Due to the specialization and integration of the modern poultry industry, poultry farms have the potential to import more nutrients than what is exported from the farm in the form of animal and plant products. In the past, phosphorus imported in poultry feed often remained on-farm in the form of poultry litter, a mixture of bedding material and manure. This litter was often land applied at rates to meet crop nitrogen needs, which resulted in soil phosphorus buildup on some farms. Because the nutrient ratio in litter is different from that of plant nutrient requirements, careful consideration must be taken when land applying to avoid over-application of certain nutrients, primarily phosphorus. If poultry litter land application is not properly managed, excess phosphorus application could degrade water quality through runoff into surrounding surface water resources. These concerns have led to environmental regulations, litigation, and successful efforts to move poultry litter outside of critical watersheds.

Figure 1 illustrates the annual amount of broiler litter produced in Eastern Oklahoma counties, which is where the majority of the state’s poultry industry is located.

The most obvious solution to this problem is to export the excess manure nutrients out of the phosphorus dense watersheds into areas deficient in soil phosphorus, relative to agronomic needs. Figure 2 shows the demand for phosphorus reported in tons of broiler litter for all Oklahoma counties.

However, since poultry litter nutrients are not as concentrated as commercial fertilizer, transportation cost is the most limiting factor for exporting poultry litter away from nutrient sensitive watersheds. The alternative litter storage technique described below promotes degradation of litter carbon, which appreciably reduces the total mass of the litter and also increases the phosphorus and potassium concentrations compared to fresh or normally stored litter. The advantage of this process is that the final product (degraded litter) can be transported at a lower cost per lb of nutrients, or put another way, it can be transported greater distances before the transport cost exceeds manure value.


In order for the process to be effective only two requirements are necessary: adjustment of litter dry matter to 0.60 (weight solids/total weight) and covering with a suitable tarp. The process was designed to use little time, money, and effort compared to a traditional composting system that involves addition of bulking agents that would increase litter mass and dilute phosphorus concentration.

**Step 1**

Uniformly add enough water to decrease dry matter content to 0.60. The amount of water (gallons) to be added per ton of litter is calculated as:
Aeration pipes (option 3) 0.77 23.0 74 104 101 157 134
One month turnover (option 2) 0.65 19.6 80 103 100 160 123
No turnover (option 1) 0.67 14.9 80 94 94 152 119
Initial 0.66 - 88 82 82 144 111

Lb/Lb   --------Lbs/ton--------                      ----$/ton----

Nutrient content is shown on a dry mass basis. Litter value is expressed on both a dry and wet mass basis.

Table 1: Impact of the litter degradation storage process on percent mass reduction, nutrient content, and litter value after a two-month period. Nutrient content is shown on a dry mass basis. Litter value is expressed on both a dry and wet mass basis.

<table>
<thead>
<tr>
<th>Litter Treatment</th>
<th>Dry mass (w/w)</th>
<th>% reduction</th>
<th>N</th>
<th>P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;</th>
<th>K&lt;sub&gt;2&lt;/sub&gt;O</th>
<th>Value Dry</th>
<th>Value Wet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>Lb/Lb</td>
<td>-</td>
<td>88</td>
<td>82</td>
<td>82</td>
<td>144</td>
<td>111</td>
</tr>
<tr>
<td>No turnover (option 1)</td>
<td>0.67</td>
<td>14.9</td>
<td>80</td>
<td>94</td>
<td>94</td>
<td>152</td>
<td>119</td>
</tr>
<tr>
<td>One month turnover (option 2)</td>
<td>0.65</td>
<td>19.6</td>
<td>80</td>
<td>103</td>
<td>100</td>
<td>160</td>
<td>123</td>
</tr>
<tr>
<td>Aeration pipes (option 3)</td>
<td>0.77</td>
<td>23.0</td>
<td>74</td>
<td>104</td>
<td>101</td>
<td>157</td>
<td>134</td>
</tr>
</tbody>
</table>

Economic Savings

As a result of the litter carbon degrading to carbon dioxide, the storage techniques are able to reduce litter mass from 15 percent to 23 percent and concentrate the nutrients (Table 1). This concentration of nutrients increases litter value per ton. Also notice that although the process involves adding water to reduce dry matter to 0.6, the litter does dry out to levels similar to the original litter. The aeration pipes allowed the litter to dry more than the original litter. This drying effect also increases the litter value on a wet weight basis. Litter value was based on the concentration of N, P<sub>2</sub>O<sub>5</sub>, and K<sub>2</sub>O and current fertilizer prices. Based on the value of the wet litter shown in Table 1, a standard tractor-trailer load (24 tons) of normal (non-degraded) litter is worth $2,664 while degraded litter from our research piles varied from $2,856-$3,216. The higher economic value of the degraded litter means that it can be transported greater distances than normal litter before the transport cost exceeds the litter value (i.e. break even distance). For example, assuming a purchase cost of $15/ton litter, $24/ton for loading, unloading, and application, and transport cost of $0.16/ton/mile, the normal litter can be transported 398 miles while degraded litter can move 444 to 525 miles. If all poultry litter from Eastern Oklahoma was stored using these degradation techniques, the increased economic benefit would be about 10 million dollars after five years and about 32 million dollars after 25 years, compared to transporting normal litter (Figure 3).

The higher nutrient density (P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O) of the degraded litter will also reduce application costs since less litter will be required to bring soil test phosphorus concentrations.
to agronomic optimum levels. In addition, degraded litter was more uniform in particle size, darker in color, and had less offensive odors compared to normal poultry litter.

Poultry litter haulers and those receiving poultry litter will gain the most benefit from this process since haulers can transport more nutrients per load and the receivers need not purchase as much degraded litter as normal litter due to greater nutrient density.

For more information please see:

Figure 3. Oklahoma economic benefit of transportation of degraded poultry litter resulting from an alternative storage technique, relative to fresh litter.
The Oklahoma Cooperative Extension Service
Bringing the University to You!

The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; family and consumer sciences; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of the Cooperative Extension system are:

• The federal, state, and local governments cooperatively share in its financial support and program direction.
• It is administered by the land-grant university as designated by the state legislature through an Extension director.
• Extension programs are nonpolitical, objective, and research-based information.
• It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
• It utilizes research from university, government, and other sources to help people make their own decisions.
• More than a million volunteers help multiply the impact of the Extension professional staff.
• It dispenses no funds to the public.
• It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
• Local programs are developed and carried out in full recognition of national problems and goals.
• The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
• Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.

The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Some characteristics of the Cooperative Extension system are:

• The federal, state, and local governments cooperatively share in its financial support and program direction.
• It is administered by the land-grant university as designated by the state legislature through an Extension director.
• Extension programs are nonpolitical, objective, and research-based information.
• It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
• It utilizes research from university, government, and other sources to help people make their own decisions.
• More than a million volunteers help multiply the impact of the Extension professional staff.
• It dispenses no funds to the public.
• It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
• Local programs are developed and carried out in full recognition of national problems and goals.
• The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
• Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.