Forests as an Alternative for Poultry Manure Application

Applying poultry manure to forestland that needs nitrogen and phosphorus can help poultry producers manage waste and put valuable nutrients to work for forest owners.

Background
Forest soils in the southern United States are almost universally deficient in nitrogen (N) and phosphorus (P). These forests often exist near animal feeding operations that produce large surpluses of N and P in animal manure. North Carolina has 30 counties where more P is produced in animal manures than can be assimilated by all the cropland and pastureland in those counties, and 7 counties where more N is produced than can be assimilated (Gollehon et al., 2001). These analyses did not consider forestland. It appears that forestland will have to be used—in addition to available cropland and pastureland—if land application is to continue to be a method by which NC poultry producers manage animal waste nutrients and retain their prominent position in U.S. animal agriculture. Thus, great potential exists to develop mutually beneficial “win-win alliances” between poultry producers and forest owners by putting the valuable N and P nutrients in poultry manure to work in forests. Research shows that fertilization can increase production of a wide variety of marketable forest products and enhance ecosystem services. Shorter-rotation forest crops, such as nursery planting stock or woody biomass species, and annual crops such as pinestraw can also benefit when pine forests are fertilized.

This publication is based on a research project designed to investigate factors that make forest fertilization with animal manures successful in North Carolina. We investigated the practical experience and perspectives of animal producers, forest owners, and forest managers through interviews with poultry producers who have used or considered using poultry litter to fertilize forests. Sometimes the poultry producers we interviewed also owned or managed the forestlands where poultry litter nutrients were being applied to increase yields of marketable forest products.

North Carolina has more than 18 million acres of forestland (60 percent of the state’s total land area), almost 90 percent of which is privately owned. That includes roughly 2.5 million acres of loblolly, slash, shortleaf, and longleaf pine plantations,
Forests as an Alternative for Poultry Manure Application

about 100,000 acres of which are fertilized with synthetic chemical fertilizers or animal manure nutrients. Plantations of hardwood trees are much less common in North Carolina and employ essentially no routine fertilization.

Southern pine plantations were the most common type of forest currently being fertilized with poultry waste by our interviewees. The amounts of poultry manure nutrients being applied usually involved applications of moderate amounts of dry poultry litter (typically containing 30 to 40 pounds of N).

Nearly 3,000 poultry farms are located in the NC piedmont and coastal plain, producing turkeys, chicken broilers, and eggs. Farms that produce eggs often use a liquid waste management system; they represent a relatively small fraction of North Carolina’s poultry sector and are not considered here. Agriculture statistics indicate that about 760 million broilers and 35.5 million turkeys were produced in 2009. The total amount of poultry manure (wet plus dry excretions) produced in North Carolina is estimated to be 8 to 10 million tons per year. As shown in the maps in Figure 2, turkey production is concentrated in the NC southern coastal plain; chicken production is distributed across the NC coastal plain and southern piedmont.

Based on 1996 to 2006 analyses, poultry litter in North Carolina has average plant-available nutrients per ton of about 29 lb N, 26.8 lb P\(_2\)O\(_5\), and 40 lb K\(_2\)O for broiler house litter and 24.2 lb N, 28 lb P\(_2\)O\(_5\), and 26.6 lb K\(_2\)O for turkey house litter (Cleveland et al., 2007).

Farms with 30,000 or more birds must develop poultry dry litter management plans but are not required to obtain general manure application permits. Poultry manure waste management plans are designed to maximize beneficial use of manure nutrients and minimize nutrient losses from the farm. Appropriate manure application rates for both agricultural crops and forest trees are determined by realistic yield expectations (RYE) for the specific crop, soil characteristics of the specific site, and the nutrient content of the poultry litter.

Benefits of Using Poultry Litter in Forest Fertilization

Using poultry litter in forest fertilization offers benefits to poultry producers and forestland owners. The quotes noted below came from the poultry producers we interviewed.

- Offers additional land for useful nutrient application. Alliances between poultry producers and forest owners and managers can provide additional land for fertilization applications. One interviewee noted that,

Figure 2.A. Turkey population density in North Carolina in 2007, 5-mile grid. B. Chicken breeder population density in North Carolina in 2007, 5-mile grid.

“This advantage is likely to become more important in the future especially if P requirements become more of an issue.”

- Allows a longer window of time during the year for application. Forests can have nutrients applied to them during periods when some pasture or row crops can’t be fertilized; the application window for pine stands usually extends from November through February.

- Provides an alternative to fully clearing a site for pasture or row crops if establishing a new application site. “A real benefit of this practice is that bulldozing a lane through an existing forest site will quickly get you 6 to 7 acres to apply to, instead of needing to clear the whole area for grass.”

- Avoids the expense of yearly harvests of annual crops. “If the trees will take it [the nutrients in poultry litter], you won’t have the expense of harvesting the hay or rye crop.”
Increases growth of a valuable crop. Most southern pine plantations are limited by nutrient availability. Long-term research by the Forest Nutrition Cooperative (formed by NC State University, Virginia Polytechnic Institute, and Universidad de Concepción in Chile) indicates that most southern pine stands throughout the southern states show strong growth in response to fertilization with N and P. A typical wood volume growth increase is 30 percent over 8 years and can be as high as 100 percent (Fox et al., 2007). Four recent studies have documented 25 to 40 percent and up to 50 percent increases in annual production of longleaf pinestraw after fertilization with either poultry litter or synthetic N and P fertilizers (Blevins, 1994; Blevins et al., 1996; Environmental Impact, 2003; Allen, 2007).

Addressing Obstacles to Using Poultry Manure Nutrients in Forest Fertilization

During interviews with poultry producers, several perceived obstacles to the use of manure to fertilize forestlands were identified and potential ways to overcome them were discussed.

Concern about delivering animal manures into forest stands

In general, forest fertilization systems have successfully utilized the same application methods and spreader equipment traditionally used on agricultural crops. Ideally, a forest stand is planted at a spacing that will allow the equipment required to spread litter to pass through the stand. Thinning to remove rows at an interval, such as every fifth row, in a stand previously established at a smaller spacing, and clearing lanes in naturally regenerated stands, are also used as ways to provide access over a whole stand rotation.

Lower rate of nutrient application than pasture or row crops

The Natural Resources Conservation Service (NRCS) nutrient application rate guidelines for forests are lower on an annual basis than guidelines for most agricultural crops, though the revised guidelines allow a relatively large rate (300 lb N/acre) to be applied every fifth year. Sufficient forestland should be identified to ensure appropriate application rates based on the poultry litter's nutrient content, either as an adjunct to pasture and cropland or as a primary application site. Most forest soils have not been subjected to repeated nutrient applications, as is the case with many agricultural soils, and so tend not to have accumulated P. NC State University and county Cooperative Extension specialists can assist with fertilizer recommendations.

Logistical and operational issues

Some interviewees raised this concern: how to coordinate the timing of poultry house cleanout with timing of forest fertilization. Maintaining storage areas for poultry litter, either on individual farms, within forests, or in centralized regional locations, is a potential solution to this problem. Because manures are low nutrient analysis materials, hauling distance can become a critical issue. Coordination of manure volumes and available forest sites is necessary to successful application contractors.

Wood and needle quality

The forest owners we interviewed were concerned that rapid tree growth induced by fertilization would cause reduced wood quality. Recent studies indicate that N added in moderate amounts (100 to 200 lb/acre) to southern pines increased growth for 3 to 5 years and did not significantly change wood strength or stiffness (Clark et al., 2004). Some evidence supports better wood quality from balanced nutrient sources compared to typical urea and diammonium phosphate fertilizers. Some longleaf pine producers believe that high fertilization rates cause growth of exceptionally long longleaf needles that decay quickly. Longleaf pine is particularly sensitive to high fertilization rates. Excessive fertilization can increase needle length and thus make stands more susceptible to ice breakage, pitch canker, and insect attack. It is important to use fertilization rates recommended for specific tree stands. NC State University and county Cooperative Extension specialists can assist with fertilizer recommendations.

Weed production

Several longleaf pinestraw producers saw an increase in weeds as an obstacle to manure application. Fertilization with any nutrient source can cause increased growth of undesirable as well as desirable species. Problems with weed production can be minimized with timing of fertilization application relative to pinestraw raking and with herbicide treatments.

Disease transmission to wildlife

The forest owners we interviewed expressed concern about the potential threat of disease to wild turkeys exposed to domestic poultry litter applied in forests. This seems to be a common worry. Anecdotal evidence exists of wild turkeys contracting diseases from domestic birds confined nearby, but we found no published evidence of disease transmission to natural wild turkey populations as a result of exposure to domestic poultry litter.
Forests as an Alternative for Poultry Manure Application

**Official Guidelines for Land Application of Manure in Forest Stands**

The NRCS Nutrient Management Standard (Code 590) and Waste Utilization Standard (Code 633) provide technical guidelines for manure application to forest plantations in addition to croplands (http://www.nrcs.usda.gov/technical/efotg/). According to these NRCS standards for North Carolina, which are based in large part on guidelines provided by the NC Interagency Nutrient Management Committee (http://www.nc.nrcs.usda.gov/technical/TechRef/nut-mgt-comm.html), up to 60 lb of plant available nitrogen (PAN) per acre per year is allowed for application on pine forestland, except for longleaf pine stands where 30 lb PAN/acre/year is the recommended limit. On hardwood forest stands suitable for organic fertilizers, application rates should not exceed 80 lb PAN/acre/year. Higher N application rates on forestland may be approved in situations where concentrated single waste applications may be necessary, or in cases designed to meet a specific forest nutrition prescription in an approved forest management plan. As a general prescription for waste application on forest plantations, when land receiving waste is predominantly pine forest, organic fertilization must be part of a forestry management plan developed by a qualified professional. Also, animal operations with NC and Nonpoint Discharge Elimination System (NPDES) permits must include all areas where waste is applied in a certified animal waste management plan.

In cases where concentrated single applications are needed, the total application rate can be as high as 300 lb N/acre. Such single applications should not be repeated more frequently than every fifth year, or every tenth year in the case of longleaf pine, in order not to exceed recommended average annual N application rates. Annual soil tests, taken at a soil-surface-to-6-inch sampling depth, must be completed in pine forest application areas to help determine the potential for P leaching. If soil test agronomic P indices are above 50, then no additional animal manure waste application should occur on forestland. A phosphorous loss assessment (PLAT) is not needed for forestland receiving animal manures.

Negative impacts on streams, wetlands, and riparian buffers must be avoided when applying animal manures, and appropriate application setbacks must be observed. At a minimum, no waste material should be applied:

- Within 75 feet of a residential property boundary
- Within 75 feet of an intermittent, seasonal, or perennial stream or river other than an irrigation ditch or canal
- Within 75 feet of an irrigation ditch or canal
- Within 200 feet of a dwelling other than those owned by the producer
- In wetlands and in poorly drained or organic soils

NC and NPDES permitted animal feeding operations are required to observe setbacks set forth by their respective permits and NC regulatory requirements.

Some native plants adapted to low fertility sites are able to compete with introduced species because of limited forestland fertility. Application of organic materials may increase the potential for introducing invasive plants, enhancing their viability, or both. Because the effects of increased fertility in native plant understory are not well understood, any application of waste materials in forestland where the health of native plant communities is a resource concern should be closely monitored for negative impacts. Any increase in noxious or invasive plant species in communities should be noted and considered when fertilizing trees with animal waste materials.

**Description of a Useful GIS Database**

An important part of our research project with forest owners and swine and poultry producers was development of a geographic information system (GIS) database that contains general information for much of the state and more detailed information for the following nine NC counties: Bladen, Duplin, Moore, Montgomery, Onslow, Pender, Richmond, Sampson, and Wayne. The database incorporates the following information: swine operations (2003); 5-mile grid of poultry farms (2007); highways, streets, municipalities, county boundaries, major water bodies, major streams, and river basins for NC; detailed water bodies for the Cape Fear, Lumber, Neuse, White Oak, and Yadkin River Basins; land use/land cover classes; and parcels, soils, and aerial photography (2007) for the nine study counties.

Figure 3 provides examples of products from the database. Figure 3A indicates the parcels of land within a 5-mile radius of a swine finishing farm (the circle is centered on the farm parcel) that fall into two land cover categories: *coniferous cultivated plantation* or *coniferous regeneration*. This represents more than 11,500 acres; a similar calculation for a 1-mile radius (Figure 3B) yields more than 500 acres. Information about poultry operations is only available as gridded population density, but similar calculations can be made if specific location information is provided by a poultry farm owner. Calculations can be made for different forest cover types and different radii. Land parcel owner-
ship information is available to assist in connecting landowners. Similar information can be found by contacting local offices of your county tax assessor, NC Cooperative Extension, NC Division of Forest Resources, USDA Farm Service Agency, or Natural Resource Conservation Service.

**Economics**

The economics of transferring poultry litter to forest stands is similar to that for agricultural crops. In many cases, poultry producers are also forest owners, and thus have associated land that is forested and can be used for manure application. In some cases, poultry producers lease land for waste application to trees. Alliances between producers of nutrients (animal producers) and potential receivers of nutrients (other landowners) are usually developed by personal contact. If a farmer wants to convert existing cropland to trees or is seeking help with transportation costs of animal manures, several incentive programs exist that may provide cost-sharing:

**NC Agricultural Cost Share Program (NCACSP)**

http://www.enr.state.nc.us/DSWC/pages/agcostshareprogram.html

The Agriculture Cost Share Program for Nonpoint Source Pollution Control uses legislative funds administered by the Soil and Water Conservation Commission to assist farmers in best management practices that reduce the input of agricultural nonpoint source pollution into NC waters. The program currently includes 33 counties and can provide up to 75 percent of the cost of a practice up to a maximum of $75,000 per year. Some practices that qualify for assistance include cropland conversion to permanent vegetation, closure of lagoons, riparian buffers or equivalent controls, and animal waste management systems and applications. Forest stands established are expected to remain for 10 years.

**Conservation Reserve Program (CRP)**


CRP is offered by the Farm Service Agency (FSA) in partnership with NRCS as an option for converting eligible erosive cropland and conservation priority areas to trees. CRP gives eligible producers the opportunity to plant trees (can be pines or hardwoods) at a 50 percent cost-sharing rate. In addition, the FSA will pay the producer a rental rate based on the soil type for a period of 10 to 15 years. CRP is a competitive program that is available only during designated signup periods.

**Conservation Reserve Enhancement Program (CREP)**

http://www.enr.state.nc.us/DSWC/pages/crep.html

CREP is a joint effort of the NC Division of Soil and Water Conservation, NC Clean Water Management Trust Fund, Ecosystem Enhancement Program, and FSA to address water quality problems of the Neuse, Tar-Pamlico, and Chowan river basins as well as the Jordan Lake.
watershed area. Under this program, some land management may be restricted.

Other Information Resources
NC Cooperative Extension: http://www.ces.ncsu.edu/
NC Interagency Nutrient Management Committee: http://www.nc.nrcs.usda.gov/technical/TechRef/nut-mgt-comm.html
NC State University/VPI/CU Forest Nutrition Cooperative: http://www.forestnutrition.org/index.htm
NC State University Hardwood Cooperative: http://www.ncsu.edu/project/hardwood/
NC State University Waste Management Programs: http://www.cals.ncsu.edu/waste_mgt/

References


Prepared by
Cari Furiness, Research Associate
Ellis Cowling, University Distinguished Professor Emeritus
Lee Allen, Professor Emeritus
Robert Abt, Professor
Doug Frederick, Professor
Kelly Zering, Associate Professor and Extension Specialist
NC State University, Raleigh, NC

Robert Campbell
Weyerhaeuser Company, Vanceboro, NC

This publication was developed in consultation with the NC Interagency Nutrient Management Committee and current leaders of the university-industry Forest Nutrition Cooperative at NC State University, Virginia Polytechnic Institute, and the Universidad de Concepción in Chile. Funding for this project was provided by the Golden LEAF Foundation and the Kenan Institute for Engineering, Technology and Science at NC State University.

350 copies of this public document were printed at a cost of $497, or $1.42 per copy.

Published by
NORTH CAROLINA COOPERATIVE EXTENSION

Distributed in furtherance of the acts of Congress of May 8 and June 30, 1914. North Carolina State University and North Carolina A&T State University commit themselves to positive action to secure equal opportunity regardless of race, color, creed, national origin, religion, sex, age, veteran status or disability. In addition, the two Universities welcome all persons without regard to sexual orientation. North Carolina State University, North Carolina A&T State University, U.S. Department of Agriculture, and local governments cooperating.