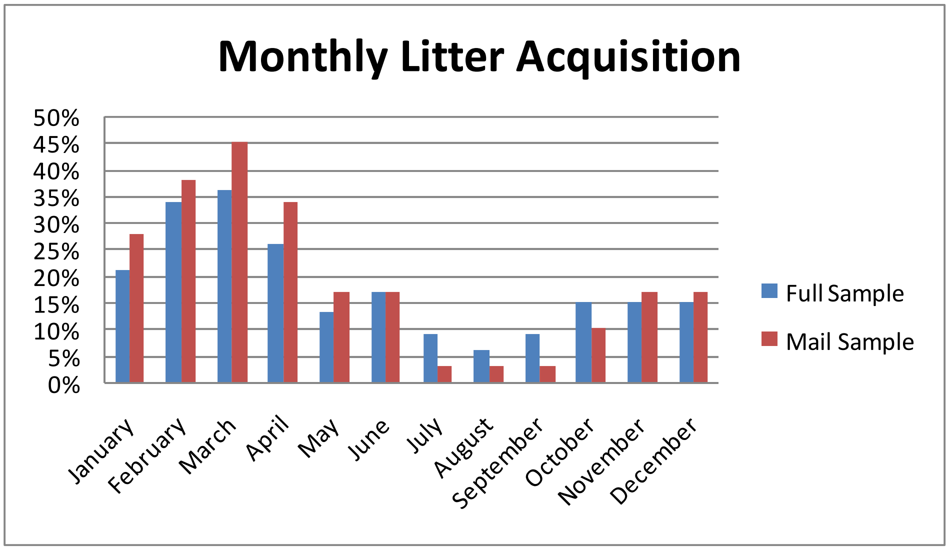


Figure 3.2-1: Month when producers acquired litter - for all crops

The large drop in litter acquisition during July, August and September suggests there may be storage issues related to litter use. However, 36% of the full sample respondents indicated they store litter after deliver, prior to application. Similarly, 32% of the mail sample also store litter. While these numbers are low, they are not insignificant, and there may be an opportunity to smooth out the timing of litter acquisition by promoting proper storage. Unfortunately, the survey did not ask about the length of time the litter is typically stored. As such, it is unclear how many producers are prepared to store litter over several months.

Figures 3.2-2 and 3.2-3 illustrate how litter is acquired by each sample. In the full sample there were a few respondents who either received litter for free or were paid to take litter from someone. However, all of these were attendees at the Perry Workshop. In the mail sample, litter was only acquired through direct purchase or by producing it oneself. In both samples, the great majority of respondents were paying for their litter.

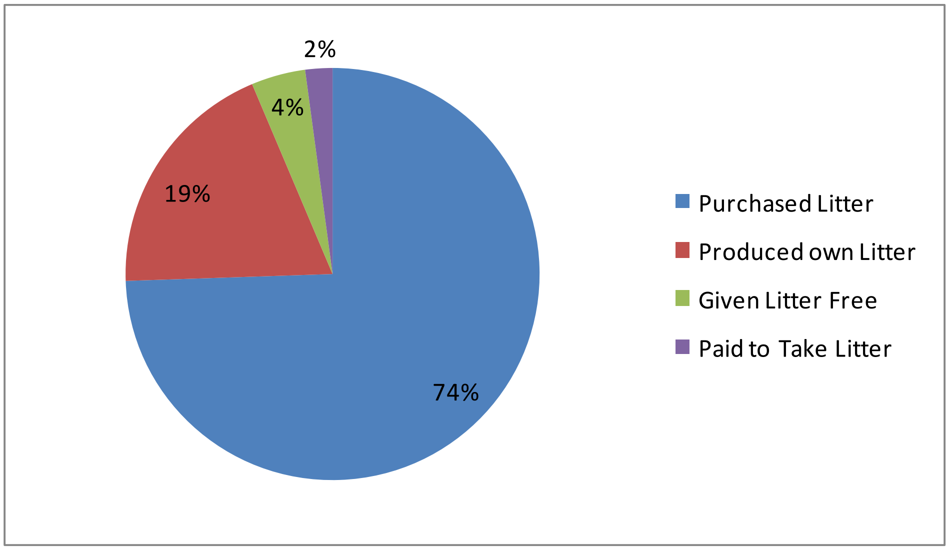


Figure 3.2-2: How litter was acquired- all surveys

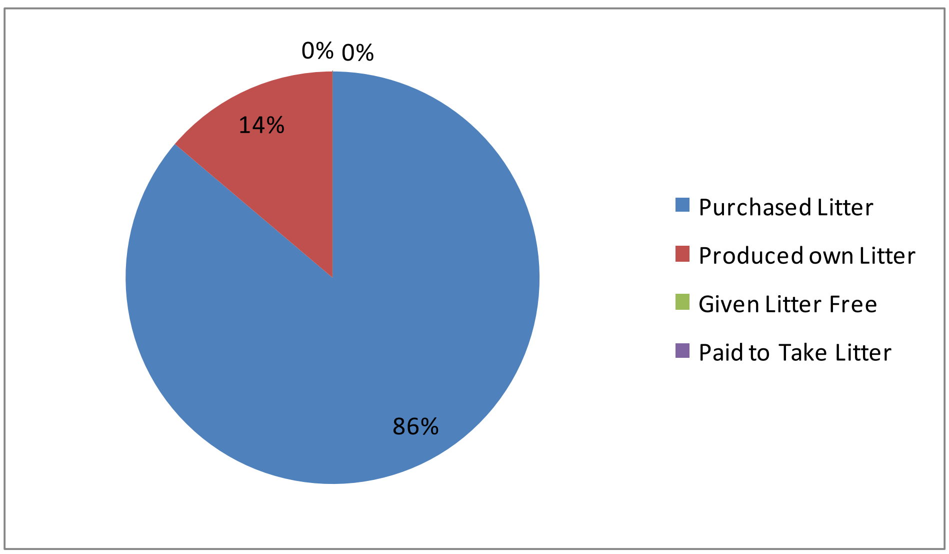


Figure 3.2-3: How litter was acquired- mailed surveys only

Respondents in both samples were asked the most they have paid per ton of litter. Because litter is often spread by the seller, some respondents included the cost of spreading in their response. These answers were identified by subsequent questions. Table 4 presents information on the price paid per ton of litter, both with and without spreading. The cost of spreading is also presented in table 3.2-4. More than half of the respondents to the Full Sample paid between $8 and $10 per ton of litter, without spreading. The distribution for the mail sample was slightly higher, with half of the respondents paying between $10 and $12 per ton, without spreading.

	Litter $/Ton Without Spreading		Litter $/Ton With Spreading		Spreading $/Ton		Spreading $/Acre	
	FS	MS	FS	MS	FS	MS	FS	MS
Mean	$13.44	$15.00	$20.77	$23.00	$ 7.00	$ 6.68	$ 9.21	$10.67
Median	$10.00	$12.00	$20.00	$24.00	$ 7.00	$ 7.00	$10.00	$10.00
Max	$27.00	$27.00	$35.00	$35.00	$15.00	$10.00	$15.00	$15.00
Min	$ 8.00	$10.00	$ 7.00	$ 7.00	$ 4.00	$ 5.00	$ 3.00	$ 6.00

Table 3.2-4: Prices paid for litter and spreading

The Mail Sample asked respondents to identify both the maximum they would be willing to pay for a ton of litter (spread and not spread). They were also asked what they considered a "fair" price for litter per ton of litter, and for spreading. Table 3.2-5 shows the results from these questions. What these data show is that both mean maximum willingness to pay and the mean fair price for litter are considerably higher than the mean price paid. In fact, with the mail survey responses we can test for statistically significant differences in these variables.

Paired t-tests between price paid and both willingness to pay and "fair" price reject the hypothesis of equivalent means at a p-value of 0.007 and 0.0006, respectively. In other words, there is strong evidence supporting the hypothesis that the average willingness to pay and the average fair price are higher than the average amount paid for a ton of poultry litter. This suggests that the value of poultry litter is higher than the current market price. This phenomenon does not happen in well-functioning markets. One way to correct this distortion is to enable potential buyers and sellers to exchange information more readily. The poultry litter exchange website is an excellent forum for this. Encouraging its use should be a priority for those interested in a well-functioning litter market.

	Maximum Willingness to Pay ($/Ton)		Fair Price for Litter ($/Ton)	Fair Price for Spreading ($/Ton)
	Without Spreading	With Spreading		
Mean	$ 26.92	$ 37.27	$ 24.44	$ 8.23
Median	$ 22.50	$ 25.00	$ 25.00	$ 7.50
Max	$ 45.00	$ 45.00	$ 40.00	$ 20.00
Min	$ 10.00	$ 10.00	$ 10.00	$ 5.00

Table 3.2-5: Maximum willingness to pay and the fair price for litter

There is no significant difference between the mean willingness to pay and the mean fair price. In the Mail Sample 27% of respondents spread their own litter, while 34% of the Full Sample spread it themselves. What was of particular surprise is that only 77% of the Mail Sample reported testing the nutrient content of the litter they use. For the Full Sample only 66% reported testing. This suggests that, despite the requirement that all poultry litter sold must be tested, between one quarter and one third of those applying litter are either unaware of the results of the test, or the test was not conducted for a considerable portion of litter sold. Here again, is another opportunity for the poultry litter exchange website – increasing awareness of requirements of litter use, increasing knowledge about the nutrient content of litter, and creating a forum in which market transactions can account for variation in nutrients.

As expected, over 90% of respondents in both samples reduced commercial nitrogen and phosphorous applications when using poultry litter.

Poultry litter is generally used close to its point of production. The Mail Sample answered questions about the maximum distance from the point of application poultry litter was acquired, as well as the typical distance. On average, the maximum distance traveled was 77 miles, and the typical distance was 33 miles.

Figure 3.2-4 illustrates the distribution, by miles, of the responses to these two questions. The distributions show that 85% of respondents typically receive litter that is produced within 50 miles of the point of application. Respondents did, however, did on occasion acquire litter from further away; two thirds reported acquiring litter from more than 75 miles away. The furthest distance reported was 150 miles. These data suggest those using poultry litter are willing to search significant distances for it. Again, the poultry litter exchange website could serve a valuable function by connecting potential buyer and sellers who are geographically far apart.

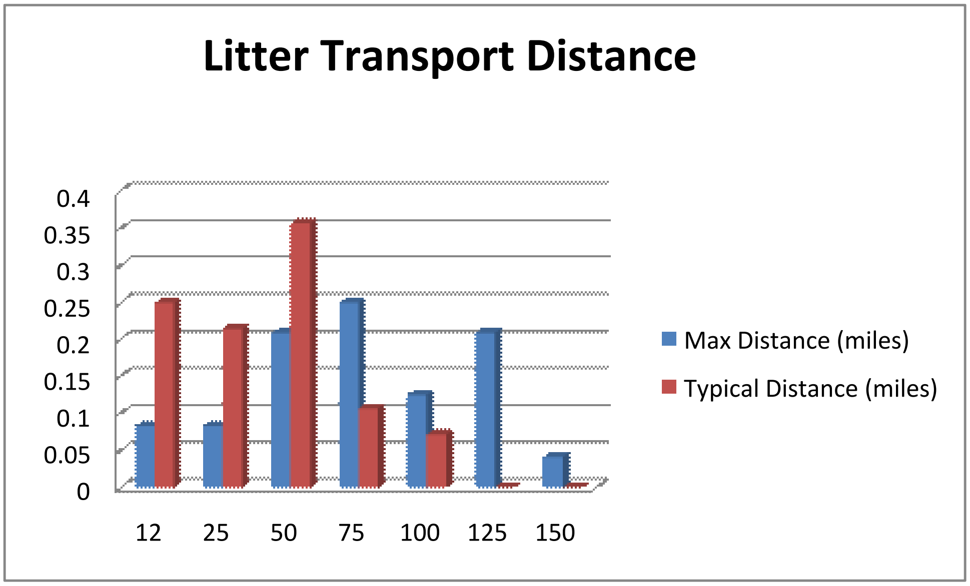


Figure 3.2-4: Distribution of the distance litter travels prior to application

The last two sections of the mail survey focused on attributes of poultry litter and general fertilizer decisions. Respondents were asked how strongly they agree with a statement. The scale used was 1 through 5, with 1 representing strong disagreement and 5 representing strong agreement. Tables 3.2-6 and 3.2-7 present the mean results from these sections. Mean values over 3 show agreement with the statement, while values less than 3 show disagreement.

Among the positive attributes of poultry litter, respondents agreed that it enhances soil organic matter, contains valuable micronutrients, and increases soil moisture retention. However, respondents also agreed that litter is difficult to acquire, varies from load to load, and is difficult to apply. The data also show, yet again, that respondents do not feel poultry litter is priced too high. Given the survey results, a program designed to address the negative aspects of using poultry litter seems to more appropriate than one designed to lower the cost of using litter.

Statement	Mean Score
Poultry litter enhances soil organic matter	4.23[a]
Poulty litter is difficult to acquire	3.95[a, b]
Poultry Litter nutrient content varies a lot from load to load	3.83[b, c]
Poultry litter adds valuable micronutrients in addition to N, P, and K	3.63[b, c, d]
Poultry litter increases soil moisture retention	3.43[c, d, e]
Poultry Litter is difficult to apply	3.26[d, e]
If I could acquire poultry litter at a fair price, I would **only** use poultry litter for my crops' phophorus needs	3.2[d, e]
It is easy to determine the best time to apply poultry litter	3[e, f]
Poultry litter costs more than it is worth	2.8[f]
If I could acquire poultry litter at a fair price, I would **only** use poultry litter for my crops' nitrogen needs	2.75[f]

Table 3.2-6: Perceptions of poultry litter attributes (1=Strongly Disagree, 5=Strongly Agree)
(NOTE: Statements whose mean value has the same letter superscript are not statistically different from each other, at a 5% significance level.)

Table 3.2-7 shows how important different factors are to fertilizer application decisions. The primary result from these data is that nitrogen, phosphorous, and commodity prices play an important role in fertilizer application decisions. This suggests that, if commercial fertilizer commodity prices remain high, the demand for poultry litter is likely to increase.

Factor	Mean
Results of a plant or soil nutrient test	4.70[a]
Cost of Nitrogen	4.52[a, b]
Cost of Phosphorus	4.48[a, b]
Expected Commodity Price	4.35[b]
Extension Service Recommendation	4.30[b]
Routine Practice (own determination based on past experience)	4.26[b]
Crop Consultant Recommendation	3.43[c]
Fertilizer Dealer Recommendation	3.17[c]

Table 3.2-7: Importance of factors in fertilizer application decision (1=Not At All Important, 5=Very Important)
(NOTE: Statements whose mean value has the same letter superscript are not statistically different from each other, at a 5% significance level.)

Poultry Litter Transport Model

The model presented below minimizes the cost of meeting plant nutrient needs. The unit of analysis is the county. Seven crops are considered: corn, cotton, wheat, hay and pasture[3], peanuts, and soybeans. The general form of the model is described in equation 1.

$$(1) \qquad \underset{F}{Min} \sum_j \sum_i \sum_C \sum_F \begin{pmatrix} P_F * Fert_{F,C,i} + A_F * Fert_{F,C,i} + P_{BL} * BL_{C,i,j} \\ + A_{BL} * BL_{BL,C,i,j} + T_{BL,i,j} * L_{BL,,C,i,j} + P_{Lime} * Lime_{i,C} \end{pmatrix}$$

where P_F is the price per ton of commercial fertilizer F;

$Fert_{F, C, i}$ is the number of tons of commercial fertilizer F applied to crop C in county i;

A_F is the application cost per ton of commercial fertilizer F;

P_{BL} is the price per ton of boiler litter;

$BL_{C,i,j}$ is the number of tons of broiler litter applied to crop C in county i, received from county j;

A_{BL} is the application cost per ton of broiler litter;

$L_{BL,C,i,j}$ is the number of loads of broiler litter received by county i from county j for crop C;

$T_{BL,i, j}$ is the cost of transporting a load of broiler litter from county j to county i;

P_{Lime} is the price per ton of lime, including the cost of applying it to the field;

$Lime_{i,C}$ is the number of tons of lime applied to crop C in county i.

[3] For counties located in the Coastal Plain, hay and pasture are assumed to be planted to Coastal Bermuda hay; counties outside the Coastal Plain are assumed to plant fescue clover on their hay and pasture land.

Equation 1 is minimized subject to constraints 1.1 through 1.6.

(1.1) $$\sum_{i}\sum_{C} BL_{C,i,j} \leq BL_{TOTAL,j} \forall j$$

(1.2) $$\sum_{j}\sum_{F} Fert_{F,C,i} N_{F} + BL_{C,i,j} * N_{BL} \geq N_{REQ,i,C} \forall i, C$$

(1.3) $$\sum_{j}\sum_{F} Fert_{F,C,i} Ph_{F} + BL_{C,i,j} * Ph_{BL} = Ph_{REQ,i,C} \forall i, C$$

(1.4) $$\sum_{j}\sum_{F} Fert_{F,C,i} K_{F} + BL_{C,i,j} * K_{BL} \geq K_{REQ,i,C} \forall i, C$$

(1.5) $$Lime_{C,i} + BL_{C,i,} \geq Lime_{REQ,i,C} \forall i, C$$

(1.6) $$T_{BL,i,j} = Dist_{i,j} * G_{BL} \forall i, j$$

(1.7) $$BL_{C,i,j}, Fert_{F,C,i}, Lime_{C,i} \geq 0 \forall C, F, i, j$$

where $BL_{TOTAL,j}$ is the amount of broiler litter produced in county j;

N_F is the proportion of fertilizer F that is nitrogen and available to the plant;

N_{BL} is the proportion of broiler litter that is nitrogen and available to the plant;

$N_{REQ,C,i}$ is the number of tons of nitrogen required for crop i in county C;

Ph_F is the proportion of fertilizer F that is phosphorous and available to the plant;

Ph_{BL} is the proportion of broiler litter that is phosphorous and available to the plant;

$Ph_{REQ, C, i}$ is the number of tons of phosphorous required for crop i in county C;

K_F is the proportion of fertilizer F that is potassium and available to the plant;

K_{BL} is the proportion of broiler litter that is potassium and available to the plant;

$K_{REQ, C, i}$ is the number of tons of potassium required for crop i in county C;

$Lime_{REQ, i, C}$ is the number of tons of lime required for crop i in county C;

$Dist_{i, j}$ is the distance, in miles, between the geometric center of county i and the geometric center of county j;

G_{BL} is the transportation cost per mile for a load of broiler litter.

The constraints represent physical relationships between the model variables, and can be interpreted as follows:

(1.1) The total amount of broiler litter transported out of a county cannot exceed the total amount of broiler litter produced in that county;
(1.2) The total amount of nitrogen applied to a crop in a given county, from all fertilizer sources, must meet, but can exceed, the total amount of nitrogen required by that crop in that county;
(1.3) The total amount of phosphorous applied to a crop in a given county, from all fertilizer sources, must exactly meet, and cannot exceed, the total amount of phosphorous required by that crop in that county;
(1.4) The total amount of potassium applied to a crop in a given county, from all fertilizer sources, must meet, but can exceed, the total amount of potassium required by that crop in that county;
(1.5) The total amount of lime applied to a crop in a given county, from all liming sources, must meet, but can exceed, the total amount of lime required by that crop in that county;
(1.6) The transportation costs per load of broiler litter between counties i and j are equal to the distance between the counties times the per mile cost of transporting a load of litter[4];
(1.7) One cannot apply negative amounts of any fertilizer.

[4] The model implicitly ignores the cost of transporting litter within a county.

The model parameters and constraints can be adjusted to investigate a number scenarios related to the value of poultry litter and the level of subsidy required to ensure poultry litter is removed from the 17 counties with excessive soil phosphorous.

Setting the Parameter Values

The starting values for each of the model parameters are based on published data, or rely on sets of assumptions.

Broiler Litter Production

The annual amount of broiler litter produced in each county depends on the number of broilers raised per year. Each broiler generates 2.5 pounds of litter and grows to an average of 6.6 pounds (Vest, Dyer, and Segars, 1994). To estimate the number of broilers produced in each county, the 2007 NASS estimates of the pounds of broilers produced are divided by 6.6 pounds/broiler. Multiplying by 2.5 pounds of litter/broiler results in the total pounds of litter, which is then converted to tons.

Crop Nutrient Requirements

The total requirement, in pounds, of each nutrient for each crop in each county depends on the number of acres grown and the per-acre crop nutrient requirement. County level crop acreages for all crops except pasture are set to the 2007 harvested acres reported by the United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS), and can be found at http://www.georgiastats.uga.edu/crossection.html.

Because NASS does not report pasture acreage, it had to be calculated for each county. NASS does report county level beef cattle, stocker, and dairy cattle numbers, which can also be found at http://www.georgiastats.uga.edu/crossection.html. As in Risse and Kissel's phosphorous index calculation [MARK OR DAVE, DO YOU HAVE A REFERENCE FOR THIS?], the acreage of pasture land in a county depends on the number of cows. Each beef cow is assumed to require 2.6 acres of pasture, while stockers and dairy cows each require 1.5 acres and 0.5 acres, respectively.

Nitrogen. Georgia Extension Service recommendations serve as the basis for setting the per acre nitrogen requirements for each crop. Peanuts and soybeans are nitrogen-fixing legumes that do not require additional nitrogen. As such, the nitrogen requirement for those crops is 0 pounds per acre. Wheat nitrogen requirements are assumed to be 90 pounds per acre for all counties. Corn and cotton nitrogen needs are based on production targets.

For corn, 180 pounds of N/acre are recommended for all production targets less than or equal to 180 bushels/acre. An additional 1.2 pounds N/acre is required for each bushel over 180. Production targets for each county are based on the county's 2007 average yield/acre, as reported by NASS.

For cotton, 60 pounds N/acre are recommended for the all production targets less than 875 pounds lint per acre. Production targets between 875 and 1125 pounds lint per acre require 75 pounds N/acre. Targets between 1125 and 1375 pounds lint/acre require 90 pounds of N, while targets above 1375 pounds lint/acre require 105 pounds N/acre. As with corn, production targets for each county are based on the county's 2007 average yield/acre reported by NASS.

Nitrogen is recommended to be applied in two separate applications for all of the row crops. The first application, about 1/3 of the total N recommended, should occur before or during planting; the after plant emergence, the remaining 2/3 of recommended N should be applied. Because poultry litter cannot be applied after plant emergence, the model accounts only for the first nitrogen application.

Hay and pasture nitrogen recommendations depend on the grass grown. For Coastal Plain counties growing Coastal Bermuda hay and pasture, the requirement is 300 pounds N/acre/year. Counties located outside the Coastal Plain growing fescue clover require 200 pounds of N/acre/year. All of the nitrogen for hay and pasture can come from broiler litter, and is applied after each cutting.

<u>Phosphorous and Potassium.</u> Phosphorous and potassium recommendations depend on soil test P and K levels for all of the crops considered in the model. Results from soil tests conducted in 2006 and 2007 by the University of Georgia Soil Test Laboratory were averaged, by county and crop, to estimate the amount of phosphorous and potassium in a typical acre growing a given crop in a given county. If soil test levels exceed a threshold, no phosphorous (potassium) is recommended. Below that threshold, a quadratic equation is used to determine the phosphorous (potassium) application recommendation. Both the thresholds and the quadratic equations are crop specific and depend on whether the field is located in Coastal Plain or not. For cotton, P and K recommendations also depend on target production levels. The threshold soil test P and K levels and the quadratic equations used to generate the P and K recommendations are presented in the Appendix E.

Two counties, Chattahoochee and Taliaferro, did not have soil test data for 2006 and 2007. To develop the P and K recommendations for these counties, the soil test levels of their contiguous neighbors were averaged.

Lime. Lime recommendations were dichotomous – either a field needed lime or did not. For those needing lime, an application rate of 0.75 tons of dolomitic lime per acre was used. It was further assumed that, pound for pound, poultry litter provides the same liming function as dolomitic lime. To estimate the total amount of lime by crop and county, soil test results for 2006 and 2007 were used. The number of acres planted to a given crop was multiplied by the proportion of soil tests requiring lime in each county, and then multiplied by the application rate (0.75 tons/acre).

Fertilizer Considerations

Eight commercial fertilizers, plus broiler litter and dolomitic lime were incorporated into the model. The nitrogen fertilizers included ammonium nitrate, ammonium sulfate, nitrogen solutions, and urea. Phosphorous fertilizers were diammonium phosphate and potassium polyphosphate. The potassium fertilizers were potassium chloride (muriate) and potassium magnesium sulfate (SPM).

Prices and Application Costs. Commercial fertilizer prices used in the model were those reported by NASS for the southeast region. Prices for 2006-2008 are presented in the Appendix F. The price of poultry litter was initially set to $10/ton, the median value from the Full Sample survey.

Application costs were assumed to be $9.50/ton of commercial fertilizer. In the model, liquid fertilizers are able to be mixed, as were dry fertilizers. The cost of application included delivery. These decisions were based on conversations with Jake Redman and Bill Segers, local fertilizer experts.

Poultry litter, on the other hand, had to be applied alone. The cost of applying poultry litter was set to $7.00/ton, the median value from the Full Sample survey. This application cost did not include delivery.

Based on conversations with litter transporters, the cost of transporting a 25-ton load of litter was set to $1.91/mile. While the model will accommodate partial loads, the transportation costs for a partial load are the same as those for a full load. The distance between each county was measured in ARC GIS.

Broiler Litter Nutrient Content. The average nutrient levels in broiler litter reported by North Carolina State University Department of Biological and Agricultural Engineering were used as estimates for nutrient content of broiler litter in Georgia. Each ton of broiler litter was assumed to contain 64 pounds of N, 54 pounds of P, and 48 pounds of K, with 60%, 90%, and 100%, respectively, available to the plant.

Model Scenarios

The model can examine a multitude of questions about the spatial demand for poultry litter as a fertilizer by adjusting the model parameters and constraints. Three scenarios were built and analyzed for this project.

Scenario I: No transportation, P equality

This scenario is designed to identify counties with excess poultry litter when nutrient application rates are based on phosphorous requirements. Transportation of litter out of a county is not allowed, which allows the model to calculate excess litter per county. Constraints 1.1 through 1.7 are set as described above. In particular, phosphorous applications must meet crop requirements, but cannot exceed them.

In addition to identifying counties with excess litter under a P-based fertilizer regime, Scenario I also calculates a shadow price for poultry litter for each county. Shadow prices represent the change in the objective function (equation 1) due to a marginal change in the limiting value of a constraint. The shadow price associated with constraint 1.1 in a given county represents how much the total fertilizer costs for the county would fall if the county had an additional ton of poultry litter. In other words, the shadow price on constraint 1.1 for county i represents the price producers in county i would be willing to pay for an additional ton of poultry litter. Obviously, in counties with excess poultry litter, the shadow price would be zero – they already have more than they can use, so they would not be willing to pay for more. These counties are potential sellers of poultry litter. Counties with a non-zero shadow price are potential buyers.

Scenario II: No transportation, P inequality

Here, phosphorous applications must meet, but are allowed to exceed, crop requirements. This is accomplished by changing constraint 1.3 from an equality constraint to a greater than or equal to constraint, as in equation 1.3a. Producers may choose the mix of commercial fertilizer and poultry litter that minimizes their nutrient costs without paying special attention to phosphorous.

(1.3a) $$\sum_j \sum_F Fert_{F,C,i} Ph_F + BL_{C,i,j} * Ph_{BL} \geq Ph_{REQ,i,C} \forall i, C$$

Again, transportation of litter out of a county is not allowed.

Comparing Scenarios I and II generates an estimate of the cost of adhering to a P-based fertilizer regime. Scenario I solves equation 1 under a P-based regime, selecting the fertilizer mix for each crop in each county, and calculating the costs. Scenario II does the same thing, but relaxes the phosphorous constraint. Because poultry litter is the cheapest source of nitrogen, the model chooses it to meet the nitrogen requirement. Litter, however, also contains phosphorous.

Under Scenario I, producers must stop applying litter and switch to a commercial nitrogen fertilizer once the phosphorous requirement is met. Scenario II allows producers to continue to apply litter after the phosphorous requirement is met. Here, the model continues to choose poultry litter as a nitrogen source as long as the cost of acquiring and applying it is cheaper than other sources of nitrogen, regardless of the phosphorous issue.

Subtracting the total cost of meeting a county's nutrient requirements under Scenario II from the cost in Scenario I equals the cost of the P-based application requirement. That is, it is equal to the extra fertilizer costs producers incur when a P-based application rate is in effect. There are several ways to interpret this value. It could be considered the cost to producers from historic over-application of phosphorous. Alternatively, it could be seen as the cost imposed on crop producers by P-based regulations. It can also be interpreted as the minimum compensation needed persuade producers to abide by a P-based fertilizer regime. Under this last interpretation, a minimum selling price for poultry litter could be estimated by dividing the cost differential between Scenario I and II by the difference in excess litter between the two scenarios. This is represented by equation 2.

(2) $$MWTA_{BL,i} = \frac{(Cost_{i,I} - Cost_{i,II})}{((BL_{TOTAL,i} - \sum_C BL_{C,i,I}) - (BL_{TOTAL,i} - \sum_C BL_{C,i,II}))}$$

where $MWTA_{BL,i}$ is, for producers in county i, the minimum willingness to accept ($/ton) for a ton of broiler litter;

$Cost_{i,I}$ is the total cost of meeting fertilizer requirements in county i under Scenario I;

$Cost_{i,II}$ is the total cost of meeting fertilizer requirements in county i under Scenario II;

$BL_{TOTAL,i}$ is the total amount of broiler litter (tons) produced in county i;

$BL_{C,i,I}$ is the amount of broiler litter (tons) applied to crop C in county i under Scenario I;

$BL_{C,i,II}$ is the amount of broiler litter (tons) applied to crop C in county i under Scenario II.

This estimate can be generated for each county to illustrate the spatial dimension of the poultry litter market.

Scenario III: Transportation, P equality

Scenario III opens up the market to litter transport, under a P-based fertilizer regime. That is, the counties with excess litter in Scenario I are now able to sell it, and the counties with non-zero shadow prices for litter are now able to buy it. The model tracks the exchange of litter between counties and identifies which counties, if any, continue to have excess litter after all exchanges are completed. It also identifies which counties continue to demand litter (those with a non-zero shadow price) after all exchanges have been completed.

If the 17 target counties from the Poultry Litter Pilot Program continue to have excess litter under current market conditions in Scenario III, that would suggest the need for financial support or regulatory mandates to remove it. In other words, under current market conditions, buyers would be unwilling to compensate the sellers in these 17 counties enough to cover their increased expenditures on commercial fertilizer.

However, if those counties are able to sell all of their excess litter in Scenario III, the case for financial support would be undermined. Rather, the preferred policy would be to encourage the application of a P-based fertilizer regime and facilitate the market exchange of litter.

Results

County level broiler production is illustrated in Figure 3.2-5. It is worth noting that, while the bulk of broilers are grown in the Piedmont, there is considerable production in throughout the state.

Maps of corn, cotton, wheat, hay and pasture, peanut, and soybean acreage by county for 2007 are presented in the Appendix G. Cotton production is located primarily in the southwest of the state, an area with low levels of poultry production and generally low levels of soil phosphorous. Corn and wheat acreage drifts a bit north of the cotton acres, with a fair amount of each located in the heavy poultry producing Piedmont counties. The hay and pasture acreages are dispersed fairly evenly throughout the state.

Scenario I

As expected, the 17 target counties from the Pilot Program all had large amounts of excess litter under this scenario. There are, however, many counties with excess litter throughout the central and southeastern parts of the state. Figure 3.2-6 illustrates the excess litter in each county.

This scenario was run separately with fertilizer prices from 2006, 2007, and 2008. Over this period the price of nitrogen fertilizers rose by 49% on average, potassium chloride (muriate) rose by 78%, and the phosphate fertilizers more than doubled, rising by an average of 125%. These are strikingly high increases, and they have direct implications for the market value of litter. As explained above, the shadow price of broiler litter in the model reflects the marginal value of litter as a substitute for fertilizers. As such, it serves as an estimate of the maximum amount a producer would be willing to pay for a ton of litter, including transportation costs. Figures 3.2-7 through 3.2-9 show the shadow price for litter under each year's fertilizer prices.

What is important to note is that there is a spatial dimension to the shadow prices. The value of an additional ton of litter in a given county depends on the crops grown, the amount of litter produced in that county, and the price of other fertilizers. There is no single "value of litter." With 2006 fertilizer prices, the shadow prices ranged from $11/ton to $60/ton in the "buyer" counties – those without excess litter. (The shadow price in the counties with excess litter, the "seller" counties, is zero.) With 2007 fertilizers prices the shadow prices rise to a range of $21/ton to $70/ton. When fertilizer prices are at 2008 levels, the shadow prices jump to between $50/ton and $100/ton.

It is interesting to note that the survey results concerning crop producers' willingness to pay per ton of litter (mean of $27 and a maximum of $45) fall squarely in the 2006 range of shadow prices. These values are higher than what crop producers have been paying (mean of $13 and a maximum of $27). This suggests that they realize the increased value of litter as fertilizer prices rise. The willingness to pay, however, is still below the 2008 shadow prices, which may reflect some "stickiness" in the perception of the value of litter. If fertilizer prices remain at current levels, the actual prices paid for litter may very well gravitate to the 2008 shadow prices. In a well functioning litter market, that is exactly what would be expected to happen.

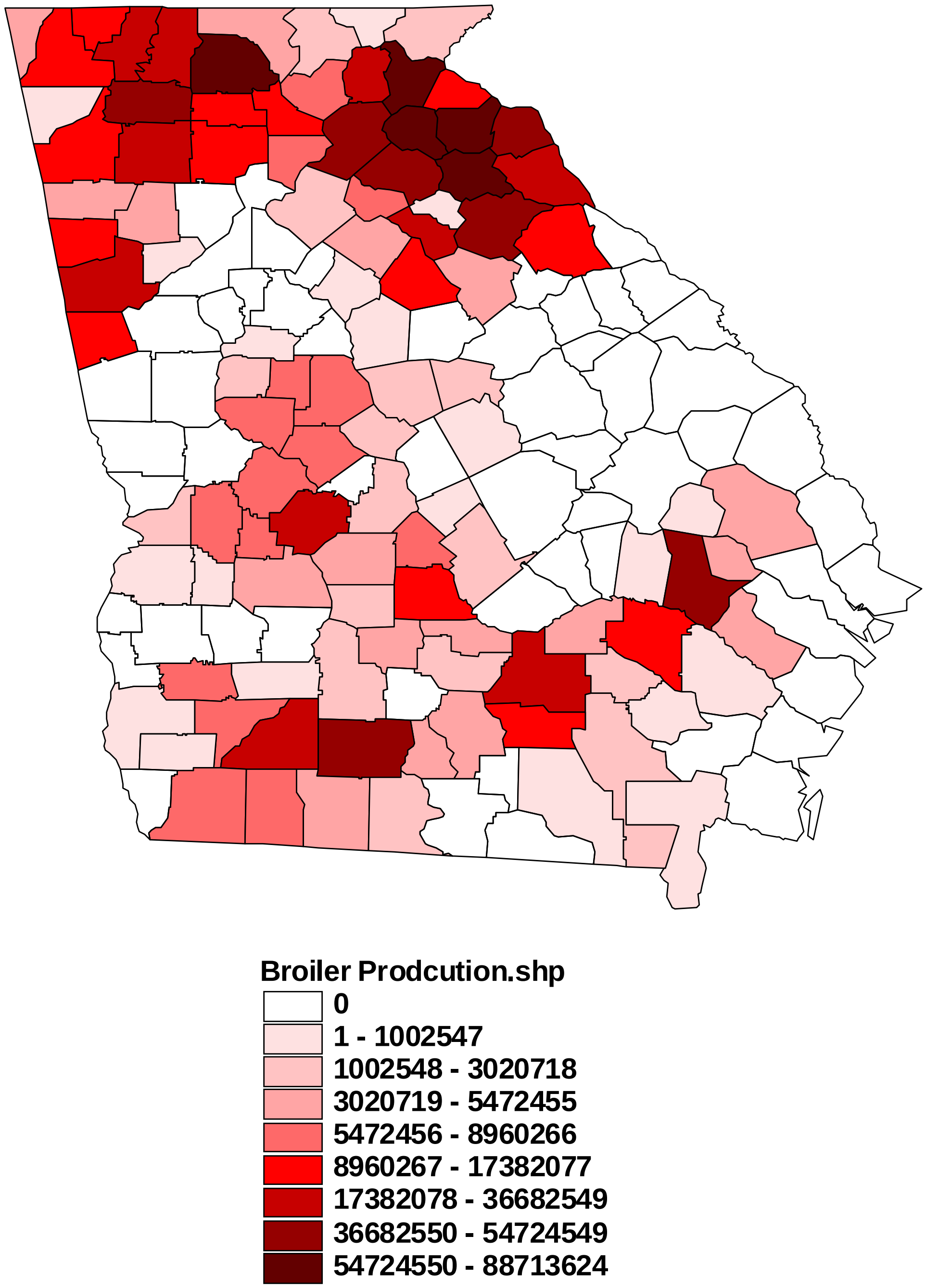


Figure 3.2-5: 2007 Broiler Production by County (# of Birds)

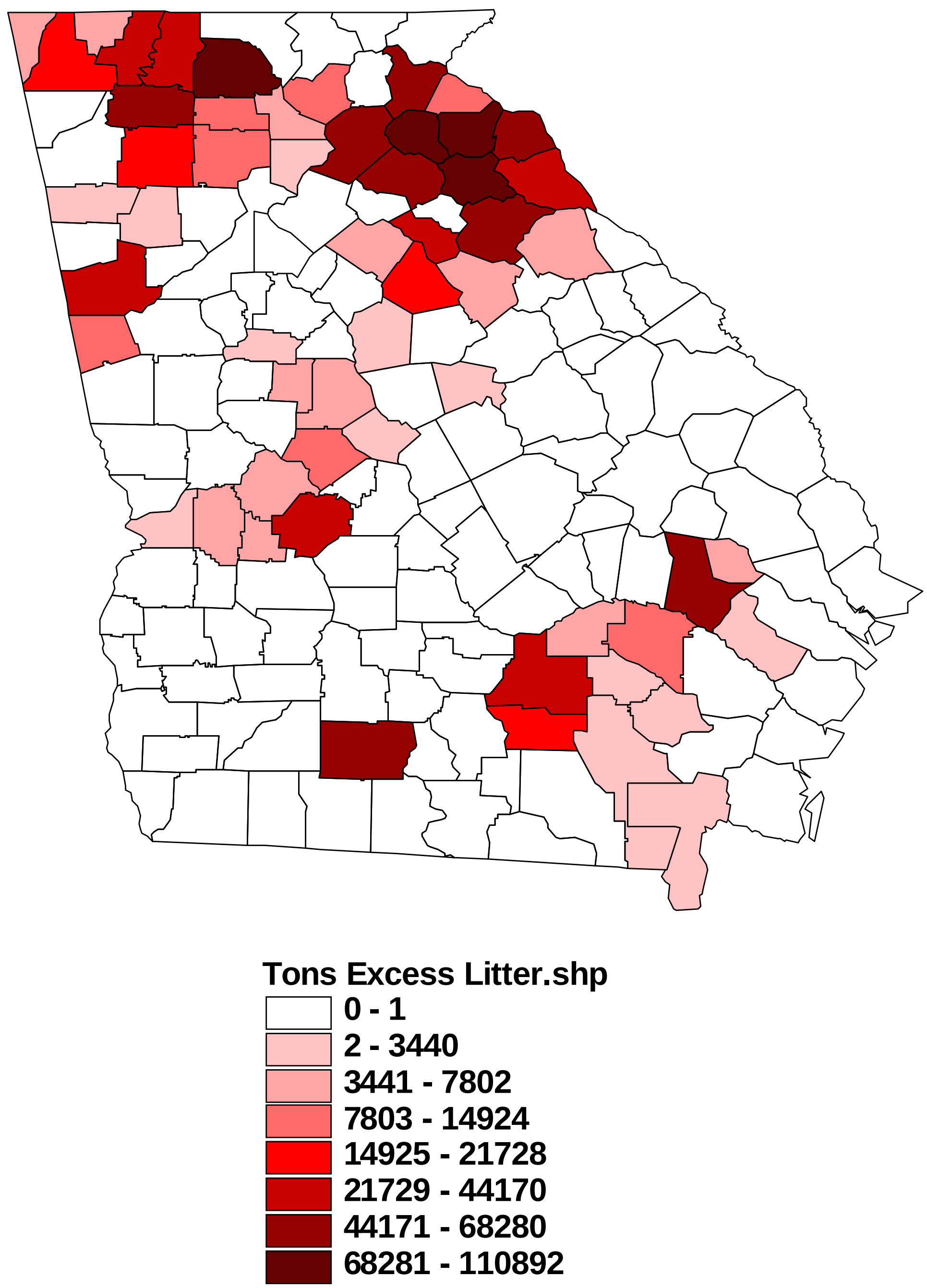


Figure 3.2-6: Tons of Excess Litter, Scenario I

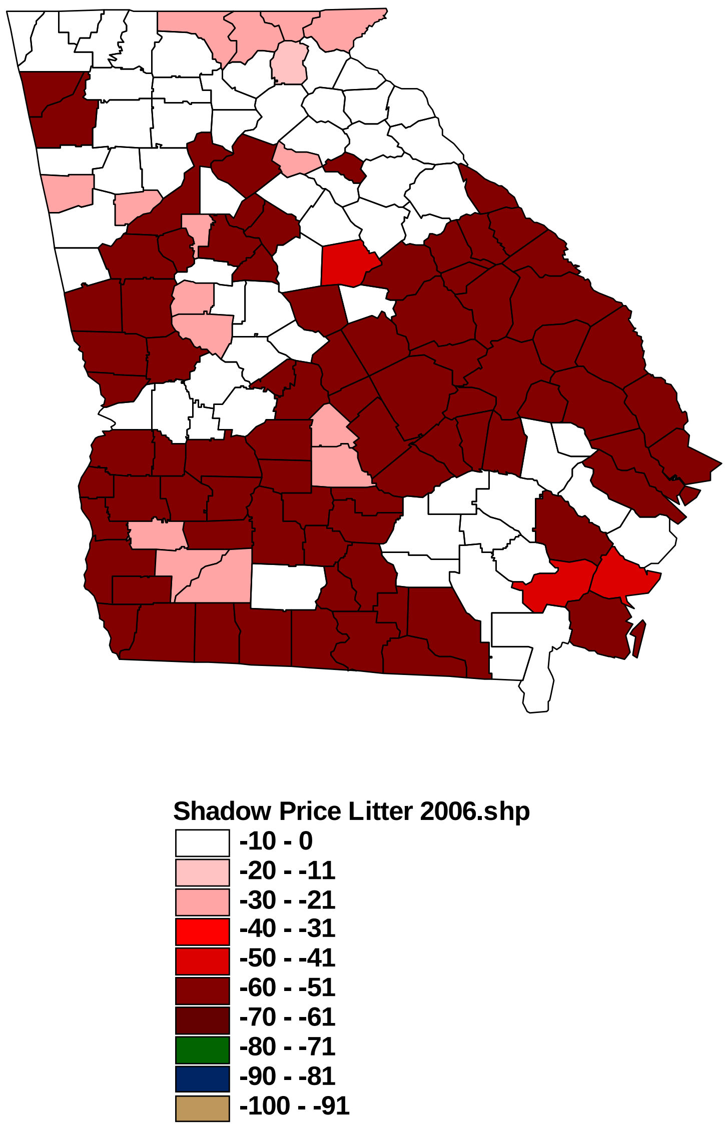


Figure 3.2-7: Scenario I Shadow Price of Litter, 2006 Fertilizer Prices

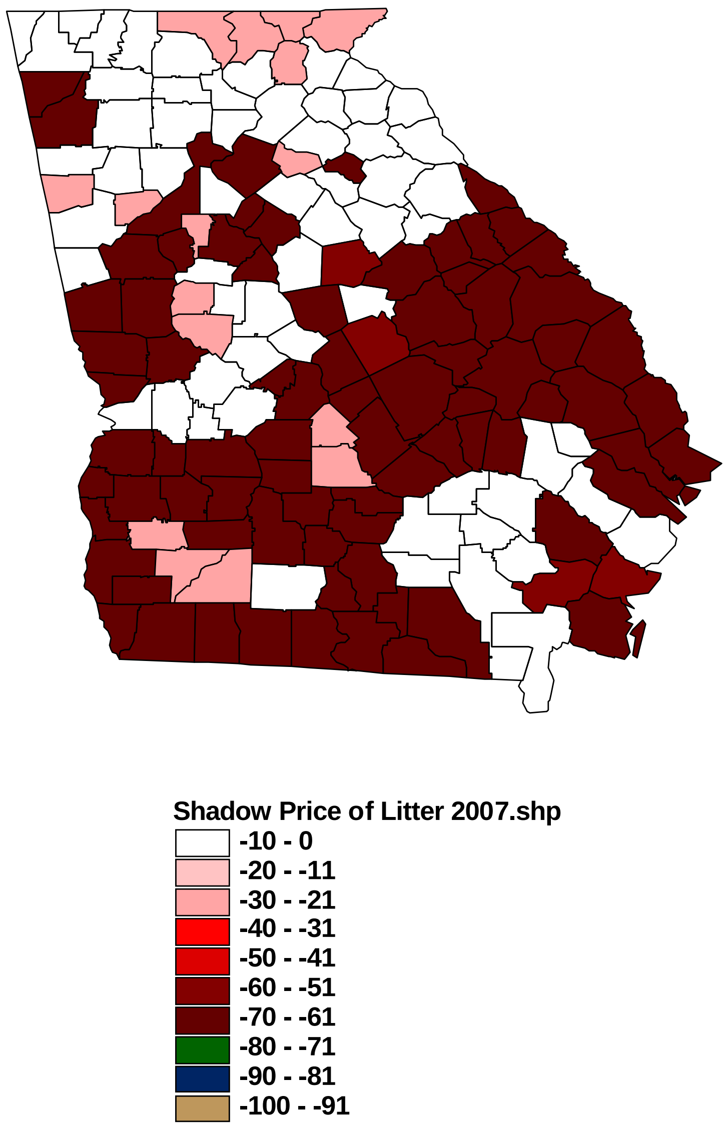


Figure 3.2-8: Scenario I Shadow Price of Litter, 2007 Fertilizer Prices

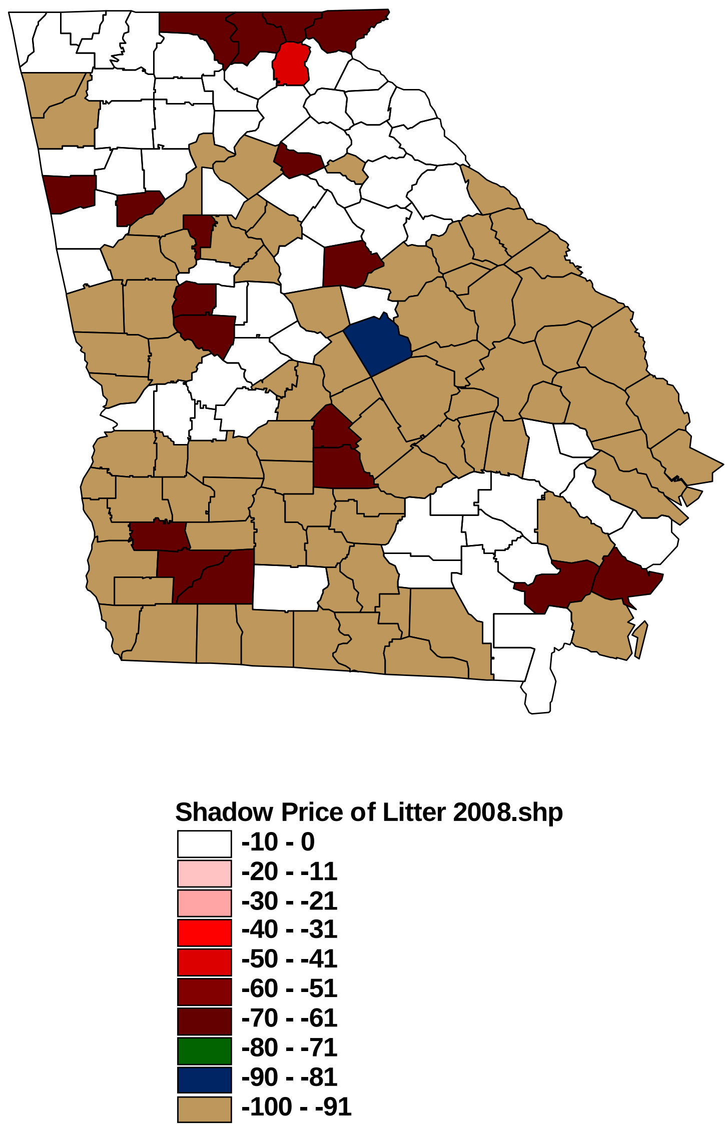


Figure 3.2-9: Scenario I Shadow Price of Litter, 2008 Fertilizer Prices

Scenario II

In the 17 target counties the cost of meeting crop nutrient needs under Scenario I was $31.2M. When the phosphorous constraint is relaxed in Scenario II the cost drops to $18M. Table 3.2-8 shows how the $13.2 million in additional costs are distributed across the 17 target counties. Also shown in the table, by county, is the difference in excess litter between Scenario I and Scenario II. This difference equals the amount of litter crop producers in the county would like to apply but are not able to because of the requirement P-based application rates. Dividing the additional costs by the excess litter differential provides an estimate of the minimum price per ton that would be needed to entice the county to apply litter at P-based application rates and export the excess. Note, this price does not include transportation costs. Rather, it is the price the litter suppliers would have to receive.

County[a]	Additional Costs due to P-based Applications ($)	Additional Excess Litter due to P-based Applications (tons)	Minimum Price for Additional Excess Litter ($/ton)
Banks	$1,388,656	59,476	$23.35
Catoosa	$109,412	6,345	$17.24
Cherokee	$174,201	13,617	$12.79
Dawson	$113,405	7,702	$14.72
Forsyth	$52,768	2,301	$22.93
Franklin	$1,536,054	88,736	$17.31
Gilmer	$489,284	34,562	$14.16
Gordon	$1,931,823	59,748	$32.33
Habersham	$1,098,747	58,702	$18.72
Hall	$754,421	62,501	$12.07
Hart	$2,066,346	63,207	$32.69
Heard	$357,626	9,868	$36.24
Jackson	$1,257,767	58,498	$21.50
Lumpkin	$206,828	10,325	$20.03
Madison	$1,506,752	89,901	$16.76
Pickens	$135,882	10,759	$12.63

Table 3.2-8 : Difference in Costs of Meeting Nutrient Needs, Scenario I vs. Scenario II ***(****a: In the solution to both Scenario I and Scenario II, White county was able to apply all of the litter produced within it.)*

Scenario III

In this scenario litter is able to be transported out of the "seller" counties and into the "buyer" counties described above. Using 2008 fertilizer prices and $10/ton broiler litter, the solution to the model transports all excess litter from Scenario I out of the 17 target counties. This is not surprising, considering the range of 2008 shadow prices displayed in Figure 3.2-9 seen above ($50/ton - $100/ton) is higher than the minimum price required by the target counties shown in Table 3.2-8 shown above ($12/ton - $37/ton). The difference between the "seller" counties' asking price and the "buyer" counties' willingness to pay is more than enough to cover the transportation costs. In fact, with 2008 fertilizer prices the excess litter from all "seller" counties is bought, transported, and applied at P-based rates to crops in "buyer" counties. This suggests that a well-functioning litter market should be able address the over-application of poultry litter in the target counties without public subsidies, given 2008 fertilizer prices.

3.3 POTENTIAL LINKS BETWEEN LITTER TRANSFER AND WATER QUALITY TRADING

Water quality trading is a market-based mechanism that can be used as a part of a water quality management strategy. Water quality trading is also known as nutrient trading, offset banking, effluent trading, and other similar terms. As a concept, water quality trading has been discussed by researchers and policymakers for many years, but only in the past decade has it begun to develop substantially in the field. Water quality trading (WQT) allows regulated pollutant sources to engage in exchanges related to compliance with pollutant reduction obligations. A permittee can choose to comply with water quality effluent standards at its own facility or pay another pollutant source to provide an equivalent (or greater) pollutant reduction instead. By allowing for this type of exchange, WQT can improve cost-effectiveness and create incentives for innovation in pollution control.

As discussed in Section 3.1 above, poultry litter in Pennsylvania is being transported out of the nutrient sensitive Chesapeake Bay watershed through a new water quality trading initiative that Pennsylvania created to help meet its Chesapeake Bay agreement pollution goals. Poultry litter transported out of the watershed is eligible for nutrient pollution reduction credits that can be sold to pollutant sources in the watershed that need credits to meet their environmental obligations. A similar arrangement might be possible in nutrient sensitive watersheds in north Georgia (e.g., Etowah, Upper Chattahoochee) through trades involving poultry litter and wastewater treatment plants.

Interest in water quality trading (WQT) is driven by its potential to improve the cost-effectiveness and flexibility of water pollution control. It can also provide for the accommodation of new growth while meeting existing or more stringent water quality objectives. Moreover, it can create an incentive for innovation in pollution control technologies and practices. However, water quality trading is a complex policy, and effective implementation must be based in a clearly defined regulatory structure, a well-developed understanding of the watershed in which it is implemented, and extensive stakeholder involvement.

WQT has been a hot topic in the U.S. over the past five years. The US Environmental Protection Agency (EPA) issued a policy guidance for water quality trading in 2003. As of 2006, EPA reported that at least 10 states had a trading framework in place or in development and at least 24 trades had occurred.[5] Additionally, WQT is in some stage of development or implementation in a number of other watersheds not included in EPA's survey in 2006. For an overview of WQT initiatives in the U.S., see: *Water Quality Trading and Offset Initiatives in the U.S.: A Comprehensive Survey*, which provides summary descriptions of numerous programs in the U.S. (Breetz et al., 2004).[6] Additional information on WQT initiatives in the U.S. can be found on-line at the Environmental Trading Network: http://www.envtn.org/wqt/stateprograms_page.html (accessed August 29, 2008).

Over the past several years, the use of WQT has begun to diversify. The Breetz et al. survey demonstrates the breadth of current applications of WQT in the U.S. Most initiatives have developed to address nitrogen and phosphorus loading in nutrient sensitive watersheds. Newer initiatives are trying to address other pollutants, including sediment and toxics. Additionally, some programs allow trading among related pollutants (e.g., oxygen reducing pollutants, including nutrients and BOD). In the past few years, the most active trading programs have been in Pennsylvania and Connecticut in the Chesapeake Bay and Long Island Sound watersheds.[7] In Pennsylvania, litter transfer accounts for 63% of the nitrogen credits and 65% of the phosphorus credits that have been approved to date. The Pennsylvania initiative has pioneered a link between WQT and litter transfer that provides a model for other states with substantial poultry production in nutrient sensitive watersheds.

WQT in Georgia

WQT is not a new idea in Georgia. It is a part of the new statewide water plan that was adopted by the state legislature in January 2008. The plan calls for the state to assess

[5] See: http://www.epa.gov/owow/watershed/trading/tradingmap.html (accessed July 18, 2008).
[6] See: http://www.dartmouth.edu/~kfv/waterqualitytradingdatabase.pdf (access July 18, 2008).
[7] For more information on the Pennsylvania WQT initiative, see: http://www.dep.state.pa.us/river/Nutrient%20Trading.htm (accessed July 18, 2008). For more information on the Connecticut WQT initiative, see: http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325572&depNav_GID=1635 (accessed July 18, 2008).

how water quality trading can be used to support the objectives of the statewide water plan. The plan directs the Georgia Environmental Protection Division (EPD) to:

> *…partner with state and local government agencies, regulated entities, and other appropriate stakeholders involved in land and water management to review the practice of pollutant allocation trading to determine the potential for use of this tool in Georgia.*
>
> (Section 13, Implementation Action 2, p. 34)[8]

It can be expected that with this directive in the water plan, interest in water quality trading will increase in the state in the coming years.

The Georgia EPD reports that WQT has already occurred in this state. In the Chattahoochee River Basin, the City of Newnan and Cobb County each has a permit that includes a "trading" arrangement. Each entity has two permitted facilities that share an aggregate phosphorus limit. These arrangements are what the EPA refers to as watershed permitting, and they are similar to an air quality "bubble permit." These arrangements did not involve market transactions, but they fit under the broad umbrella of the term WQT.

Additionally, over the past several years, two major initiatives have focused research and outreach efforts toward evaluating the feasibility of using water quality trading in Georgia:

- "A Framework for Trading Phosphorus Credits in the Lake Allatoona Watershed" at the University of Georgia

- "Building a Foundation for Water Quality Trading in Georgia" at the Georgia Water Planning and Policy Center in partnership with the UGA Warnell School of Forestry.

The Lake Allatoona project at UGA includes research, education, and extension activities focused on developing a framework for water quality trading between point and nonpoint sources in the Lake Allatoona watershed of the Etowah River Basin in

[8] See: Georgia Comprehensive State-wide Water Management Plan (January 2008), available on-line: http://www.georgiawatercouncil.org/Files_PDF/water_plan_20080109.pdf (accessed July 18, 2008).

North Georgia. As a whole, the objectives of this project are to estimate pollutant loading for phosphorus and sediment in the watershed, to use monitoring data to calibrate a watershed model, and to use the model to examine the spatial distribution of the current point and nonpoint sources in the watershed. The model will support evaluation of the feasibility of trading under various scenarios in the watershed. The project is developing scientifically-based trading ratios using uncertainty analysis of the model for best management practices that might be used to generate nonpoint trading credits. The project also is studying the feasibility of trading in the watershed using a cost analysis and evaluating possible institutional arrangements for trading in the watershed. This project is working with stakeholders in the watershed to initiate discussion about water quality trading. The project includes researchers from the Departments of Crop & Soil Sciences, Biological & Agricultural Engineering, and Agricultural and Applied Economics, the Warnell School of Forestry and Natural Resources, and the River Basin Center.

At the Georgia Water Planning and Policy Center (GWPPC), water quality trading research has been a part of the Center's research efforts since 2002. This research has brought together economists, lawyers, engineers, scientists, policymakers, and stakeholders to consider the feasibility of using WQT in Georgia. These efforts have included close collaboration with Dr. Bruce Beck in the Warnell School of Forestry at UGA. The GWPPC's reports relating to this research are listed in Appendix H. The objectives of the GWPPC's WQT research have been to: (1) Evaluate Georgia watersheds and policy with respect to the feasibility of implementing water quality trading (WQT); (2) Develop cost estimates for wastewater treatment of phosphorus, a commonly traded pollutant, and evaluate the economic driver for WQT in Georgia and across the U.S.; (3) Conduct modeling and monitoring to support analysis of possible WQT scenarios for Georgia; and, (4) Initiate and facilitate discussion of WQT as a policy option among a wide audience of Georgia policymakers and stakeholders.

Thus, WQT is in the early stages of development in Georgia. Given its inclusion in the statewide water plan, interest is likely to increase. However, the path for the development of WQT is not yet clearly defined. A recent report from the GWPPC research provides an updated overview of current policy issues that should be considered as a part of discussion of WQT in this state (see Rowles, 2008). This report reviews potential barriers, including the possible lack of an adequate regulatory driver for WQT at this time. The Pennsylvania experience demonstrates that poultry litter transfer provides a practice that can generate WQT credits at a cost that can support active trading, and this example may provide a model to support WQT development in Georgia.

Linking WQT and Poultry Litter Transfer: Pennsylvania

Pennsylvania does not directly subsidize poultry litter transfer through an incentive program. Instead, poultry litter transfer is a practice that is eligible for nutrient credits in the Pennsylvania nutrient trading initiative. To date, litter transfer has generated more nutrient credits in the trading initiative than any other practice.

Pennsylvania created a nutrient trading initiative in order to help meet its obligations under the Chesapeake Bay Agreement. Pennsylvania entered into the Chesapeake Bay Agreement with neighboring states in 2000. As a part of the agreement, Pennsylvania agreed to comply with stringent pollutant loading reductions to protect the Bay. The Chesapeake Bay Agreement aims to reduce pollution to the Bay sufficiently by 2011 to remove the Bay from the EPA list of impaired waters.

The Chesapeake Bay is adversely affected by high levels nutrients and sediment that enter the system from across its large watershed. Over half of the state of Pennsylvania is in the Chesapeake Bay watershed, including the Susquehanna and Potomac River watersheds (see Figure 3.1-1 for a map of the Chesapeake Bay watershed). Under the Chesapeake Bay Agreement, Pennsylvania is required to reduce pollutant loading of nutrients and sediment by 40% by 2011.

To comply with the nutrient reductions required by the Chesapeake Bay Agreement, the cost of wastewater treatment facility upgrades necessary in Pennsylvania were estimated to be $1 billion. Pennsylvania decided to explore WQT in order to try to reduce compliance costs and reap ancillary environmental benefits, such as habitat restoration. In August 2000, the Joint Legislative Air and Water Pollution Control and Conservation Committee of the Pennsylvania legislature directed the state Department of Environmental Protection (DEP) to establish a pilot program to evaluate the feasibility of nutrient trading in the Conestoga River portion of the state's Chesapeake Bay watershed region. If successful, the Conestoga River pilot program could be expanded into surrounding watersheds.

The Conestoga River pilot program was developed by several partners, including the Pennsylvania DEP, Enterprising Environmental Solutions (EESI), the Conservation Fund, the Pennsylvania Environmental Council, Environmental Defense, and the Chesapeake Bay Foundation. In the pilot project, the partners sought to identify potential sources and trades and to develop guidelines for structuring trading policy. In 2004, a pilot trade was executed between Pfizer Inc. and the Borough of Lititz. In this exchange, Pfizer paid for a stream restoration project in the borough that generated nutrient credits that Pfizer could apply toward its effluent permit obligations.

Also as a part of the Conestoga pilot project, in 2005 and 2006, several partners, including the Pennsylvania Environmental Council, the Lancaster County Conservation

District, and the Natural Resources Conservation Service, the Pennsylvania DEP, and the World Resources Institute, conducted a reverse auction for farmers in the watershed to bid on best management practices (BMPs) to control runoff. The low bidders in the auction received funding to implement the BMPs, and the practices generated WQT credits. The auction provided farmers with a real-life demonstration of how WQT works, and it also generated initial credits for WQT in the Conestoga watershed. The auction also demonstrated the use of NutrientNet, which is a software tool developed by the World Resources Institute to facilitate WQT implementation. The Pennsylvania Nutrient Trading initiative uses Nutrient Net to administer WQT in the state.[9]

At the same time that the pilot program was being implemented in the Conestoga River Basin, the state also worked to develop draft guidelines for WQT that would apply to the state as a whole. The guidelines were adopted in 2006, and with their adoption, the nutrient trading initiative began. The guidelines include the following provisions:

- Trades must be *within* a watershed.
- Credits can be earned for activities starting after January 1, 2005.
- WQT can be conducted for phosphorus, nitrogen, or sediment loading.
- Cross-pollutant trades are not permitted.
- Credits must be certified by the Pennsylvania DEP before they can be exchanged.
- The number of credits earned is calculated based on the Chesapeake Bay Program Watershed Model. It is affected by the location of the practice implemented. Fewer credits are earned for practices located at greater distances from the Bay.
- The Pennsylvania DEP assesses a 10% reduction against each credit earned in order to create a risk management pool of credits that can be used in the event of BMP failures.
- Credits must be generated in the same year that they are exchanged.
- Water quality trades in Pennsylvania can involve point sources, indirect dischargers to point sources, nonpoint sources, and third parties.

For WQT credits earned by agricultural practices:

- Farmers must meet a threshold requirement of environmental practices in their operation before they can implement additional practices that can earn WQT credits. Threshold practices include using a nutrient management plan and creating a 100-foot (or 35 foot vegetated) setback from streams in manure applications.
- Farmers can earn WQT credits using any of 24 Best Management Practices (BMPs) identified in the Chesapeake Bay Agreement. For these practices, the number of credits earned is based on their pollution reduction efficiencies in the watershed model.

[9] See: http://pa.nutrientnet.org/ (accessed July 18, 2008).

- Other agricultural BMPs may be eligible, but they must be reviewed by the Pennsylvania DEP, and they are likely to be subject to additional monitoring requirements and higher trading ratios to compensate for uncertainty.

Farmers can use NutrientNet to estimate the number of WQT credits that a BMP can earn. NutrientNet also provides an on-line marketplace to facilitate WQT exchanges in Pennsylvania.

The poultry industry in Pennsylvania grosses over $700 million annually for the Pennsylvania farm sector, ranking it only behind diary as the highest income grossing farm sector for the state. Pennsylvania is a major producer of poultry in the United States and it is the leading producer for the Northeast. With over 1,500 poultry farmers in the state, Pennsylvania producers generate an abundance of poultry litter. Much of the waste is used to fertilize agricultural fields in the state.

Under the Pennsylvania Nutrient Trading initiative, the Red Barn Trading Company, a private entity, has been generating nutrient trading credits by transporting poultry litter out of the Chesapeake Bay watershed. The Red Barn Trading Company is a third-party credit aggregator. Red Barn has received authorization for nutrient credits earned through 21 different proposals to the Pennsylvania DEP. All of the Red Barn proposals for nutrient credits are for projects involving poultry litter export from the watershed. Red Barn transports poultry litter to nutrient-poor strip-mined land outside of the watershed. Red Barn has generated more than 60% of the WQT nutrient credits authorized in the Pennsylvania Nutrient Trading initiative to date. One other entity has also earned credits for a poultry litter transfer from the watershed (Chesapeake Nutrient Management). Litter transfer accounts for 63% of the nitrogen credits and 65% of the phosphorus credits that have been authorized in the initiative to date. Clearly, poultry litter transfer is central to reducing nutrient loading in Pennsylvania’s Nutrient Trading initiative.

Not only has Red Barn earned credits, but it has also sold credits in three trades to date. Two trades were made with small, private wastewater facilities, and one trade was made with a municipal wastewater system in Fairview, PA. These agreements range from five to fifteen years, and credit prices range from $5 to $9 per pound for nitrogen and $4 per pound for phosphorus. Red Barn is the seller in three of the four trades that have been executed in the Pennsylvania Nutrient Trading initiative to date.

Red Barn pays farmers between $15 and $30 per ton for their litter. However, the mine site that purchased the manure paid only $5 per ton. Red Barn also had to cover the costs of transporting the litter. Red Barn earns revenue from the credit sales, but it reports that its recent trade with Fairview did not generate a profit (Kenny, 2008).

The township of Fairview that purchased the nutrient credits from Red Barn saw the trade as very beneficial. Prior to the trade, the township expected to pay $6.2 million to upgrade its wastewater treatment plant to comply with Chesapeake Bay watershed water quality requirements. When the township investigated nutrient trading as an alternative, it found that trading would allow it to comply at one quarter of the cost. Fairview has entered into a 15 year contract with Red Barn Trading Company. Under the contract, Fairview will purchase nutrient credits to comply with its effluent loading limits. The credits will be generated with poultry litter exports by Red Barn from the watershed.

Pennsylvania's nutrient trading program has received some criticism. The Chesapeake Bay Program's Science and Technical Advisory Committee is concerned that the trading program will not provide the nutrient reductions that wastewater facility upgrades could attain. Others believe that the program lacks adequate safeguards and that it is giving credit for practices that would have happened anyway in the absence of a trading program. The latter criticism arises because Pennsylvania allows for credits to be generated by practices funded through federal and state cost-share programs.

Some are concerned that trading does not adequately address the uncertainty associated with nonpoint source nutrient reductions. Each trade is subject to a 10% reduction that creates a reserve fund to address problems with nonpoint source practice implementation, but critics believe that 10% is not enough.

The Pennsylvania Nutrient Trading initiative allows for credits to be generated when agricultural land is converted to another use, for which lower levels of nutrient loading can be documented. Critics are concerned that conversion of farmland to low-density development would be granted nutrient credits, but that the land conversion would result in a net increase in nutrient loading through indirect means, including air deposition of nutrients from increased levels of driving in the area. They are concerned that the trading program can effectively support the development of suburban sprawl. Homebuilders do not view nutrient credits as a major factor in development patterns, but they do counter that they should be able to earn credits if they can document nutrient loading reductions (Blakenship, 2007).

These concerns with the involvement of nonpoint sources in WQT are not unique to the Pennsylvania program. The following section provides an overview of the challenges of nonpoint sources in WQT.

Nonpoint source involvement in WQT

In Georgia, nonpoint sources are the greatest source of impairment in rivers and streams. WQT is often promoted as a means to leverage point source regulation to attain nonpoint source pollutant loading reductions. WQT can direct new resources toward nonpoint source controls, but the involvement of nonpoint sources in WQT raises the complexity of trading and creates some challenges that need to be considered by policymakers.

First, nonpoint sources introduce a higher level of uncertainty with respect to environmental performance. Because nonpoint source runoff is diffuse, the effectiveness of pollution control best management practices (BMPs) in the field is difficult to measure. In most existing WQT initiatives, the value of tradable credits for nonpoint source reductions is calculated based on modeling, not in-field evaluation of pollutant loading effects. Environmental monitoring can evaluate in-stream impacts, but monitoring individual nonpoint sources that sell WQT credits is costly and likely to be a deterrent to WQT. Uncertainty is usually addressed and mitigated through the use of trading ratios that can provide a margin of error.

Second, WQT affects the revenue flow for nonpoint source WQT credit sellers, and therefore, WQT can affect decisions to enter, exit, or expand agricultural operations. In doing so, WQT can affect land use and related pollutant loadings. In the absence of WQT, marginal land may be taken out of production, but with WQT, revenues from pollutant trading credits may help to keep marginal land in production. The net effect may be that pollutant loading is higher than it would have been in the absence of WQT. On the other hand, the net effect might be lower pollutant loadings if the alternative land use would have generated higher levels of pollution. The effect is difficult to evaluate, but the point is that the inclusion of nonpoint sources as credit sellers introduces complexity and uncertainty.

Last, nonpoint sources are difficult to evaluate with respect to “additionality,” which is an evaluation of environmental impact relative to what would have happened in the absence of WQT. It is the determination of whether tradable credits are earned for pollutant reductions that would not have otherwise occurred. Additionality is a criterion for evaluation of trades under the EPA WQT policy, but assessing whether a nonpoint pollution load reduction meets the criteria of additionality can be difficult. When agricultural operations receive cost-share funding from state and federal agencies to support pollution control best management practices, can these practices earn WQT credits? This question concerns additionality: would the practice have been implemented in the absence of WQT due to its subsidy support? The EPA and USDA do not have an official position on this issue, and other states are grappling with how to address it. The World Resources Institute supports the inclusion of cost-share recipients, but only to the extent of the farmer's investment in the cost-shared practice (Greenhalgh et al., 2006).

The issues raised here create challenges that require careful policy design. As noted above, trading ratios can play a role in addressing the uncertainty that nonpoint sources introduce into WQT initiatives. Some of these concerns may also be addressed by setting performance baselines, like those used in Pennsylvania for agricultural participants in WQT. Tradable credits can only be earned after a farmer has implemented certain basic practices that are not eligible for credits. With respect to additionality for cost-share funded practices, the Tar-Pamlico WQT initiative in North Carolina has been used to increase funding for the state agricultural cost-share program. Funding raised through the WQT initiative is to be targeted to control nutrient loading in the watershed. Cost-share practices are a part of the WQT program, but their additionality is clear: these practices would not have received funding in the absence of WQT. Although the effect of involving nonpoint sources in WQT has not been fully assessed, many concerns may be addressed through WQT policy design. However, further study is needed to evaluate whether additionality and water quality objectives are attained when nonpoint sources are included in WQT.

Analysis of WQT Credits Earned for Poultry Litter Transfer in Pennsylvania

As described above, Pennsylvania has been successful in establishing a WQT initiative that has experienced several trades in the past two years, and the most significant source of WQT credits in this trading initiative is poultry litter transfer. The number of credits earned per ton of poultry manure exported from the watershed was a calculation that interested the project team to support our understanding of how poultry litter transfer might be supported through WQT.

In WQT, trading activity will not occur if there is not a sufficient economic driver. To date, many WQT initiatives have experienced little or no trading activity, and one important reason for the lack of trading is that, in many cases, regulation has not been restrictive enough to create an economic driver (Rowles, 2008; King and Kuch, 2003). The case for WQT is often built on the belief that nonpoint source pollutant control costs are substantially less than that for point sources, but this is not always the case. In fact, for phosphorus, until point source regulation reaches 1.0 mg/l or less, treatment costs for point sources will usually not be high enough to create an interest in WQT with most nonpoint sources.[10] However, the experience of Red Barn Trading Company in Pennsylvania indicates that poultry litter transfer may be a nonpoint source pollutant

[10] See Rowles, 2008 for a more complete discussion of treatment costs and the economic driver for point to nonpoint WQT.

reduction practice that can be performed at sufficiently low cost to support higher levels of WQT activity than have been observed to date in other WQT initiatives. Thus, the project team wanted to explore the Pennsylvania experience further. Our primary objective was to estimate the number of credits that could be earned per ton of poultry litter removed from the watershed.[11]

We contacted Red Barn Trading Company and the Pennsylvania Department of Environmental Protection (PADEP) to discuss their calculation methodology.[12] The PADEP has created calculation worksheets which farmers can use to calculate the nutrient credit value of various best management practices. These are available on-line: http://www.dep.state.pa.us/river/Nutrient%20Trading.htm#Calculation (accessed September 3, 2008). However, for poultry litter transfer, Red Barn and PADEP did not use these spreadsheets, but instead developed a practice-specific calculation methodology.

The calculation used by Red Barn for poultry litter export from the watershed was developed in cooperation with the PADEP and based on the Chesapeake Bay Model. They focused on creating a method for nitrogen first. To start, the nutrient content of litter is estimated based on research by Pennsylvania State University. Next, for broiler litter, it is assumed, again based on Pennsylvania State University research, that 15% of the litter nitrogen content is available for crop uptake. The remaining 85% of the litter nitrogen content is lost to the environment. If we assume that a ton of broiler litter has 62 pounds of nitrogen, then 52.7 pounds is presumed lost to the environment for this calculation.

For the 52.7 pounds lost to the environment, next they make an adjustment for the location of the farm to which the litter would have been applied (from which it is now exported) based on the Chesapeake Bay Model. This adjustment uses a Delivery Ratio from the model. It varies throughout the watershed, and it estimates how much of the nitrogen will migrate from its point of entry to the stream to the Bay. Next, they make another adjustment, also based on the Chesapeake Bay Model, to estimate what portion of the nitrogen lost to the environment as it travels from the farm to the stream edge. This adjustment uses an Edge of Segment ratio from the model. Red Barn estimates that the typical reduction of the 52.7 pounds N by these two adjustments would result in an estimate that about 38% of the applied N reaches the Bay. For a ton of litter applied, this amount would be approximately 23.6 pounds N that would reach the Bay.

[11] The project team was assisted in this analysis by David Keiser, a graduate student at the University of Georgia College of Agricultural and Environmental Sciences, Department of Agricultural and Applied Economics.

[12] At Red Barn Trading Company, George Hazard was our primary contact. He spoke at the final workshop for the project. At the Pennsylvania DEP, Ann Smith was our primary contact.

Next, two additional adjustments are made. First, an adjustment is made to account for use of replacement fertilizer on the exporting farm. PA DEP had to make an assumption as how a farmer might typically compensate with commercial fertilizer when he does not apply litter. They assumed that the farmer would want to replace the amount of N content that the litter supplied for crop uptake (15% of N content of the litter). To do so, assuming the replacement commercial fertilizer would be 50% available for crop uptake, they assume that the farmer will apply commercial fertilizer with an N content equivalent to 30% of the N content that would have been in the applied litter, or 18.6 pounds N. Assuming that this N is 50% available for crop uptake and that 50% will be lost to the environment, they calculate that 9.3 pounds of N will be lost to the environment from the replacement commercial fertilizer. Then, they adjust this amount by the Delivery Ratio and Edge of Segment Ratio to estimate what amount of the N content of replacement fertilizer will reach the Bay. With the same ratios used for the litter, this value would be about 4.2 pounds. This estimate represents the amount of N that would reach the Bay from the replacement fertilizer, and therefore, any credits earned by removing litter must be reduced by this amount. After this adjustment, a typical credit calculation for Red Barn would be 19.4 pounds N credits per ton of litter removed.

The last adjustment is made by PADEP to create an emergency reserve of credits to address shortfalls. Sources will be able to purchase credits from the PADEP reserve fund if an unexpected shortfall in credits arises (e.g., as a result of non-performance by a credit seller). PADEP reduces all credit earnings calculations by 10% to create this reserve. Therefore, the final estimate for a typical number of N credits (pounds) that Red Barn can earn by exporting one ton of broiler litter is 17.5.

To estimate P credits earned from the same ton of litter, the PADEP and Red Barn simply divide the N credits by 8. Therefore, the P credits earned for a typical ton exported would be 2.2.

A few points should be made about the preceding discussion of the credit estimates:

- The numbers given are based on discussions of what might be a "typical" case for a Red Barn poultry litter export credit proposal. They are not averages. The amounts will vary based on factors such as litter nutrient content and location.
- These estimates are not directly transferable to Georgia. Adjustments for a number of variables would have to be made to more closely match conditions in our state.
- The discussion of the "typical" case was intended to provide a sense of why litter export has been such a common practice in the Pennsylvania nutrient trading initiative.
- The procedure for P credits (divide N credit by 8) is very simple at this time. A new proposal from a different credit generator (i.e., not Red Barn) is being

developed that will consider the P content of the litter and P availability for crop uptake more directly.

Red Barn and PADEP had some disagreements about the methodology as it was developed. In particular, Red Barn did not agree with the assumptions used in the replacement fertilizer adjustment. Any calculation like this one, which is based largely on modeling, is likely to generate questions and disagreements among the interested parties.

Next we tried to put the “typical” estimate for Pennsylvania into perspective relative to other nutrient treatment costs and litter transport incentives. We looked at phosphorus which would likely be the primary focus of WQT in Georgia. If a poultry producer can earn WQT credits for exporting litter from a watershed, then the producer will create a new source of revenue that will facilitate poultry litter transfer, nutrient loading reductions, and the farmer’s profitability. The Pennsylvania analysis demonstrates that, in that program, the export of a ton of litter from the watershed can earn two or more pounds of P credits.

Most poultry litter transfer subsidies pay in the range of $10-15 per ton to transport litter. In the Georgia NRCS pilot program, the subsidy was $10 per ton or less (if the participant opted for a lower rate in exchange for higher ranking). In Pennsylvania, P credits exchanged to date have sold for $4 per pound. At that rate, a farmer that earned 2.2 pounds of P credits per ton of litter would earn an amount on par with a typical litter export subsidy ($8.80 per ton). Revenue from the sale of other pollutant credits (e.g., nitrogen) may increase potential revenue from WQT.

Would point sources be interested in buying such credits? Based on estimates of treatment costs for phosphorus by municipal wastewater treatment facilities, P credits of $10 or less per pound would provide a cost-effective alternative to capital upgrades, and the practice should be able to support trading activity, such as it has in Pennsylvania (Rowles, 2008).

In Georgia, of course, conditions are different than they are in Pennsylvania. The number of credits earned would be subject to Georgia-specific conditions and trading ratios and reserve assessments that might be stricter than those in Pennsylvania. Also, the price that could be earned for P credits would be different than that in Pennsylvania, and it would be driven primarily by the level of point source regulation for phosphorus. Given that dischargers in Pennsylvania are driven more by N reduction requirements, the price for P credits in Georgia could be higher than that in Pennsylvania, because P would more likely be the primary pollutant of concern. However, again, the price for P credits would depend on the level of P regulation for point sources.

In summary, poultry litter transfer has been a significant source of nutrient credits in the Pennsylvania nutrient trading program. The Pennsylvania experience indicates that linking poultry litter transfer with nutrient trading is a viable alternative to poultry litter transport subsidies. When a poultry producer can earn WQT credits for exporting litter from a watershed, then the producer gains a new source of revenue that facilitates poultry litter transfer, nutrient loading reductions, and the farmer's profitability. The cost of poultry litter transfer as a nutrient reduction practice is low, and therefore, as the Pennsylvania case demonstrates, it could support active nutrient trading.

Anticipating Stakeholder Response

Because of the success of Red Barn Trading Company in supporting poultry litter transfer with nutrient trading, we wanted to learn more about their operation. We invited them to present their WQT activities at the final workshop for this project on August 20, 2008 in Athens, GA. We also invited GA Environmental Protection Division and regional EPA officials to attend, and both agencies sent personnel to the meeting.

After the Red Barn presentation, we discussed WQT and poultry transfer with GA EPD officials. They noted that with WQT in the new statewide water plan, the agency would be making an effort to evaluate trading in the near future. However, at this time, given the agency's lack of experience on this issue to date, they could offer little in the way of reaction to this particular idea. However, they did note interest in the topic, and discussions involving stakeholders and agency personnel should continue.

Sometimes stakeholder response to WQT in general can be quite negative. The official from Red Barn Trading Company noted that in Pennsylvania several non-governmental organizations have threatened litigation over WQT issues.[13] In the U.S, recently litigation has developed involving two WQT initiatives. These cases are reviewed in detail by Showalter and Spigener in a paper prepared for the Scientific and Technical Advisory Committee of the EPA Chesapeake Bay Program (2007).

In Georgia, during the development of the statewide water plan, many environmental stakeholders indicated a general skepticism or opposition to the use of WQT in this state. Many who commented on the plan noted the issues of complexity, the need for better information, and concerns about pollutant "hot spots". Some are opposed in principle to the use of market mechanisms for water resource management.

[13] *In re City of Annandale,* 731 N.W. 2d502, 518 (Minn. 2007) and *Friends of Pinto Creek v. EPA,* 2007 U.S. App. LEXIS 23251, 9th Cir. (Oct. 4, 2007)

Clearly, environmental policymakers in Georgia have an interest in exploring the use of WQT. The new statewide water plan includes a directive to them to do so. On-going efforts at UGA and the Georgia Water Planning and Policy Center provide a foundation of information necessary to develop WQT policy in this state. If the state does work toward using WQT in any form, stakeholder concerns may be substantial. A broad range of stakeholders should be engaged in any process which seeks to create a WQT policy or initiative in this state. The threat of litigation for WQT will not disappear and on-going cases should be tracked by policymakers, but with stakeholder involvement, some conflicts may be avoided.

3.4 VALUE ADDED PROCESSING

Value added processing is another way to encourage transport of litter from areas where surpluses exist. Litchenberg et al., 2002 investigated the economic value of poultry litter supplies in the Delmarva region and found that application to nearby cropland were the highest value use of poultry litter when compared to many alternative uses. Even when application rates were limited to minimal P based needs and out of county transport was required, application of poultry litter to cropland as fertilizer was likely the highest value. They go on to state that the use of poultry litter as fertilizer on cropland could be limited by factors not considered in their economic calculations, including difficulties encountered in arranging poultry litter sales and the desire of some farmers to avoid regulatory scrutiny associated with poultry litter use. They conclude that efforts to improve manure matching services and the emergence of brokers handling poultry litter could reduce difficulties encountered in arranging transactions for this and other uses.

While land application may be the highest value and preferred use, investigating value added processing is important because the economics of the alternative uses change over time. Furthermore, removal from watersheds of concern could be facilitated through processes that make transport of the nutrients more attractive. For example, staff with the Red Barn nutrient trading program indicated that they were very interested in processes in which they could convert litter to other products to facilitate transport of the litter that they purchased from non-point sources. In this section, we provide an overview of some of these technologies and discuss the opportunities for greater use of these technologies in Georgia.

Composting

Composting is advanced processing option that could use large quantities of poultry litter. As much as 70% of the municipal solid waste in Georgia is organic material that could potentially be composted. Georgia produces over 2 million tons per year of food processing waste, 2.5 million tons per year of wood waste, and almost 400,000 tons per year of municipal biosolids. Most of these byproducts can be composted. (Governo et al., 2003) Diverting this material from landfills could help meet the State's 25% waste reduction goal. In addition, the reuse of these organic materials can improve soil fertility, tilth, water holding capacity, and reduce erosion, which can improve our water quality by reducing the amount of sediments and associated pollutants that reach surface waters.

Composting is a natural aerobic process that stabilizes a variety of organic matter ranging from yard or food waste to municipal or industrial sludges. It is one of the major recycling processes by which materials return to the soil in the form of nutrients available for future use. Poultry litter is an excellent feedstock for composting operations and usually improves the composting of most other feedstocks either by improving the C:N ratio or moisture content. When animal manure is properly composted, the available organic matter is stabilized to the extent that it is no longer readily decomposable and no longer subject to further anaerobic decomposition with its associated odors. Well-composted animal manure has the odor of humus and is acceptable for land application in locations such as vegetable and flower gardens or nursery plantations where fresh manure would be objectionable. Volume reduction during composting ranges from 25% to 50%, depending upon the initial material. Because of the heat produced during composting, well-controlled composting results in the destruction of most pathogens and weed seeds.

Composting is most often accomplished by mixing feedstocks to obtain an ideal blend resulting in moisture contents of 40-60% and C:N ratios of 20-50:1. There are three general methods of producing compost: static pile, windrow, and in-vessel and agitation. Static pile, the simplest, involves mixing the poultry litter with a carbon source (most often sawdust) and putting it into a pile that is aerated from below. Windrow methods (figure 3.4-1) involve laying out the poultry litter/sawdust mixture in long piles that form tall rows. The rows are turned periodically to increase aeration and thus speed the composting process. In-vessel and agitation systems (figure 3.4-2) involve putting the input mixture into trough bays or large drums that mechanically agitate the product. This system has the shortest production cycle but involves the greatest expenditure on equipment, facilities, and operation.

Figure 3.4-1 In-vessel composting system.

Figure 3.4-2 Tractor-driven windrow turner to aerate compost piles.

Livestock and poultry producers who wish to compost must have a market for the finished product. That market may be nearby garden or nursery supply outlets, landscaping services, or contractors establishing lawns or landscaping after a construction project has been completed. Cities frequently use compost to establish and maintain parks and other recreational areas. Recent growth in the organic food production sector and increases in the demand for compost in stormwater and erosion control are creating opportunities for growth in the demand for compost. The advantages of compost over fresh manure in land application are reductions in odor, fly attraction, pathogens, and weed seed concentration, and according to many horticultural studies, a better plant response due to the addition of organic material that builds better soil tilth. The disadvantages are the additional processing cost, additional space, and amount of nitrogen lost in the composting process.

Litchenberg et al., 2002 analyzed the economics standard windrow used on-farm and improved windrow used off-farm composting systems at three scales of operation. They concluded off-farm systems are more expensive to operate due to higher capital expenditures on facilities and the cost of transporting poultry litter from the poultry grower to the composting facility. The increased expenditures on facilities resulted from a need for better control of dust, odors and runoff at an off-farm facility. The average cost of compost produced at an 80,000 ton facility was only 4 percent lower than the average cost at a 40,000 ton facility, suggesting that economies of scale are largely exhausted at a capacity of 40,000 tons. They estimated that an on-farm operation producing bulk compost could afford to pay only $1.10 per ton of litter and still earn a normal rate of return on investment. In contrast, off-farm operations producing bulk compost and small off-farm operations producing bagged compost would only be profitable if they charged a disposal fee for poultry litter. In their analysis, the collection of tipping fees for co-composting litter with other waste materials was not considered.

Based on the analysis of the composting operations in Georgia (Governo at al., 2003), it was determined that the successful composting operations controlled the critical parameters of the composting process (i.e., carbon:nitrogen ratios, temperature, moisture, and air) to produce a consistent product. These operations charged tipping fees for materials and sold the finished product. Another important feature of the successful composting operations surveyed was an effective marketing strategy, which resulted in the operations stockpiling small quantities of product. The survey they conducted also identified several common problems for large-scale composting operations. These included: a confusion between what defines compost versus mulch, low carbon:nitrogen ratios that caused odors or leachate problems, and generally low compost quality. The operators surveyed indicated that low tipping fees, logistical problems (e.g., locating facilities near areas generating the largest volumes of feedstock), and the difficulty in obtaining a Solid Waste Handling Facility permit were impediments to expansion or new operations. The survey also indicated the maximum haul distance to acquire high nitrogen feedstocks such as poultry litter was within a 50-mile radius of the facility.

Based on the literature research and analysis of Georgia's composting infrastructure, educational materials that would help promote the production of consistent, high quality composts as well as increase user satisfaction are needed. Additionally, the Governo et al., 2003 report discusses several regulatory changes that could be considered to facilitate the development of improved composting infrastructure in Georgia. The state could also actively promote composting by encouraging state agencies to use the material in landscaping and for erosion control, especially within the Georgia DOT and in Georgia Soil and Water Conservation Commission erosion control standards. The state and local economic development agencies could work with the kaolin mine industry to encourage facilities to locate near the areas where compost could be used in reclamation activities. State/local government could also provide economic incentives such as tax breaks to composting facilities or tax the landfilling of organic materials to help address issues associated with low tipping fees.

Pelletizing for Fertilizer

With processing, animal wastes have been converted into commercial fertilizer products. For example, pelletizing (Hara, 1998) can be done to change the nitrogen and phosphorus ratios to more nearly match the typical plant growth requirements. Nutrients can be injected to adjust the ratio. Pelleted nutrients have reduced moisture content, fewer odors, and reduced transportation costs. Rulkens and Have (1994) proposed central manure treatment facilities in areas of concentrated animal production to extract high value fertilizer suitable for wide distribution.

Perdue AgriRecycle, a joint venture between Perdue Farms and AgriRecycle, owns and operates a plant in Seaford, Delaware that transforms raw litter into dry pellets. The product, MicroStart 60®, is marketed mainly as a source of organic matter and micronutrients in formulated fertilizers, especially those produced for precision agriculture. Everything the plant produces is currently exported by rail from the region, primarily to southern Ohio, Arkansas, southern Illinois, Maine, and Florida.

The Perdue AgriRecycle plant was constructed at a cost of about $12 million with the state of Delaware is providing $2 million for assistance with transportation improvements and the Maryland Department of Agriculture providing subsidies for transporting litter from Maryland chicken houses to the plant through its Poultry Litter Pilot Transport Project. Litchtenberg et al., 2002 included this plant in their economic analysis and estimated that the company could pay on average as much as $8.50 per ton of raw litter and still earn a normal rate of return on its investment in plant and equipment.

Fractionation is another process that is not used currently, however, it has the potential to improve the ability of farmers to move nutrients. In fractionation, litter is run over a screen and divided into a coarse and fine fraction. The coarse fraction contains mostly bedding material and can be reused in the poultry house or used as a feedstock for composting or energy production (Singh et al., 2008). Ndegwa et al. (1990) fractionated poultry litter by using #6 and #20 mesh screens and divided the poultry litter into three fractions: coarse, medium, and fine. The fine fraction (fraction that passed through screen #20 or mesh size 0.85 mm) had the highest nitrogen content whereas, phosphorous and potassium were uniformly distributed in all three fractions. Coloma (2005) studied the effect of screening on fractionation of mass, density, and nutrients. The results of that study agreed with Ndegwa et al. (1990). Fractionation is a technology that could be used to reduce the volume that needs to be transported and can create opportunities to add value to a pelleted product.

Energy Production

According to Reardon et al. (2001), if poultry litter were used for fuel, almost every poultry farm would have surplus energy after meeting its own demand. Generally a poultry farm with production capacity 100 to 110 k birds per year will produce 125 dry tons litter per year. The heating value or energy content of that litter is more than sufficient to supply all the energy needs of the farm. A number of entities have proposed using poultry litter as a fuel source for electricity generation. Several studies have investigated the technical and economic feasibility of producing electricity for sale into a wholesale power grid using poultry litter as a fuel (Antares Group 1999, Pierson and Wyvill 2001, Dagnall 1992).

Combustion Processes

Direct combustion, gasification, co□firing with coal, and pyrolysis are the known options available for extracting energy from poultry litter. Heating the biomass with unlimited oxygen is called combustion. Gasification is a process of heating the biomass in limited oxygen and in pyrolysis oxygen is absent during the heating process. Every method has its own advantages and limitations. During direct combustion, gasification and co□firing, NOx and NH3 emissions may cause environmental concerns. Also, high ash and moisture content require supporting fuel, and high volatiles cause corrosion of boilers. Both of these methods require storage of poultry litter. Long□term storage causes microbial decomposition of litter resulting in reduced heating value (Jirjis, 2004). In general, broiler litter is a lower quality fuel than coal due to its high mineral and ash content (Mukhtar et al., 2002).

Despite the drawbacks of combusting raw poultry litter as fuel, the Fibrowatt LLC (Langhorne, Pa.) has built three electricity generation plants in the United Kingdom (Ward, 2003) and is building five such power plants (Benson, Minnesota, Arkansas, Maryland, Mississippi, North Carolina) in the United States (HRE, 2007). The 12.6 MW Fibrowatt plant in operation in England since 1992 uses almost 141,000 tons of poultry litter annually. Fibrowatt operates two other poultry litter fueled power plants in England, one with a capacity of 13.5 MW in operation since 1993 and one with a capacity of 38.5 MW in operation since 1998. It has proposed building a 40 MW plant on the Delmarva Peninsula that would utilize 500,000 tons of poultry litter annually. A similar facility could be constructed in Georgia.

The Antares Group (1999), Dagnall (1992), ElectroTek Concepts (2001), and Licthenberg et al., 2002 have all presented estimates of the costs of producing electric power using various processes. Most of these analyses have shown that the electric power generators would not be able to afford to pay a positive price for poultry litter because electricity produced using poultry litter under these technologies is expensive relative to the alternatives available. The before-tax net cost of producing electricity ranges between 5.1 and 9.5 cents per kilowatt-hour. While this compare favorably with current retail rate for electricity in Georgia, most plants could not operate sustainably with such costs. However, with increasing consumer demand for green energy, tax credits or other federal or state subsidies, carbon credits, and increasing prices for by-products such as the ash these plants would produce, the landscape for these economic comparisons is very dynamic and location specific.

Cogeneration of poultry litter and other byproducts to produce heat and steam may also provide new opportunities to use litter. Several units that do this have been established around the U.S. and in Georgia (http://www.remenergy.com/news.htm). While these facilities use the same technologies as the previously discussed power plants, they offer the advantage of not having to convert the energy to electricity which improves efficiencies. They are also located at facilities that use substantial amounts of energy so implementation is easier in that you do not need to involve power companies and sell to the grid.

The direct combustion of litter or a mixture of litter and coal as a fuel source for a small electric generator is another alternative being considered. Coal burning by U.S. electrical power utilities consumes the majority of coal production and has been targeted as a significant air pollutant source. New techniques are being developed to reduce production costs and gaseous emissions. Overall emissions of greenhouse gases can be reduced when litter is blended with coal. In addition, litter releases less mercury to the atmosphere and would aid in emission reductions at the power plants.

Anaerobic digestion

Anaerobic digestion has been used with beef, dairy, swine, and poultry manures to produce methane gas, which farm owners may use to produce electricity for on-farm use or sale to an electric utility. An anaerobic digester is a device that promotes the decomposition of manure or "digestion" of the organics in manure by anaerobic bacteria (in the absence of oxygen) to simple organics while producing biogas as a waste product. The principal components of biogas from this process are methane (60% to 70%), carbon dioxide (30% to 40%), and trace amounts of other gases. Methane is the major component of the natural gas used in many homes for cooking and heating, and is a significant fuel in electricity production. Biogas can also be used as a fuel in a hot water heater. As a result, the generation and use of biogas can significantly reduce the cost of electricity and other farm fuels such as natural gas, propane, and fuel oil.

While the use of anaerobic digestion technologies is growing on dairy, swine, and poultry farms with liquid waste management systems (U.S. EPA, 2008), very few have been established on poultry farms to manage litter. The primary benefits of anaerobic digestion are improved waste management, odor control, nutrient recycling, greenhouse gas reduction, and water quality protection. These benefits are less important on poultry farms with dry litter that is relatively easy to export compared to liquid wastes. The principal by-product of anaerobic digestion is the effluent (i.e., the digested manure). Because the process is anaerobic, liquid would have to be added for poultry litter digestion and the effluent from the process would need to be dried for efficient transport off the farm. HWT Energy, Inc. presented on-farm digestion technology for poultry litter at our final outreach meeting and are looking to expand from Alabama to Georgia.

Other Emerging Technology

A number of innovative litter uses exist that currently remain in the developmental and testing stages. In the past, significant quantities of litter have been used as cattle feed in either a pelleted form or mixed with other feeds. Deep-stacked poultry litter has also been used as a protein supplement for animal feed. Public perception and the threat of BSE (mad cow) and other diseases has thrown this idea into some question and the National Cattleman's Association has even come out against this practice so it is doubtful that widespread feeding will occur. However the use of litter in fish feeds is something that has been considered and may be acceptable. Other researchers are exploring ways to extract the carbohydrates and proteins from litter to produce commodity chemicals, such as glycols or diols, animal feed, and other higher-value products (PNNL, 2001). It is uncertain if any such exotic processes will achieve cost-effectiveness in the near future, however some may be cost effective in small markets. These markets are easily saturated and this will likely prevent the widespread use of such practices.

Litter can also be used as a fertilizer on non-traditional crops. Composted litter is a beneficial addition to nursery potting soil and can be used to grow ornamental crops. These components can substitute for nutritional additives such as dolomitic limestone and minor element supplements. The litter tends to increase P tissue levels in crops that are frequently deficient when grown in standard nursery potting soils. Litter can also provide nutrients early in the growth stage and serve the role of starter fertilizers that growers frequently apply. Since these products come in contact with humans, quality control in the composting process is essential to control odors and assure pathogen control.

Another potential use for poultry litter is to fertilize forest land. A number of studies have shown that fertilizing forests at replanting and at mid-rotation (when stands are thinned in order to promote growth) increases tree growth rates substantially (Henry 1986, Allen and Lein 1998). Poultry litter would be applied to forest land primarily as a substitute for commercial phosphorus fertilizer such as diammonium phosphate (DAP). While increasing costs of fertilizers may encourage forest managers to consider litter use, the cost of application and the distance to commercial timber production areas in Georgia may limit the usefulness of considering these alternatives.

Summary of Project Findings

While the highest value use for poultry litter is direct land application as a fertilizer, value added processing may offer opportunities for encouraging greater transport of litter from watersheds with phosphorus issues. Of these, composting and energy production appear to be the most promising opportunities. Through composting it is possible to move the litter nutrients to new land uses that may need to phosphorus or organic matter to build soils and establish vegetation. With energy production, litter can be used to create "green" energy and convert the nutrients into a valuable ash that can be used in fertilizers. Both processes could occur either on-farm or in stand alone facilities and both would benefit from programs that encourage litter transport from farms with excess nutrients. To encourage the development of such facilities, the state could:

- Offer low interest loans, grants, or tax incentives to entities that would use excess litter as a feedstock and transport the nutrients out of the watershed.
- Encourage the development or refinement of existing solid waste regulations to maintain environmental quality but also recognize the benefits of such facilities.
- Create or expand educational programs on compost production and use and on the bioenergy opportunities associated with poultry litter.
- Facilitate the development of nutrient credit trading at the watershed level.

PUBLIC OUTREACH

In order to engage more Georgia stakeholders and increase knowledge of Poultry Litter issues and current trends, we conducted three public workshops: October 10, 2007 in Gainesville, March 19, 2008 in Perry and August 20, 2008 in Athens. These meetings helped to generate discussion about poultry litter transfer, to discuss program improvements, and to build interest in the topic. They also included Extension professionals from around the Southern Region.

The introductory and closing public workshops featured many invited speakers from other states, so attendees were educated on different states' approaches to managing litter and nutrients from those implementing the approaches. A number of value-added processes were presented, as well, including composted/treated litter and litter-to-energy processes.

Over 120 people participated in the first two workshops, and the closing workshop in Athens was attended by 70 people. As in the Workgroup meetings, we continued to emphasize that our focus on stakeholders in the agricultural community did not mean that we were holding them responsible for nutrient problems to a higher degree than other sources of excess nutrients (such as commercial and residential runoff, water treatment plants, etc.). Rather, we were exploring ways that the agriculture community could provide the fastest and most efficient reductions in nutrient loading, and that other sources may be willing to pay farmers to achieve them, making this an opportunity.

The first meeting, in October, 2007, brought nearly 100 participants to the campus of Gainesville State College in Oakwood. We held small group sessions on Litter Transport issues, Nutrient Trading, Economics of Litter and Value-Added Products. This was the first of several discussions on these topics, and the notes from these sessions were a springboard into the Workgroup discussions in the months to come.

During plenary sessions, speakers from Alabama, Arkansas and Maryland described very different nutrient management programs. These presentations gave attendees a chance to see that the issue is being successfully addressed in other states, and that there are choices to make in the design of a program. The Maryland program has a greater emphasis on regulation, the Arkansas program uses a non-profit organization as a "one-stop shop" for brokering nutrient transfers between poultry producers and farmers. The Arkansas model generated a lot of interest during the conference, and in the months to come. We continue to monitor the progress of this model and see which elements are transferable to Georgia. One activity that we will be doing in our future outreach work that is similar to Arkansas' program is the online nutrient value calculator.

The presentation by Glen Harris on his soil fertility work in Georgia- was particularly of interest to the farmers who attended the Perry meeting. This meeting included middle- and south-Georgia farmers who grow row crops, pecans, livestock and other products, as well as farmers who also raise poultry and thus have litter to use or sell. Harris' research on the value of litter for several crops, like cotton, peanuts, corn and soybeans, included cost comparisons and pictures of side-by-side comparisons of cotton crops with and without litter application.

Several farmers pointed out that the comparison with commercial fertilizer is not straightforward, however, in that litter "smells like what it is" – it is stinky, bulky, dusty and dirty. They noted the need for special equipment such as a spreader, at a cost of $15,000.

During the Athens conference, we brought in quite a few outside speakers. But we also reported on the results of our 10 months of dialogue through the Workgroup as well as reporting on the research done as a part of this report.

Agendas of each of these meetings are included in the Appendix I.

Presentations at Outreach Meetings

The following PowerPoint presentations were made during the Outreach meetings:

October 10, 2007 Outreach Workshop – Gainesville, GA

Mitchell, Charles – Auburn University, Alabama & Zona Beaty – USDA-NRCS, GA "Moving Manure off the Mountain"

Astle, Norman – Maryland Department of Agriculture "Nutrient Transfer Incentives: Learning from Experience. Manure Transport Project"

Heron, Sherri – BMPs Inc., Arkansas "Poultry Litter Export: Eucha/Spavinaw & Illinois River [Arkansas & Oklahoma]"

Ritz, Casey – UGA Department of Poultry Science "Georgia's Poultry Industry"

Page, Andy – NRCS Program Liaison – "Georgia's Experience with the Poultry Litter Transfer Pilot Project"

March 19, 2008 Outreach Meeting – Perry, Georgia

Harris, Glen – UGA, Tifton Campus "Cotton Fertility Response to Poultry Litter"

Risse, Mark – UGA Pollution Prevention Specialist "Why Transport Poultry Litter?"

Rowles, Kristin – Georgia Water Planning & Policy Center of Albany State University "Protecting Water Quality with Incentives for Litter Transfer in Georgia: Learning from Experience"

<u>August 20, 2008 Outreach Conference – Athens, GA</u>

Miguel Cabrera-UGA-"Phosphorus and Water Quality"

Josh Payne-Oklahoma State University- Arkansas-Oklahoma Nutrient Case Study

Liz Kramer-UGA-Land use and Sustainability in Gerogia

George Hazard-Red Barn Trading Company-Nutriet Credit Trading

Jeff Mullen-UGA-Survey Results

Kristin Rowles-Georgia Water Planning and Policy Center-Georgia Nutrient Transfer Project: Findings

David Kissel-UGA-Calculating the Fertilizer Value of Poultry Litter

Jeff Mullen-UGA-Programming Model on Commercial Fertilizer Substitution/Distribution

David Mooney-REM Engineering, Inc.-Litter to Steam Demonstration

Shannon Vinyard-HWT Energy, Inc.-On-Farm Poultry Waste to Energy

K. Singh and Mark Risse-UGA-Value Added Products from Poultry Litter using Fractionation, Pyrolysis, and Pelletizing

Chad Ingles-Iowa State University-Incentive based programs for agricultural pollution control

Josh Romeis-UGA-Phosphorus Delivery by Streams Draining Commercial Poultry Farms in Georgia

David Radcliffe-UGA-Modeling Phosphorus Loading to Lake Allatoona

Mike Roden-Alabama's Mountains, Rivers, and Valleys RC&D Council-AMRV-RC&D Poultry Initiatives

4.1 FUTURE OUTREACH PLANS

Publications

We will publish this report on two web sites:

- UGA AWARE web site www.agp2.org/aware

- Georgia Water Planning & Policy Center web site: www.h2opolicycenter.org

We will also publish the Fact Sheet on The Replacement Value of Litter as a UGA Extension Bulletin. The Southern Region Water Quality Program will also be used to share the results with stakeholders in other States of the region.

Online Calculator for Replacement Value of Litter

Due to the changing prices of commercial fertilizer, and to account for the varying nutrient requirements of various crops and soils, we will also develop an Online Calculator that will allow farmers across Georgia to calculate the value of litter for the nutrients they need to apply on their lands. We will be comparing the functionality of our online calculator to the one used in Arkansas.

Informational Articles

We will prepare an information article on the project for publication in various agricultural newsletters and magazines.

We will publish the article in "Water Talk," the outreach publication of the Georgia Water Planning & Policy Center. This publication reaches many farmers in southwest Georgia.

Presentations at Conferences

Our outreach efforts include a variety of other venues in addition to these three workshops. In February, Kristin Rowles made a presentation about the project to water resource management professionals at the USDA-CSREES National Water Conference in Reno, NV. We will present the findings of this report at the following conferences over the coming year:

- USDA CSREES National Water Conference in St. Louis

- National Poultry Waste Management Symposium in Des Moines, IA

- Georgia Water Resources Conference in Athens

-The Soil and Water Conservation Society Annual Meeting in Dearborn, Michigan.

CONCLUSIONS

This project had three primary objectives:

(1) Develop a partnership to implement a litter transfer incentive program in Georgia;

(2) Compile environmental and economic information to support program implementation; and

(3) Conduct outreach to build support for litter transfer program implementation.

The project was successful in attaining each of these objectives. The workgroup created by the project has developed a partnership of committed members that can be engaged as supporters, advisors, and participants in future litter transfer efforts in this state. The research and analysis sections of this report reflect the information-gathering efforts in the project and provide a wealth of material to support policymakers in designing effective litter transfer initiatives. Finally, outreach efforts, including three stakeholder workshops held in Perry, Athens, and Gainesville, communicated information to potential participants and stakeholders in Georgia and beyond.

A primary outcome of this project is a set of observations and recommendations for policymakers that will carry forward with efforts to reduce nutrient loading in North Georgia watersheds. This summary of findings and suggestions compiles and distills the wealth of information that we collected from a broad range of sources as we conducted this project. Overall, our major findings after conducting this project are:

- Transportation subsidies are just one approach to promoting poultry litter transfer, and they may not be necessary to support active litter movement from North Georgia, especially with the recent increase in commercial fertilizer prices that is driving increased interest in poultry litter as a substitute.
- Strong interest in the development of alternative uses of poultry litter is present in North Georgia. These uses will provide an additional outlet for poultry litter to be removed from nutrient sensitive watersheds. The development of litter-to-energy and composting operations appears to be promising and to offer near-term alternatives for litter management. Government policies such as streamlined regulations and economic development incentives could facilitate more rapid development of such facilities.

- In nutrient sensitive watersheds where poultry production is strong, such as the Upper Chattahoochee, many pasture owners apply litter, which is available to them at low or no cost, as fertilizer as nitrogen-based rates, which leads to the over-application of phosphorus. Providing these litter users with financial and educational inducements to use commercial nitrogen fertilizer or legume planting will support increased litter transfer. Our economic model indicated that strictly applying litter at P based rates would costs the farmers in the nutrient excess counties an estimated $13.2 million annual in purchased nitrogen fertilizers.
- Water quality trading is actively supporting poultry litter transfer in Pennsylvania, and it is a viable alternative means of support for litter transfer when phosphorus regulation is sufficiently strict to create interest in water quality trading as an alternative means of compliance.
- On the demand side, increase extension efforts regarding the nutrient replacement value of litter. Use the worksheet developed by this project (see Appendix A). Focus on cotton producers in particular. To further develop this knowledge-based tool, adapt the worksheet as an on-line calculator. This tool can be used to educate current litter users in nutrient sensitive watersheds, too.
- To support the poultry litter transfer market, intensify efforts to increase use of the poultry litter exchange website. Consider hiring a market-maker to support this effort and to facilitate the distribution of information and the development of market relationships.
- The partnership developed by this project is a group of committed stakeholders. Their willingness to support litter transfer should be capitalized on, perhaps through continued meetings as a steering committee that can provide feedback and perspectives and maintain a communication and marketing network.

Future Efforts

Although this project is ending, project team members will be taking several steps in the coming months to extend the outreach efforts that were initiated in this project. The following activities are planned:

Publications: We will publish this report on two web sites:

- UGA AWARE web site www.agp2.org/aware
- Georgia Water Planning & Policy Center web site: www.h2opolicycenter.org

Fact Sheet for Wide Distribution: We will also publish the Fact Sheet on The Replacement Value of Litter as a flyer for mass distribution.

Online Calculator for Replacement Value of Litter: Due to the changing prices of commercial fertilizer, and to account for the varying nutrient requirements of various crops and soils, we will also develop an Online Calculator that will allow farmers across Georgia to calculate the value of litter for the nutrients they need to apply on their lands. This calculator will be available on-line, and its use will be promoted in extension materials.

Informational Articles: We will prepare an information article on the project for publication in various agricultural newsletters and magazines. One article is already planned for "Water Talk," the outreach publication of the Georgia Water Planning & Policy Center. This publication reaches many farmers in southwest Georgia.

Presentations at Conferences: We will present the findings of this project at the following conferences over the coming year:

- USDA CSREES National Water Conference in St. Louis (February 2009)
- National Poultry Waste Management Conference in Des Moines, IA
- Georgia Water Resources Conference in Athens (April 2009)

In summary, this project has attained its objectives and provided a set of findings and recommendations that will support policymakers that seek to facilitate improved management of poultry litter and to reduce phosphorus loading in nutrient sensitive watersheds. We recommend an approach focused on facilitating market communication, rather than transport incentives. Also, we urge support for alternative uses of litter and for exploration of alternative means of addressing nutrient over-enrichment, including performance-based incentives and water quality trading.

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APPENDIX A:

THE VALUE OF POULTYR LITTER - FACTSHEET

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Calculating the Fertilizer Value of Broiler Litter

Given below is a procedure to calculate the value of broiler litter based on prevailing retail selling prices of common fertilizer materials containing nitrogen (N), phosphorus (P) expressed as P_2O_5 (the oxide expression used in the fertilizer industry), and potassium (K) expressed as K_2O (fertilizer recommendations are made on the oxide basis for both P and K). Because different fertilizer materials contain different concentrations of N, P, and K, the first step will be to calculate the cost per pound of each of the primary nutrients (N, P_2O_5, and K_2O) contained in them. Steps in this assessment are as follows:

I. Calculate the cost per pound of available nutrient as follows:

Cost per pound = retail price per ton divided by the pounds of nutrient per ton. Nutrients per ton are given below for N, P, and K fertilizers. For example:

With urea selling at $600 per ton, and because urea contains 920 pounds of N per ton from the table below, the cost is $600/920 = $0.65 per lb of N. A similar calculation for P and K fertilizers can establish their retail costs.

II. Go to step II tables for each nutrient (N, P, and K), using the calculated price for N, P, and K in step 1 to find the equivalent fertilizer value per ton of the litter for N, for P, and for K.

III. Add the three nutrient values for N, P, and K to obtain the total value of litter for all three nutrients.

Tables for STEP I. Nutrient percentages and pounds of available nutrients per ton of common fertilizers.

NITROGEN FERTILIZERS	Nitrogen Content

Ammonium sulfate	21	420
Urea	46	920
UAN solution	32	640

Triple superphosphate	46	920
Monoammonium phosphate	52	1040
Diammonium phosphate	46	920

	N Fertilizers	Nitrogen Content	
Muriate of potash	60	1200%	lbs N/ton
Sulfate of potash	50	1000	
Sulfate (			420

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Tables for STEP II.

Nitrogen (N) value of litter

Cost of N	$ per pound of N						
	0.40	0.50	0.60	0.70	0.80	0.90	1.00

Litter value	$ per ton @ 3.1% nitrogen with 50% available[1]						
	12.40	15.50	18.60	21.70	24.80	27.90	31.00

[1] For litter applied for row crops and incorporated into the soil, multiply its nitrogen value times 1.3.

Phosphate (P2O5) value of litter

Cost of P	$ per pound of P2O5						
	0.40	0.50	0.60	0.70	0.80	0.90	1.00
Litter value	$ per ton @ 3.1% P2O5 with 90% available						
	22.32	27.90	33.48	39.06	44.64	50.22	55.80

Potash (K2O) value of litter

Cost of K	$ per pound of K2O						
	0.30	0.40	0.50	0.60	0.70	0.80	0.90
Litter value	$ per ton @ 2.8% K2O with 100% available						
	16.80	22.40	28.00	33.60	39.20	44.80	50.40

Step III. Adding the N, P, and K values

After determining the value of each nutrient in a ton of litter, add the three values together to get a total value for the available N, P, and K. For N, P_2O_5, and K_2O, valued at $0.60, $0.50, and $0.30 per pound respectively, the litter value based only on the N, P, and K values would be $18.60 + $27.90, + $16.80 = $63.30 per ton.

Special notes: There is additional value from micronutrients, but difficult to determine because micronutrients are often in adequate amounts in agricultural soils. In addition, there is evidence that less agricultural lime is needed when poultry litter is used as a source of available N for crop production

(Endale, et al., USDA-ARS Southern Piedmont Experiment Station). We estimate this liming value at $3 per ton.

If less than three of the nutrients are needed for a particular crop and field, just add the value of the nutrients that are needed. For pastures that have received litter for many years, P and K values frequently have a high soil test level, therefore, P and K fertilizers are not needed. In such a case, applying the litter to this pasture may be wasteful if only N is needed for the pasture. In the example above, the P and K value was equal to $44.70 per ton, more than enough value to purchase an amount of N fertilizer equal to the N contained in one ton of the litter (valued at $18.60). In this case, the poultry farmer could then sell the litter to other farmers that need all three nutrients for crop production, and use the money from the sale to purchase N fertilizer for the pasture. The above calculations are based on average values of nutrients in broiler litter at the UGA laboratory. **Broiler litter should be tested to accurately determine its nutrient content (contact your county agent for information about litter testing). Broiler litter is not as convenient to use as commercial fertilizer and it has additional costs for hauling and spreading that depend on local conditions.**

By: D.E. Kissel and Others

University of Georgia, 08/20/08

APPENDIX B:

AGENDAS FOR WORKGROUP MEETINGS

POULTRY LITTER WORKGROUP

AGENDA

December 12, 2007

10am – 2pm

10:00 Summary of October 10 workshop & Initial Workgroup meeting

10:15 Responses to Questions and Information Requests:

"What We Know About Poultry Litter in Georgia"

- ♦ Amount of litter available for transport in the Lanier and Etowah Basins, David Kissel
- ♦ Value of Litter, Jeff Mullens
- ♦ Educational Materials Available, Mark Risse

11:00 Discussion of barriers to litter transfer in Georgia

11:30 Scenario Exercise – Develop the four scenarios and "try them on for size." The purpose of this exercise is to determine:

- ♦ What is required to get from here to each scenario
- ♦ What needs each scenario fulfills
- ♦ What would be needed to sustain each scenario
- ♦ Advantages and disadvantages of each scenario
- ♦ Elements that might be transferred among scenarios

A. The "Do Very Little" Scenario – No formal transfer program, just an expanded education and outreach component

B. The "Modest Support" Scenario – Support for branding & marketing, possibly assisting private investors with trading

C. The Maryland Scenario – modeled after what they are doing to facilitate transport

D. The Arkansas-Oklahoma Scenario – third party operator provides one-stop shop that transfers litter and implements incentive programs

12:30 Lunch (provided)

1:15 Discussion: Information Needs -- What do we need to know?

1:45 Next steps

2:00 Adjourn

POULTRY LITTER WORKGROUP

AGENDA – Session 3

January 30, 2008

10:00 Agenda Review

10:10 NUTRIENT TRADING – Kristin Rowles

- What it is
- How it works
- How it could be applied to litter transport
- Q & A

10:50 Nutrient Loads in Chattahoochee & Etowah Basins – Mark Risse

11:20 Trading Scenario: Potential Sources/Potential Contributors – Mark Risse

12:00 Lunch (provided)

12:45 LT/VLT Update

1:15	Discussion: Draft of Fact Sheet on Value of Litter
1:45	Next Meeting – Perry area
2:00	Adjourn

APPENDIX C:

ANNOTATED BIBLIOGRAPHY OF RELEVANT RESEARCH

Review of selected literature

The following section list a number of important articles from the literature concerning poultry litter transfer. This review is not comprehensive, but it seeks to highlight important findings in recent years in this field.

Bukenya, J.O., J. Befecadu, H. S. Jones, K. C. Reddy, and A. Baiyee-Mbi. 2000. Economic Feasibility of Substituting Fresh Poultry Litter for Ammonium Nitrate in Cotton Production. *Journal of Sustainable Agriculture* 16(1); 81-89.

> The paper uses a linear programming model to evaluate the economic feasibility of using poultry litter as a substitute for ammonium nitrate in cotton production in northern Alabama. The findings demonstrate that litter is a feasible substitute up to a maximum distance of 124 miles.

Carreira, R.I., K.B. Young, H.L. Goodwin, and E.J. Wailes. 2007. How Far Can Poultry Litter Go? A New Technology for Litter Transport. *Journal of Agricultural and Applied Economics* 39 (3):611-623.

> This paper evaluates the feasibility of poultry litter export from Northwestern Arkansas to other parts of the state. It concludes that if litter users will pay for litter nutrients what they pay for commercial fertilizer nutrients, then litter export would not require a subsidy except with very low commercial fertilizer prices. They note that costs for export are lowest when transported with truck back-hauls and with litter packaged in plastic bales, a new technology that is still in development and reviewed in this paper. The paper considers various transport scenarios, including rail, truck, and barge, and estimates costs for various transport and handling methods. The authors maintain that poultry litter export in Arkansas could exist without subsidy, but note that the absence of a fully developed market may indicate asymmetric information problems for which public intervention, in the form of education, is needed to stimulate market development.

Collins, A.R. and T. Basden. 2006. A Policy Evaluation of Transport Subsidies for Poultry Litter in West Virginia. *Review of Agricultural Economics* 28(1): 72-88.

> This paper evaluates a pilot litter transfer incentive program administered by the West Virginia Department of Agriculture in 2000 and 2001. They find that 62% of

participants were first time litter users. They also found that most of the litter used was used in counties where liter could provide a net savings over commercial fertilizer without a subsidy. However, the program failed to develop long-term litter use among participants. In a survey of participants, most said they would not use litter without a transport subsidy, and 90% did not purchase litter in the two years after the pilot incentive program ended. The authors suggest that the need for special spreading equipment and greater time to apply litter than commercial fertilizer may be factors that hinder its use. In focus groups, end users showed increased interest in litter application is contract land application similar to commercial fertilizer were available. The authors conclude that it may be difficult to develop litter transport without subsidies. They recommend that new programs focus on transport to the closest range outside of the region of concern to support economic viability. They also find that with nutrient management planning requirements the environmental practices of receiving users should be comparable to those of poultry growers.

Govindasamy, R. and M.J. Cochran. 1995. The Feasibility of Poultry Litter

Transportation from Environmentally Sensitive Areas to Delta Row Crop Production. *Agricultural and Resource Economics Review* 24(1):101-110.

This paper is an early paper on this topic and is frequently cited in subsequent literature. It evaluates the feasibility of transferring surplus litter from northwestern Arkansas to eastern Arkansas for use as fertilizer. The paper finds that it is economically feasible to transfer significant portions of litter. They note the growing importance of litter as a soil amendment for rice production.

Jenkins, M., C. Truman, G. Siragusa, J. Line, J. Bailey, J. Frye, D. Endale, D. Franklin, H. Schomberg. D. Fisher, R. Sharpe. 2008. Rainfall and tillage effects on transport of fecal bacteria and sex hormones 17ß-estradiol and testosterone from broiler litter applications to a Georgia Piedmont Ultisol. *Soil Science* (forthcoming).

This paper considers the survival and transport of pathogens, sex hormones, and antibiotic residues from broiler litter land application. They monitored soil and runoff concentrations from poultry litter application under various rainfall and tillage conditions. They found that when using litter application rates commensurate with corn production, among those bacteria, hormone, and antibiotic residue levels monitoring, only soil concentrations of E. coli and runoff concentration of testosterone appeared above background levels, and

these effects did not appear to be at levels that would threaten public health. Further study is suggested.

Jones, K. and G. D'Souza. 2001. Trading Poultry Litter at the Watershed Level: A Goal Focusing Application. *Agricultural and Resource Economics Review* 30(1): 56-65.

This study uses a number of methods to develop an optimal scenario of litter transport in a sub-watershed of the Potomac River Basin. They offer the optimal case as guidance to policymakers in designing regulatory and incentive programs to address environmental concerns with poultry litter management.

Lichtenberg, E., D. Parker, L. Lynch. 2002. Economic Value of Poultry Litter Supplies

in Alternative Uses. Center for Agricultural and Natural Resource Policy. Policy Analysis Report 02-02.

This report evaluates six alternative uses of poultry litter from the Delmarva Peninsula: land application, compost, pelletization, electric power generation, cogeneration of steam and electric power, and forest fertilization. The report estimates the economic value of poultry litter for each use (i.e., the maximum a user would be willing and able to pay for poultry litter). The report finds that application to nearby cropland is the highest value use of poultry litter and could provide an outlet for 80% or more of the poultry litter from the region. The authors find that adequate land is available to absorb litter nutrients at legal rates on the peninsula. They suggest that manure matching services or brokers may be needed to overcome transaction costs. They find that the value of poultry litter in forest fertilization is high relative to other uses, but that this use is limited by forest acreage that is replanted or reaching mid-rotation each year. They estimate that only 2-3% of litter from the region could be used for this purpose. They find that the value of poultry litter for compost is relatively low and assert that this use will remain minor in the region (1-2% of current litter supply). The report finds that the value of poultry litter in electric generation is negative and suggest that it would be viable only if electric generators could charge poultry producers for litter disposal. For cogeneration, the report finds that a renewable energy tax credit would make this use viable.

Oladiran F., J. Fulton, P. Srivastava, W. Wood, and F. Owsley. 2006. “Volume Reduction Technologies for Transporting Poultry Litter.” American Society of Agricultural and Biological Engineers, Paper Number 066173, 2006 ASAE Annual Meeting.

This paper reports the results of an evaluation of densification of poultry litter for transport and energy use. It estimates the moisture content, minimum pressure, and energy requirements to compact poultry litter into blocks. The energy requirements were less than that for pelletizing. More investigation into compaction of litter into blocks will be pursued to evaluate further the energy requirements, economics, chemical and biological changes to the litter, and possible commercialization.

Park, W.M., L.M. Warren, R.K. Roberts, and H.C. Goan. 2005. “The Role of Poultry Litter Handlers in Tennessee’s Off-Farm Litter Market.” Journal of Applied Poultry Research 14:246–253.

This paper reports the results of a survey of poultry litter handler’s in Tennessee, including information on number of houses cleaned, storage times, distances transported, and prices charged for their services. The handlers were generally aware of proposed CAFO regulations and willing to consider a voluntary certification initiative for litter handlers.

Paudel, K., M. Adhikarib, and N. Martin. 2004. Evaluation of broiler litter transportation in northern Alabama, USA. *Journal of Environmental Management* 73:15–23.

This paper evaluates how litter in northern Alabama can be redistributed throughout the state to address water quality concerns. They find that it will be necessary to export litter from the 29 northernmost states to overcome the surplus litter problem there. They find that it will likely not be possible to export all surplus litter without a subsidy. They evaluate changes in litter use with respect to changes in commercial fertilizer prices. They suggest extending the study regionally to consider litter movement across Alabama, Tennessee, and Georgia.

Payne, J. and M.D. Smolen. 2006. "Oklahoma's Poultry Litter Market." Proceedings of the 2006 National Poultry Waste Management Symposium. Springdale, AR, October 23-25, 2006.

> This paper reviews the development support for the poultry litter market in Oklahoma. It notes that the telephone-based approach was not heavily utilized and replaced with a web-based approach. The web-based approach allows for the delivery of educational information to market participants. The paper also discusses barriers to litter use and transactions, including: transportation costs, lack of handling equipment, record-keeping requirements, timing, and litter availability.

Pelletier, B.A., J. Pease, and D. Kenyon. 2001. *Economic Analysis of Virginia Poultry Litter Transportation*. Virginia Agricultural Experiment Station, Bulletin 01-1, College of Agriculture and Life Sciences, Virginia Tech, February 2001. Available on-line: http://www.vaes.vt.edu/research/publications/01-1.pdf (accessed September 2, 2008).

This paper evaluates the potential for poultry manure transport to address nutrient-related water quality concerns in Virginia. The study estimates litter transport amounts with and without transport subsidies and based on varying levels of adoption. Focus groups with litter users and potential litter users found that price, handling, storage, and spreading, performance, weed seeds, and regulation could be barriers that limit adoption. The study notes the need for further research into public concerns and alternative uses of litter. Timmenga & Associates Inc. 2003. Evaluation of Options for Fraser Valley Poultry Manure Utilization. Report prepared for Broiler Hatching Egg Producers' Association

BC Chicken Growers Association, BC Turkey Association and Fraser Valley Egg Producers' Association.

> This report evaluates options for managing surplus poultry litter in British Columbia. The recommendations support a multi-pronged approach that includes litter transfer from the area of concern, composting, use as fertilizer in mushroom production, production of customized fertilizer including blended, granulated, and small-scale gasification for energy use. They recommend evaluation of adding amino acids and phytase to poultry feed to lower the nutrient content of poultry manure in order to assist with disposal concerns. They also suggest evaluation of several possible funding sources to support litter management alternatives,

including carbon credits, grants, industry financing, check-off programs, and consumer impact fees.

Vietor, D.M., E.N. Griffith, R.H. White, and T.L. Provin, J.P. Muir, and J.C. Read. 2002. "Export of Manure Phosphorus and Nitrogen in Turfgrass Sod." *Journal of Environmental Quality* 31:1731-1738.

This paper evaluates the nutrient removal from nutrient sensitive watersheds through the production of turfgrass sod with manure nutrients and export from the watershed. The high value of turfgrass as a commodity can support transportation costs, and nutrient removal rates appear favorable to support increased use of this practice to address nutrient concerns.

Young, K., R.I. Carreira, H.L. Goodwin, E. Wailes. 2005. "Economics of Transporting Poultry Litter from Northwest Arkansas to Eastern Arkansas Croplands." Presented at the Southern Agricultural Economics Association Annual Meeting, Little Rock, Arkansas, February 5-9, 2005.

This paper used an optimization analysis to evaluate options for transporting poultry litter from northwest Arkansas to eastern Arkansas to supply crop nutrients. The study considered raw and baled litter and transport by truck and barge. The results find that baled litter from northwest Arkansas shipped by trucks that have backhauls, in combination with chemical fertilizer supplementation, is the least costly way to deliver crop nutrients to eastern Arkansas.

APPENDIX D

FARMER SURVEY

Farmer Survey

PART 1: Past and Current Poultry Litter Use

1. Have you ever used poultry litter as a fertilizer on your farm? (Please circle one.)

YES NO

(Go to PART 2, Question 15)

2. For each of the following crops, please indicate the most recent year you used poultry litter, the acreage poultry litter was applied to, the application rate per acre or total amount applied, and the month in which you acquire your litter.

CROP	Most Recent Year Applied Litter	Month Litter was Acquired	Acreage to which Litter was Applied	Application Rate (tons/acre) -OR-	Total Amount Applied (tons)
Corn					
Cotton					
Peanut					

Soybean					
Hay/Pasture					
Other Crops List Below					

3. Did you acquire any litter through the NRCS Poultry Litter Transfer Pilot Project in 2006 or 2007?

_____2006_____ _____2007_____

YES NO YES NO

4. Consider the poultry litter you have used in the past. Approximately, what percentage of this litter did you purchase, produce on your own farm, acquire at no cost to you, or were paid to take?

Purchased……………………________%

Produced on your own………________%

Acquired at no cost…………________%

You were paid to take it……..________%

If you have not purchased litter in the past, please skip over Question 5 and Question 6. Go to Question 7.

5. What is the most you have paid for poultry litter in the past?

Year _______ $/ton________ Crop___________

6. Did the amount paid in Question 5 include the cost of spreading? (Please circle one.)

YES NO

7. Do you typically store poultry litter prior to application, or is it applied at the same time it is delivered? (Please circle one.)

Store it　　　　　　Apply upon delivery

8. Do you typically spread the litter yourself or pay someone else to spread it? (Please circle one.)

Self　　　　　　Pay Someone Else

9. Approximately, how much do you have to pay, or how much does it cost you for poultry litter spreading?

________$/ton　　　　OR　　　　_______$/acre

10. Is the poultry litter you use typically tested for nutrient content prior to application? (Please circle one.)

YES　　　　　　NO

11. When you apply poultry litter to a field, do you typically reduce the amount of commercial nitrogen fertilizer applied to that field? (Please circle one.)

YES　　　　　　NO

12. When you apply poultry litter to a field, do you typically reduce the amount of commercial phosphorous fertilizer applied to that field?

YES NO

13. Consider the poultry litter you have received in the past. Have you ever received litter from…

a. More than 25 miles from your operation? YES NO

b. More than 50 miles from your operation? YES NO

c. More than 75 miles from your operation? YES NO

d. More than 100 miles from your operation? YES NO

e. More than 125 miles from your operation? YES NO

f. More than 150 miles from your operation? YES NO

g. More than 200 miles from your operation? YES NO

14. How far away from your farm operation does your poultry litter typically come?

___________ miles

PART 2: Future Poultry Litter Use

15. Do you expect to use poultry litter as a fertilizer in the future on your farm? (Please circle one.)

YES NO

(Go to PART 3, Question 19)

16. Please consider your future poultry litter applications. For each of the following crops, indicate the maximum acreage you expect to apply poultry litter to, and the application rate per acre or total amount you expect to apply per year in the future.

CROP	Maximum Acreage	Application Rate (tons/acre) -OR-	Total Amount Applied per year (tons)
Corn			
Cotton			
Peanut			
Soybean			
Hay/Pasture			
Other Crops List Below			

17. What is the maximum amount you would be willing to pay per ton for poultry litter in the future?

____________$/ton

18. Does this amount include spreading costs?

YES NO

PART 3: Poultry Litter Attributes

19. Please indicate how strongly you agree or disagree with the following statements where 1 indicates you STRONGLY DISAGREE and 5 indicates you STRONGLY AGREE.

	Strongly Disagree				Strongly Agree
a. Poultry litter enhances soil organic matter……….	1	2	3	4	5
b. Poultry litter is difficult to acquire……………….	1	2	3	4	5
c. Poultry litter increases soil moisture retention…...	1	2	3	4	5
d. Poultry litter costs more than it is worth…………	1	2	3	4	5
e. Poultry litter is difficult to apply………………….	1	2	3	4	5
f. Poultry litter nutrient content varies a lot from load to load…………………………….	1	2	3	4	5
g. Poultry litter adds valuable micronutrients in addition to N, P, and K……………………...	1	2	3	4	5
h. It is easy to determine the best time to apply poultry litter…………………………………	1	2	3	4	5

i. If I could acquire poultry litter at a fair price,

I would **only** use poultry litter for my

crops' nitrogen needs………………………..1 2 3 4 5

j. If I could acquire poultry litter at a fair price,

I would **only** use poultry litter for my

crops' phosphorous needs…..………………..1 2 3 4 5

20. What do you believe is a fair price for poultry litter and spreading costs?

LITTER: __________$/ton

SPREADING:__________$/ton OR ________$/acre

PART 4: General Fertilizer Applications

21. Please indicate how important each of the following factors is in your decision regarding the application rate of nitrogen and phosphorous, where 0 indicates it is NOT AT ALL IMPORTANT and 5 indicates it is VERY IMPORTANT.

	Not Important					Very Important
a. Results of a plant or soil nutrient test…………………………	0	1	2	3	4	5
b. Crop consultant recommendation………	0	1	2	3	4	5
c. Fertilizer dealer recommendation………	0	1	2	3	4	5
d. Extension service recommendation……..	0	1	2	3	4	5
e. Cost of nitrogen…………………………	0	1	2	3	4	5
f. Cost of phosphorous.……………………	0	1	2	3	4	5
g. Expected commodity price………………	0	1	2	3	4	5
h. Routine practice (own determination based on past experience)……….....	0	1	2	3	4	5

22. In what county(s) is your farm operation primarily located?

____

24. Please indicate how strongly you agree or disagree with the following statements regarding the Natural Resource Conservation Service (NRCS) Poultry Litter Pilot Project, where 1 means you STRONGLY DISAGREE and 5 means you STRONGLY AGREE.

	Strongly Disagree				Strongly Agree
a. I was well informed of the Project……………...…	1	2	3	4	5
b. I understood the rules of the Project………………	1	2	3	4	5
c. I did **not** participate in the Project because the payments were too low………………………	1	2	3	4	5
d. I did **not** participate in the Project because I was not eligible………………………………	1	2	3	4	5
e. I did participate and would like the Project to continue…………………………….………..	1	2	3	4	5
f. I did **not** participate but I would like the Project to continue…………………………..	1	2	3	4	5
g. The only way to increase poultry litter use is to pay farmers to use it………………..….	1	2	3	4	5

Thank you for your time. Please use the following space to provide any comments or additional information you would like to share.

APPENDIX E:

NITROGEN AND PHOSPHORUS RECOMMENDATIONS

Phosphorus Recommendation Models

Crop	K_2O Coastal Plain lbs/A	K_2O Piedmont lbs/A	P_2O_5 Coastal Plain lbs/A	P_2O_5 Piedmont lbs/A
Corn (for Grain) Irrigated	if (K<250) $152 - 0.79K + 0.0019K^2$	if (K<350) $158 - 0.614K + 0.00107K^2$	if (P<100) $121 - 0.755P + 0.00147P^2$	if (P<75) $122 - 1.23P + 0.00574P^2$
Peanuts	if (K<150) $96 - 1.111K + 0.00185K^2$	if (K<200) $94 - 0.547K - 0.00053K^2$	if (P<60) $94 - 1.822P - 0.00593P^2$	if (P<40) $94 - 2.733P - 0.01333P^2$
Small Grain - Wheat	if (K<250) $98 - 0.622K + 0.00066K^2$	if (K<350) $103 - 0.472K + 0.00036K^2$	if (P<100) $102 - 1.509P + 0.00293P^2$	if (P<75) $103 - 2.459P + 0.01148P^2$
Soybeans	if (K<275) $109 - 0.268K + 0.00021K^2$	if (K<400) $110 - 0.175K + 0.00006K^2$	if (P<100) $84 - 0.868P - 0.0022P^2$	if (P<75) $85 - 1.538P + 0.00096P^2$
Coastal Bermuda Pasture	if (K<250) $149 - 1.024K + 0.00215K^2$	if (K<350) $157 - 0.79K + 0.0012K^2$	if (P<100) $76 - 1.132P + 0.0022P^2$	if (P<75) $78 - 1.844P + 0.00861P^2$
Hybrid Bermudas - Pasture	if (K<250) $149 - 1.024K + 0.00215K^2$	if (K<350) $157 - 0.79K + 0.0012K^2$	if (P<100) $76 - 1.132P + 0.0022P^2$	if (P<75) $78 - 1.844P + 0.00861P^2$
Coastal Bermuda-Hay	if (K<250) $273 - 0.779K + 0.00083K^2$	if (K<350) $278 - 0.588K + 0.00044K^2$	if (P<100) $88 - 0.491P - 0.00293P^2$	if (P<75) $89 - 0.924P - 0.00191P^2$
Hybrid Bermudas-Hay	if (K<250) $273 - 0.779K + 0.00083K^2$	if (K<350) $278 - 0.588K + 0.00044K^2$	if (P<100) $88 - 0.491P - 0.00293P^2$	if (P<75) $89 - 0.924P - 0.00191P^2$
Fescue-Clover Associations	if (K<250) $123 - 0.779K + 0.00083K^2$	if (K<350) $128 - 0.588K + 0.00044K^2$	if (P<100) $127 - 1.886P + 0.00366P^2$	if (P<75) $129 - 3.074P + 0.01435P^2$
Fescue Pasture	if (K<250) $98 - 0.622K + 0.00066K^2$	if (K<350) $103 - 0.472K + 0.00036K^2$	if (P<100) $102 - 1.509P + 0.00293P^2$	if (P<75) $103 - 2.459P + 0.01148P^2$
Orchard Grass Pasture	if (K<250) $98 - 0.622K + 0.00066K^2$	if (K<350) $103 - 0.472K + 0.00036K^2$	if (P<100) $102 - 1.509P + 0.00293P^2$	if (P<75) $103 - 2.459P + 0.01148P^2$
Common Bermuda Pasture	if (K<250) $98 - 0.622K + 0.00066K^2$	if (K<350) $103 - 0.472K + 0.00036K^2$	if (P<100) $102 - 1.509P + 0.00293P^2$	if (P<75) $103 - 2.459P + 0.01148P^2$
Cotton - 750 lbs yield goal	if (K<275) $123 - 0.672K + 0.00054K^2$	if (K<400) $126 - 0.439K + 0.00016K^2$	if (P<100) $127 - 1.886P + 0.00366P^2$	if (P<75) $129 - 3.074P + 0.01435P^2$
Cotton - 1000 lbs yield goal	if (K<275) $131 - 0.591K + 0.00002K^2$	if (K<400) $133 - 0.373K - 0.00011K^2$	if (P<100) $144 - 1.943P + 0.00183P^2$	if (P<75) $146 - 3.228P + 0.01196P^2$
Cotton - 1250 lbs yield goal	if (K<275) $155 - 0.724K + 0.00012K^2$	if (K<400) $158 - 0.46K - 0.00008K^2$	if (P<100) $160 - 2P + 0P^2$	if (P<75) $163 - 3.383P + 0.00957P^2$
Cotton - 1500 lbs yield goal	if (K<275) $163 - 0.644K - 0.0004K^2$	if (K<400) $165 - 0.394K - 0.00035K^2$	if (P<100) $170 - 2P + 0P^2$	if (P<75) $173 - 3.383P + 0.00957P^2$
Fescue Hay	if (K<250) $98 - 0.622K + 0.00066K^2$	if (K<350) $103 - 0.472K + 0.00036K^2$	if (P<100) $102 - 1.509P + 0.00293P^2$	if (P<75) $103 - 2.459P + 0.01148P^2$

APPENDIX F:

FERTILIZER COST USED IN TRANSPORT MODEL

Fertilizer Prices ($/Ton)

	2006	2007	2008
Nitrogen			
Ammonium nitrate	$390.00	$425.00	$543.00
Ammonium sulfate	$266.00	$288.00	$391.00
Nitrogen solutions	$249.00	$286.00	$392.00
Urea	$362.00	$453.00	$552.00
Phosphate			
Diammonium polyphosphate	$354.00	$481.00	$879.00
Ammonium Polyphosphate	$318.00	$358.00	$650.00
Potash			
Potassium chloride (muriate)	$294.00	$309.00	$524.00
Potassium magnesium sulfate SPM[a]			$449

Source: USDA, NASS

a: USDA did not publish prices for SPM. The price used came from US 1 Farm Service in Lyons, GA.

APPENDIX G:

CROP PRODUCTION MAPS

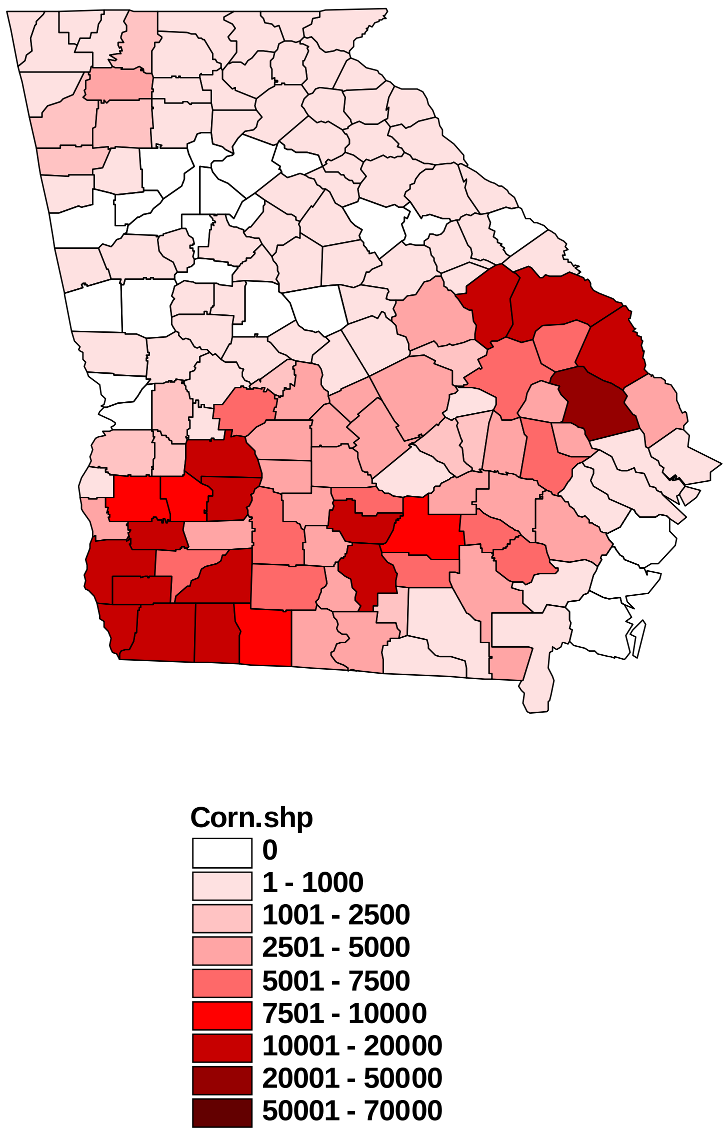


Figure 2007 Corn Acreage

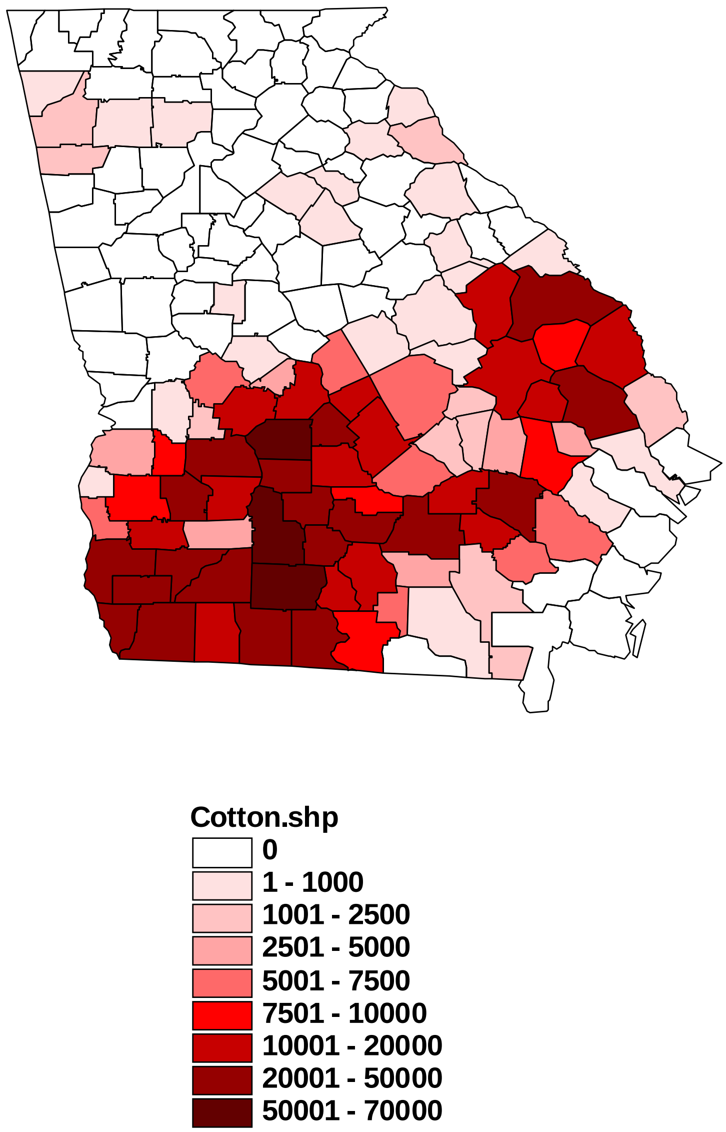


Figure 2007 Cotton Acreage

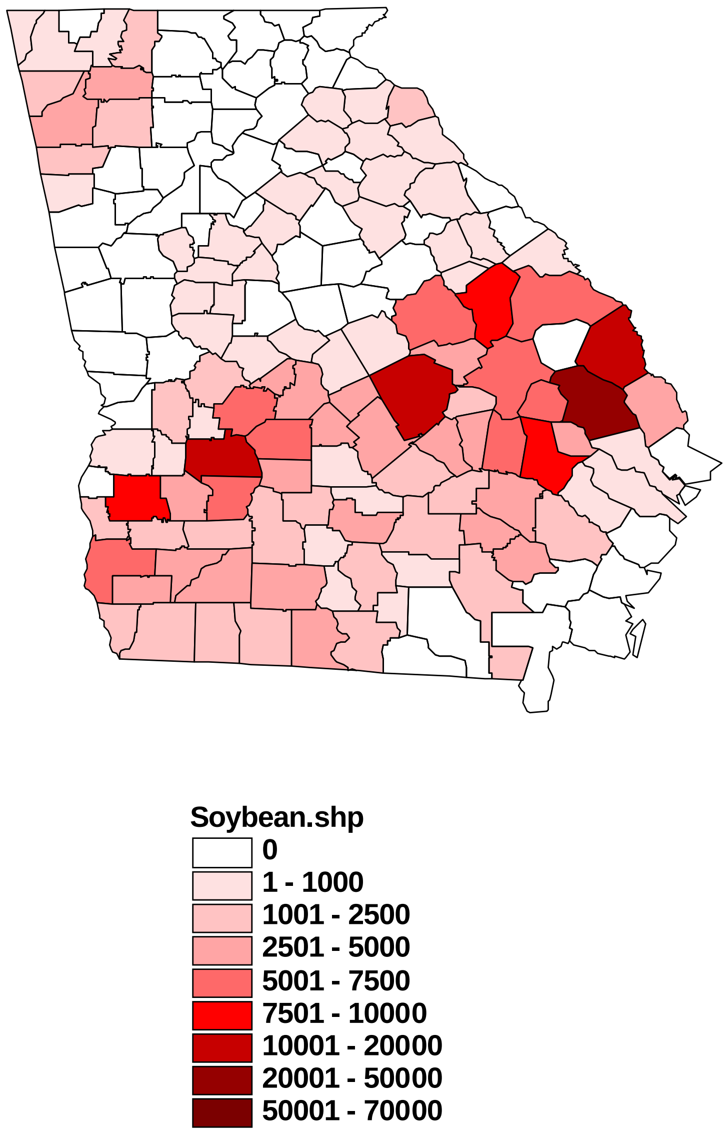


Figure 2007 Soybean Acreage

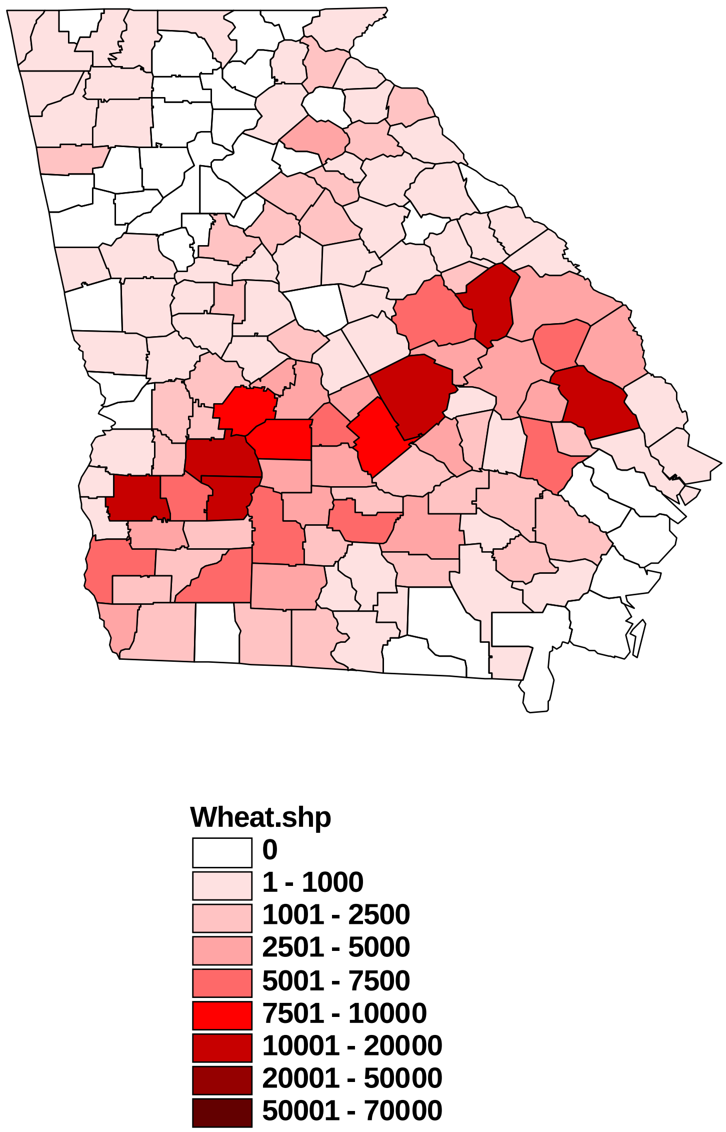


Figure 2007 Wheat Acreage

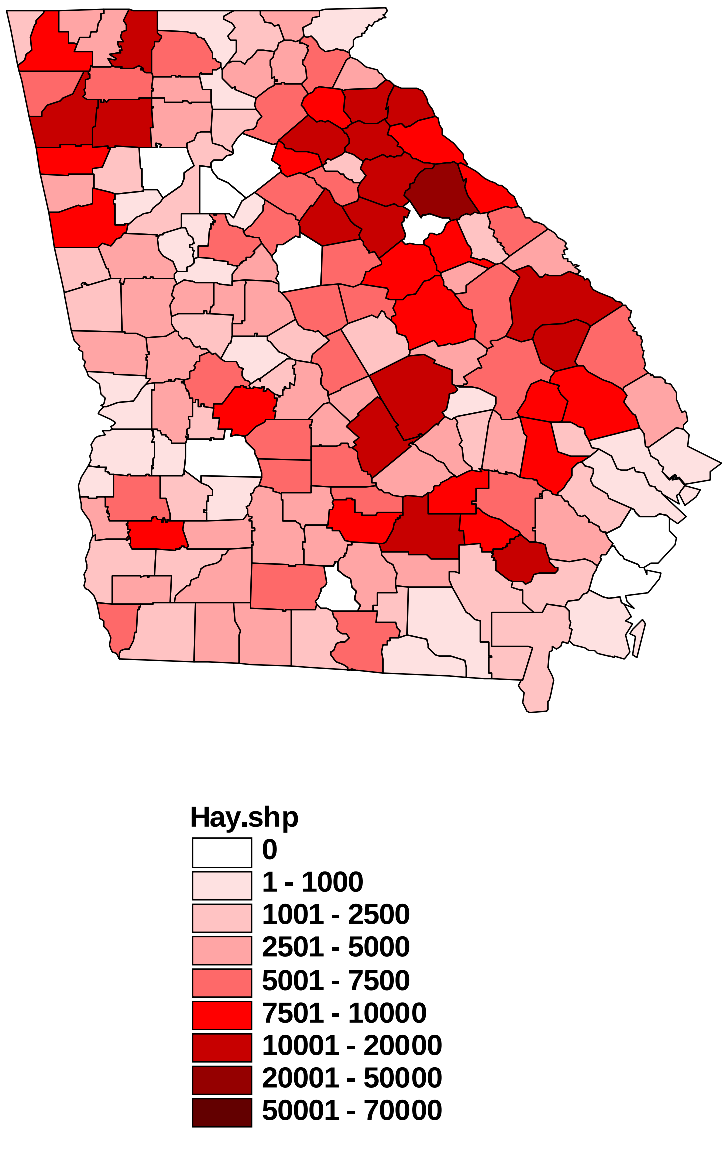


Figure 2007 Hay Acreage

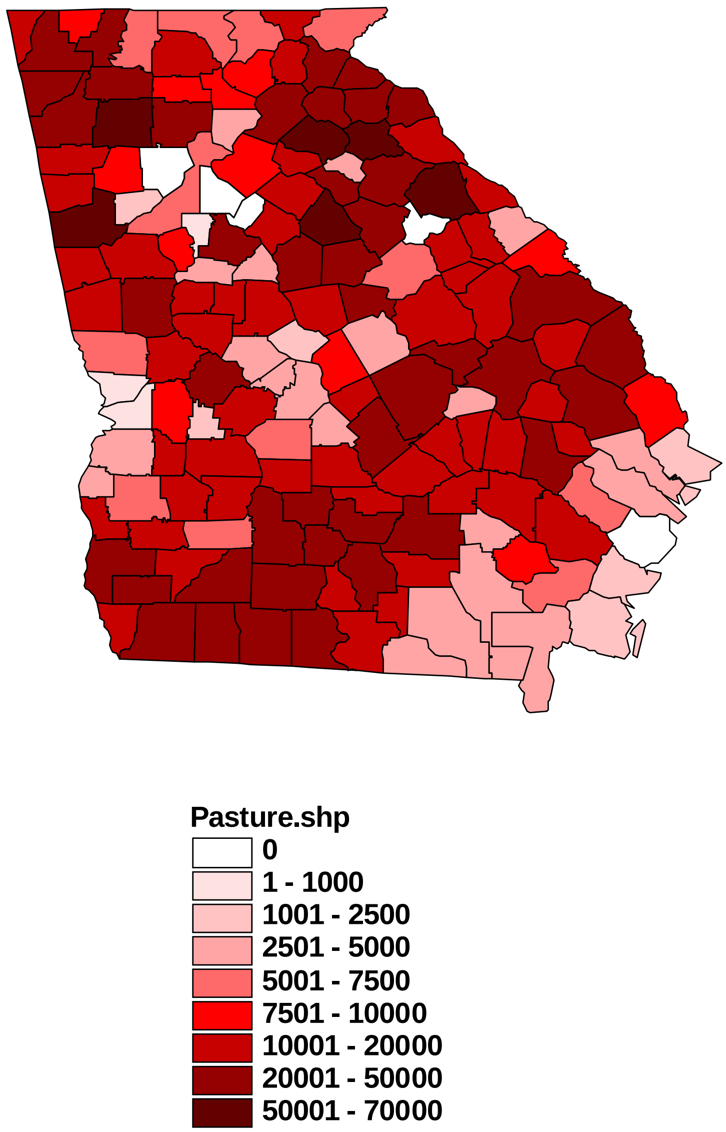


Figure 2007 Pasture Acreage

APPENDIX H:

GEORGIA WATER PLANNING AND PLOICY CENTER PAPERS ON WATER QUALITY TRADING

Georgia Water Planning and Policy Center Papers on Water Quality Trading

Paper #2008-001 Water Quality Trading: Recent Developments and Policy Implications. K. Rowles, June 2008.

Paper #2006-012 Building a Foundation for Water Quality Trading in Georgia. K. Rowles, R. Cummings, and L. Taylor, August 2006.

Paper # 2006-010 Water Quality Trading in the Context of the Antidegradation Requirements of Federal and State Clean Water Policies, K. Rowles and B. Thompson, June 2006.

Paper # 2005-023 Watershed Pollutant Trading: Estimating Costs of Phosphorus Removal in Wastewater Treatment Facilities, F. Jiang, M.B. Beck, R.G. Cummings, and K. Rowles, December 2005.

Paper # 2005-021 Water Quality Trading: Legal Analysis for Georgia Watersheds, K. Rowles and B. Thompson, June 2005.

Paper # 2005-020 A Feasibility Analysis of Applying Water Quality Trading in Georgia Watersheds, K. Rowles, June 2005.

Paper # 2005-011 Estimation of Costs of Phosphorus Removal in Wastewater Treatment Facilities: Adaptation of Existing Facilities, F. Jiang, M.B. Beck, R.G. Cummings, K. Rowles, and D. Russell, February 2005.

Paper # 2005-003 An Evaluation of Water Quality Trading for Georgia Watersheds, K. Rowles, January 2005.

Paper # 2004-015 Nutrient Trading in the Upper Chattahoochee Watershed: A Feasibility Analysis, K. Rowles, June 2004.

Paper # 2004-010 Estimation of Costs of Phosphorus Removal in Wastewater Treatment Facilities: Construction De Novo, F. Jiang, M.B. Beck, R.G. Cummings, K. Rowles, and D. Russell, June 2004.

Paper # 2003-002 Developing Offset Banking Systems In Georgia, R.G. Cummings, L. Taylor and M.B. Beck, March 2003.

Paper #2002-004 Offset Banking – A Way Ahead For Controlling Nonpoint Source Pollution In Urban Areas in Georgia, M. Morrison and L. Taylor, May 2002.

All reports are available on the Georgia Water Planning and Policy Center website:
http://www.h2opolicycenter.org

APPENDIX I:

AGENDAS FOR OUTREACH MEETINGS

Workshop Announcment

Poultry Litter Transfer: Learning from Experience

October 10, 2007
9:00am to 3:45pm

Gainesville State College
Business/Continuing Education/Performing Arts Building
3820 Mundy Mill Road
Oakwood, GA

For more information, visit www.agp2.org/aware

Poultry litter is a resource to farmers in Georgia that must be managed carefully so that it does not threaten water resources. While many potential users would like to obtain more litter for use as fertilizer, as fuel, or for value-added processing, transportation costs and other barriers limit these applications.

This workshop seeks to learn from our experience and the experience of other states with incentive payments for litter transfer. It is organized to evaluate and improve current litter transfer efforts in Georgia.

The workshop will:

- **Provide an overview of the industry;**
- **Discuss Georgia's pilot poultry litter transfer incentive program;**
- **Present ideas for litter transfer programs from other states;**
- **Gather recommendations for improving Georgia's programs; and**
- **Recruit members for a litter transfer advisory group.**

Who should attend: **Stakeholders with an interest in the poultry industry, including chicken producers, poultry processors, manure brokers and transporters, farmers and others interested in using manure as fertilizer, conservation district leaders, value-added manure processors, and environmental advocates and professionals.**

Registration:

Free, but **advance registration is required**.
To register, send an e-mail to **poultryworkshop@h2opolicycenter.org** with your name, affiliation, address, phone number, and e-mail address.
Note: Registration will be limited to the first 100 registrants.
Hotel Accommodations available at Comfort Inn, Oakwood, GA, (770) 287-1000

The University of Georgia — Georgia Water Planning & Policy Center — GSWCC Georgia Soil and Water Conservation Commission — NRCS

Registration questions: Please contact Kristin Rowles at poultryworkshop@h2opolicycenter.org or (404) 822-2395.

Posters & Displays: Free display space is available at the workshop. Please contact Mark Risse at mrisse@engr.uga.edu or (706) 542-9067.

Map of Gainesville State College available at: http://www.gsc.edu/map2.pdf

Agenda:

9:00 am	**Registration**
9:30 am	**Welcome**
9:45 am	**Georgia's Poultry Industry** **Casey Ritz, UGA Poultry Science**
10:00 am	**Poultry Litter Distribution in Georgia** **David Kissell, UGA Crop and Soil Science**
10:15 am	**Georgia's Pilot Nutrient Transfer Project** **David Lamm, USDA NRCS & Jeff Mullen, UGA Agricultural Economics**
10:45 am	**Break**
11:00 am	**Panel: Lessons Learned in Other States** ***Litter Transport in Oklahoma and Arkansas*** **Sherri Heron, BMP's Inc.** ***Maryland, the original transport program*** **Norman Astle, Maryland Department of Agriculture** ***Alabama's Experience*** **Zona Beaty, NRCS & Charlie Mitchell, Auburn University**
12:30 pm	**Lunch & Poster Session**
1:15 pm	**Break-Out Group Discussions** ♦ ***Georgia Program Recommendations*** ♦ ***Opportunities for Value-Added Processing and Products*** ♦ ***Impediments/Roadblocks*** ♦ ***Transportation Options***
2:15 pm	**Break**
2:30 pm	**Break-Out Group Discussions –** ***Repeat same topics listed above***
3:15 pm	**Report Back from Breakouts & Conclusion**
3:45 pm	**Workshop Ends**

♦ ♦ ♦ ♦ ♦ ♦ ♦ ♦ ♦ ♦ ♦ ♦ ♦ ♦ ♦ ♦ ♦ ♦ ♦

4:00 pm **Initial Advisory Group Meeting** ***(1-hour)***

One of the primary objectives of the workshop is to form an advisory group that will assist in developing recommendations for poultry transfer incentives in Georgia. This advisory group will meet on October 10 from 4-5pm, and approximately four additional times between November 2007 and September 2008. Any interested stakeholder is invited to attend this important first meeting of the advisory group at the conclusion of the October 10th workshop.

Registration questions: Please contact Kristin Roles at poultryworkshop@h2opolicycenter.org or (404) 822-2395.

NPK

NPK

Workshop Announcement

THE VALUE OF POULTRY LITTER AS FERTILIZER:

Concerns & Benefits

What is the nutrient value of poultry litter?

How does the NPK compare with commercial fertilizer?

How do the costs compare?

What lessons have farmers learned about getting and using poultry litter?

Date: Wednesday, March 19, 2008

Time: 10:00 am to 2:00 pm

Location: New Perry Hotel, 800 Main Street
Perry, Georgia 31069

AGENDA

MARCH 19, 2008

10am – 2pm

New Perry Hotel in Perry, Georgia

Arrive early if possible, since we would like for you to review in advance our survey on litter application, which we will discuss during the presentation

10:00 Welcome & Introductions

10:15 Overview of Project (Kristin Rowles)

10:30 Overview of Poultry Industry & Litter (Mark Risse)

10:45 Calculating Nutrient Replacement Value of Litter (Dave Kissel)

11:05 Cotton Fertility Response to Poultry Litter (Glen Harris)

11:20 Pilot Project Overview & discussion of Survey (Jeff Mullen)

12:00 Lunch (Provided)

12:45 Discussion (facilitated by Sam Collier)

1. Have you or someone that you know used litter?
2. What was your (their) experience? (advantages, disadvantages)
3. How easy/difficult is it to source litter?
4. Are you aware of the litter website?
5. What do you think it would cost for litter?

   How does that compare to equivalent commercial fertilizer?

6. How would you store litter?
7. What would make you more interested in using litter?
8. What lessons learned would you offer for using poultry litter?
9. Where would you look for litter first?
10. Are local sources adequate?

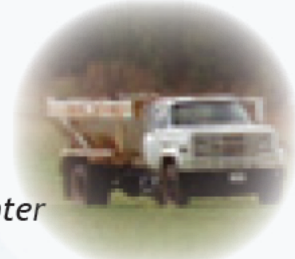
1:45 Summary and Wrap-up

Poultry Forum: Turning Litter into Opportunities

AGENDA

Wednesday, August 20, 2008

8:00 - 9:00 am	Registration
	General Session *Moderator:* Mark Risse
9:00 - 9:20 am	Phosphorus and Water Quality *Miguel Cabrera - University of Georgia*
9:20 - 9:40 am	The AR/OK Nutrient Case Study *Josh Payne - Oklahoma State University*
9:40 - 10:00 am	Land Use and Sustainability in Georgia *Liz Kramer - University of Georgia*
10:00 - 10:30 am	Nutrient Trading: How does it work? *George Hazard - Red Barn Trading Company*
10:30 - 10:45 am	Break
	Results of Georgia Nutrient Transfer Project
10:45 - 11:00 am	Stakeholder Response *Sam Collier - Georgia Southern University*
11:00 - 11:15 am	Survey Results *Jeff Mullen - University of Georgia*
11:15 - 11:45 pm	Research Results and Summary of project findings *Kristin Rowles - Georgia Water Planning and Policy Center*
11:45 - 12:00 pm	The Value of Poultry Litter *David Kissel - University of Georgia*
12:00 - 1:00 pm	Lunch



Demand/Value of Poultry Litter

1:00 - 1:30 pm	Programming Model on Commercial Fertilizer Substitution/Distribution *Jeff Mullen - University of Georgia*
1:30 - 2:45 pm	What Drives the Market for Off-site Litter Use? (Panel discussion) *Bob Edwards - Triple E Poultry (Litter Hauler)*
2:45 - 3:00 pm	Break

Breakout Sessions

Value Added Processing

3:00 - 3:30 pm	Turning Poultry Litter into Steam *Dave Mooney - EcoREMedy*
3:30 - 4:00 pm	TOP Organic Fertilizer *Chris Nichols - Organic Growing Systems Inc.*
4:00 - 4:30 pm	Poultry Litter Digestion *Shannon Vinyard - HWT Energy Inc.*
4:30 - 5:00 pm	Fractionation and Pyrolysis of Litter *K. Singh & Mark Risse - University of Georgia*

Other Innovative Programs

3:00 - 3:30 pm	Performance-Based Incentives for Agricultural Pollution Control *Chad Ingels - Iowa State University*
3:30 - 4:00 pm	Policy and Feasibility of Nutrient Trading *Kristin Rowles - Georgia Water Planning and Policy Center*
4:00 - 4:30 pm	Water Quality in the Etowah Watershed *Josh Romeis & David Radcliffe - University of Georgia*
4:30 - 5:00 pm	Alabama Nutrient Programs *Mike Roden - Alabama RC&D*

5:00 - 7:00 pm	Meeting Wrap-up & Reception *Poster Session/Exhibits*

The University of Georgia

GEORGIA Water PLANNING & POLICY CENTER

GSWCC Georgia Soil and Water Conservation Commission

NRCS