


## Utilizing Animal Waste as Alternative to Inorganic Fertilizers in Oklahoma



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### Purpose/Objective

What is the economic and environmental feasibility of using animal waste as an alternative to inorganic fertilizer in Oklahoma?



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### Yesterday's Animal Production

Open Grazing, Land Extensive



Diverse & Self-Sufficient Large # of Producers

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## Today's Animal Production

Mgmt Intensive      Confined Feeding

Economy of Scale-  
Larger size & fewer operators.

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## Oklahoma Agriculture: Yesterday

From the time of the land rush, Oklahoma was an agriculturally diverse state.

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## Oklahoma Agriculture: Today

Specialization has reshaped the agricultural landscape.

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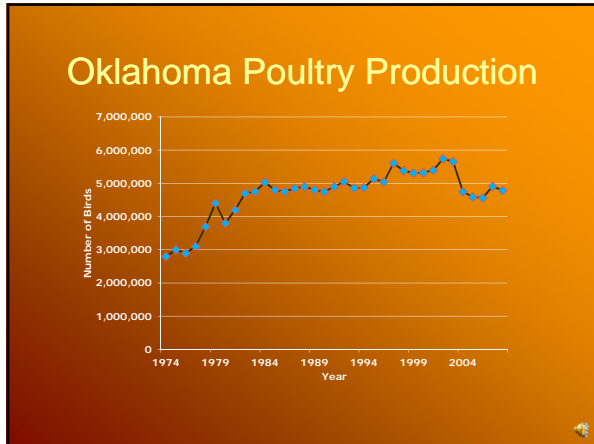
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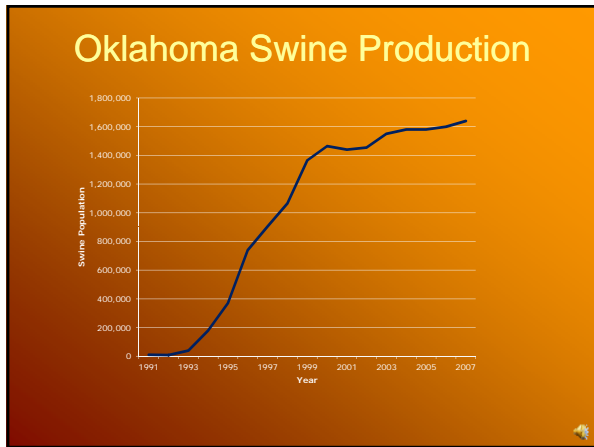
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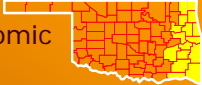
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### Oklahoma Poultry Industry

Significant Growth & Economic Benefits



- \$447 million industry in 1997
- \$663 million industry in 2008
- 2<sup>nd</sup> largest agriculture revenue generator
- Oklahoma ranks 12<sup>th</sup> in US broiler production
- Rural employment
- Tax revenue for local and state governments

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## Oklahoma Swine Industry

- \$447 million industry in 1997
- \$637 million industry in 2008
- 3<sup>rd</sup> largest agriculture revenue generator
- Oklahoma ranks 12<sup>th</sup> in US swine production
- Rural employment
- Tax revenue for local and state governments



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## Problem Statement

- Confined feeding operations produce large quantities of animal waste: What is the best way to dispose of it?



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## Potential Animal Waste Uses

- Excellent low-cost fertilizer (when applied on-site or nearby)
  - Recycles plant nutrients and organic matter into a sustainable closed-loop system
  - Builds soil fertility and soil quality
- Fuel source



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## Concerns & Constraints

- **Environmental concerns**
  - Over-application of manure creates potential for nutrient runoff
  - Runoff concerns limit the amount of manure that can be field applied
- **Nutrient imbalance**
  - N:P ratio in poultry litter different from plant requirements
  - Tendency to over apply manure to satisfy plant N needs, resulting in an accumulation of P not taken up by plant
- **Less consistent in nutrient content than inorganic fertilizer**
- **Bulky & costly to transport off-site**

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## N:P Ratio Imbalance

<p><b>1:1</b></p> <p>Poultry Litter</p> 	<p><b>4:1 to 8:1</b></p> <p>Plant Requirement (uptake)</p> 
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➔ Over-apply P to satisfy N needs  
Accumulation of P in soil can lead to run-off in local waterways

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## Animal Waste Mgmt: Concerns/Issues

- **Field application of poultry litter has been challenged as contributing to water quality problems in Eastern Oklahoma watersheds**
- **Land application of swine effluent has caused air quality issues in the Oklahoma Panhandle**



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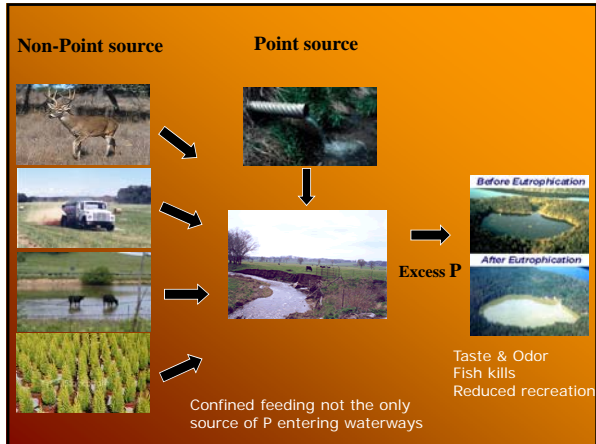
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### Watersheds of Concern

- **Lake Eucha / Spavinaw**
  - Tulsa water supply
  - Taste/odor concerns
- **Illinois R. / L. Tenkiller**
  - OK Scenic River
  - Major recreational lake
  - Water supply

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### Animal Waste Mgmt in Oklahoma

- The environmental concerns have led to regulations on the application of animal waste in Oklahoma
  - Register all operations with confined feeding
  - Develop animal waste mgmt. plan
  - Take soil samples
  - Keep waste application records
  - Attend waste mgmt. training classes
- Programs and research to encourage the movement of animal waste out nutrient surplus areas
  - Subsidies
  - Improved processing
  - Improved uses



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### Animal Waste Movement in Oklahoma

- In Oklahoma, moving animal waste off-site is challenged by long distances manure must be hauled
- Operators are located in the eastern and western parts of the state, whereas crop producers are located primarily in the central part of the state
- Here's some results from our recent study where we developed supply and demand projections over next 25 years to identify nutrient deficient soils

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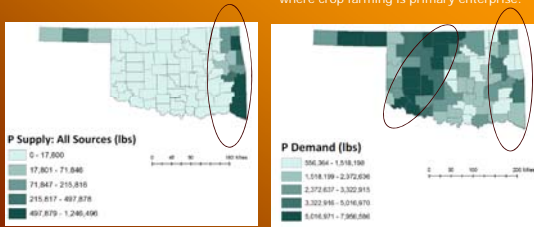
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### P Supply and Demand

Nearly all of the P from animal waste is produced by poultry operators in Eastern Oklahoma.

Poultry producing region in Eastern Oklahoma has weak demand for P due to limited crop activity and prior land application of poultry litter.

Most of the demand central part of the state where crop farming is primary enterprise.



Supply is the annual quantity of P produced based on NASS statistics.

Typical Distances of 150 -250 miles to connect poultry operators with P deficit areas.

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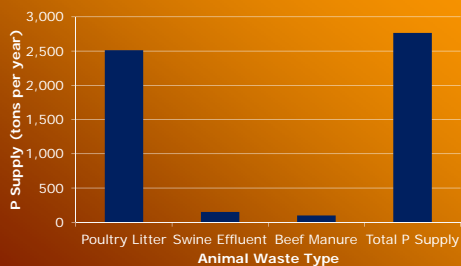
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### P Supply Potential

- Most of the P that could be transported would be produced by poultry operators, accounting for 90% of the total P




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## Our Recent Research

- ✦ Researching ways to increase the efficiency of transporting animal waste in Oklahoma (poultry, swine, and beef manure) through storage techniques and identifying new uses
  - Degraded poultry litter
  - Swine effluent study
  - Phosphorous strips
- ✦ Economic model to project flows of animal waste movements over the long-term, with and without improved storage techniques
  - How much animal waste can be moved?
  - If a limit is reached, when would it occur?

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## Economic Model

- ✦ Optimizes the movement of animal waste over a long-term planning horizon
  - Minimizes manure shipping costs
  - Maximizes the benefits of field applying animal manure
    - ✦ Uses nutrient equivalent values for N-P-K.
  - Constrains manure field application such that soil P levels never exceed 32.5 PPM (Mehlich 3 test)
    - ✦ Conservative approach: maintains P levels well below set by regulations.
    - ✦ Corresponds to satisfying plant needs.

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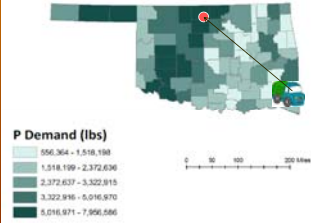
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## Transportation Model

Transport cost proportional to distance hauled (\$0.18 per ton mile)

Calculates benefit of field application at demand location

Updates P soil level at application site



Model searches demand map for closest location subject to having P levels under 32.5 PPM.

Model transports animal waste from supply locations once on-site P thresholds have been reached

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### Transportation Model Data

- ✦ Animal manure demand estimated using Oklahoma State recommended NPK applications (lb/acre) for wheat and forage crops.
- ✦ NASS data used to determine the number of acres in each crop
- ✦ Transportation distances measured from the centroid of each county

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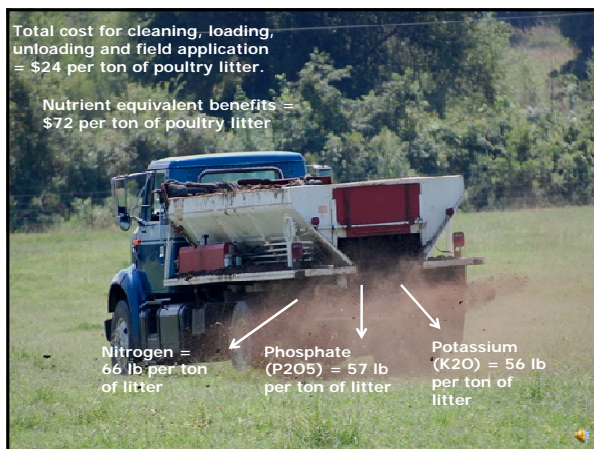
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## Transportation Model Results

- Now let's look at how much P can be delivered over the next 25 years in Oklahoma
- We'll focus on P movements since it's the most environmentally sensitive nutrient
- See our article for the delivery of N over the next 25 years

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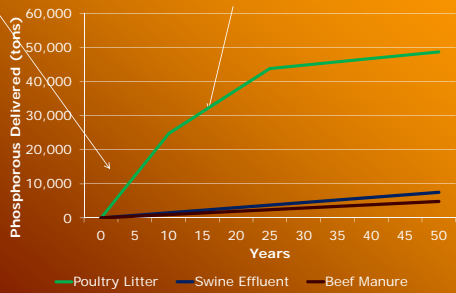
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## P Delivered

All poultry litter able to be delivered for first 10 years

After 10 years P levels in some soils reach 32.5 PPM; not all of the poultry litter is transported



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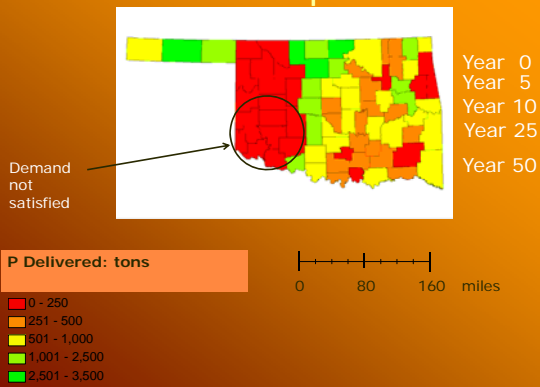
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## P Delivered: Spatial View



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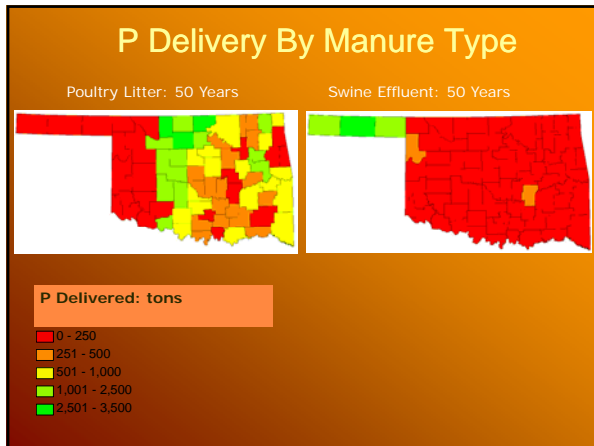
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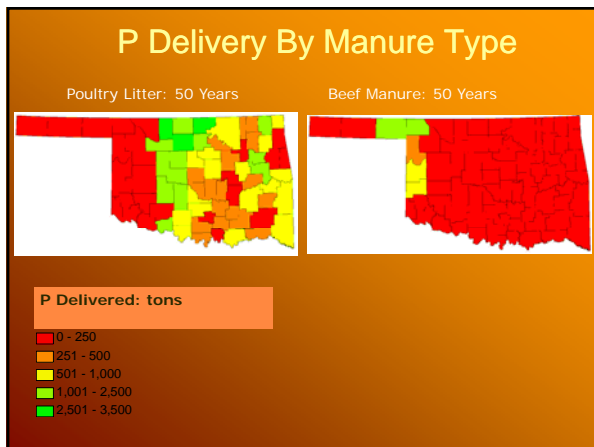
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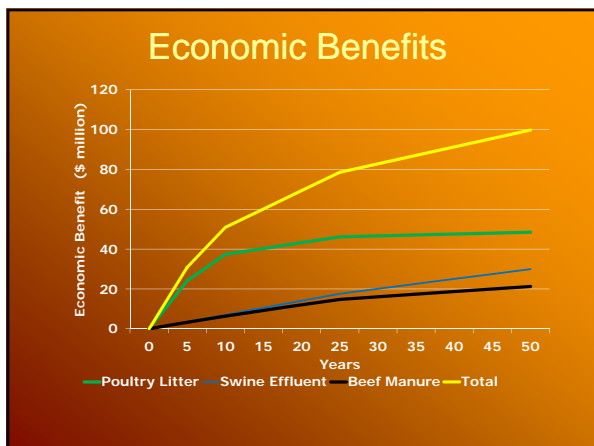
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### Degraded Poultry Litter

- ✦ Studied how degraded litter can reduce shipping costs
- ✦ Results recently published in Journal Environmental Quality
- ✦ Degraded litter increased the quantity of litter transported by 19.2% and increased economic benefits by 35.1%

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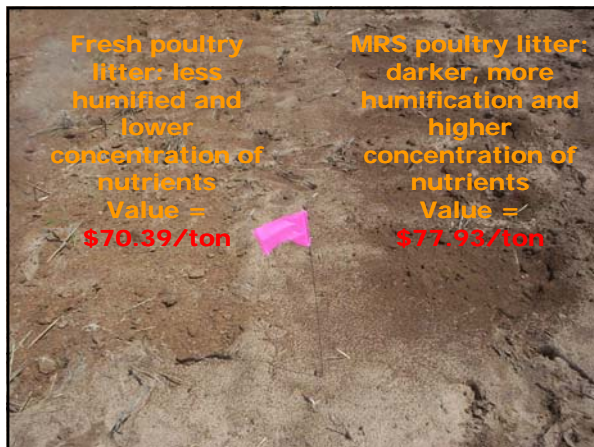
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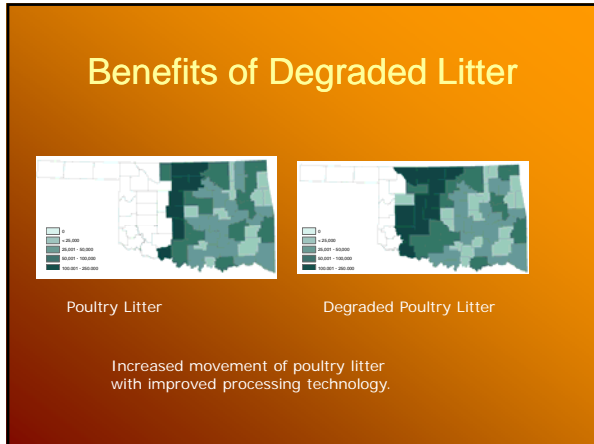
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### Conclusions

- Available evidence indicates sufficient P demand will exist for the next 25-50 years in Oklahoma
- Poultry litter would account for about 90% of the nutrients transported
- Provides researchers with adequate time to develop new technology so that costs can be reduced and new technology can be identified

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### Conclusions

- Degraded litter is an excellent example of how the cost of transporting poultry litter can be reduced
- By using an integrated approach that identifies and combines complementary technologies, the research community could make significant advances in improving the economic feasibility of animal waste over the coming decades.

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## Conclusions

- ✦ In Oklahoma, poultry litter would be the biggest contributor to manure production
- ✦ Shifting poultry production further west closer to demand is one potential solution. However, this would also move poultry operators further away from the processing facilities located across the Arkansas border so this is unlikely to be

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## QUESTIONS??



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