

## Land Application of Manure for Beneficial Reuse

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## Animal Manure Use

- Historically, manure was a fertilizer and soil amendment.
- With advent of fertilizer and concentration of animal production, instead of being beneficial, most consider it a waste and liability.
- This presentation is designed to highlight potential benefits of land application that go beyond traditional NPK benefits of manure.



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## This is important because:

- Land Application is the preferred use.
- Farmers need to account for it
  - what is our manure resource worth
  - TMDL and Watershed Assessments
- Benefits must be recognized
  - By regulatory agencies
  - For economic value



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### Paper Development

- Paper developed by a National Animal and Poultry Waste Management Center team in 2005. Primarily a Literature Review
- Benefits: Manure as fertilizer and soil amendment, carbon sequestration, impacts on runoff and erosion.
- Limitations: Water Quality, Manure Variability, Transportation and handling costs, public perception and odor.
- Ends with listing of research and Extension needs.
- Citations given in paper.



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### We know manure:

- Improves
  - Soil Quality
  - Organic Matter
  - Physical Properties
  - Crop Yields
  - On-farm economics



- Can cause public concern, air and water quality problems



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### We don't know as much about:

- The impacts manure has on soil properties
  - Carbon Sequestration
  - Soil Biology
- Differences between
  - manure types
  - amounts
  - application methods



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### Manure as Fertilizer


- Manure nutrient content affected by:
  - Collection/Treatment Method
  - Animal Species
  - Application method
- Usually, N-P-K contributions are only consideration
- Lots of data available on N-P-K





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### Nutrient Availability


- Available Nitrogen = inorganic and organic N.
  - Inorganic N is relatively easy to measure, however losses are difficult to quantify or estimate.
  - Availability factors range from 0.1 to 0.95.
  - Mineralizable N is much more difficult to measure and has just as much variability.
- Studies conflict on P availability with some suggesting manure P is more available than inorganic. Range:60-100%.
- 90-100% of K available





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### Micronutrients


- Manure is a source of many plant micro nutrients.
- Many are not accounted for routinely but but can impact productivity.
- Value depends on soil availability





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### Crop Response to nutrients

- Many studies suggest that crop response is equivalent or improved with manure.
- Some indicate food quality improvements.
- Most attribute this to soil quality improvements.



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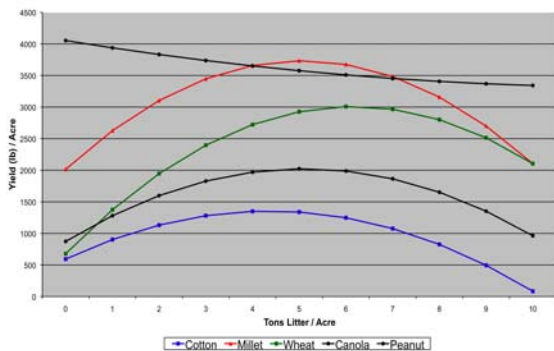
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Crop Response to Poultry Litter, Multi-year study in Tifton Georgia



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### Soil benefits of manure

- Soil pH: numerous studies indicate the ability of manure, especially poultry litter, to neutralize soil acidity.
- Soil Organic Matter: over 20 studies citing organic matter increases, some suggesting manure is more effective than plant residues.
- Data supports increases in water stable aggregates-> infiltration, erosion, compaction, energy required for tillage.



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### Soil Benefits

- Increases in CEC and more buffering capacity with manure additions.
- Water holding capabilities are improved.
- Speeds degradation of pesticides.
- Many changes are linked to soil biology.
  - Increases in OM and biological activity
  - Some studies show decreases in plant disease
  - Impacts on nemotodes are mixed



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### What about Manure Type?

- This paper looked only at manure and not compost.
- The literature is poor at distinguishing differences due to treatment or manure type.
- Irrigated manure generally less documented benefits.
- Few side by side comparisons



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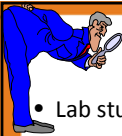
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### Impacts on runoff and soil erosion



- Lab studies have reported conflicting results.
- Many have looked at surface sealing and irrigation and found runoff increases.
- At least 6 rainfall simulator studies have identified less runoff or erosion while 3 show no impact or more for variety of crop and manure types.
- Most just report nutrient concentrations.



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### Runoff and Erosion: Plot Data

- Few studies due to labor and expense.
- Many do not report runoff differences
- Four recent studies found and all report equal or less runoff and erosion with manure or litter applications.
- The best data set is the USLE natural runoff plot data.



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### Runoff and Erosion Impacts

- Natural Runoff Plots at 7 Stations in USA
- 100+ plot-years data from 1930-1974
- Slope varying from 4 to 16%
- Variety of Soils
- Land Use
  - Many crops



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### Old runoff plot data shows

- Runoff reduced from 1 to 68%
- Soil Loss reduced 13 to 77%
- Incorporation seemed to improve effect
- Manure application rate explained the most variability



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### Runoff and Erosion: Modeling

- Most infiltration and erosion models have no way to account for manure additions outside of nutrients.
- USLE K-values and some erodibility measures can be modified through soil OM and some have developed models for a manure layer on top of soil.




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### Manure as a Carbon Sink

- Carbon sequestration
  - Increases with manure rate
  - Decreases with high temps
  - Moisture influences
- Methane & Nitrous Oxide
  - more important than CO<sub>2</sub>
  - methane emissions reduced in aerobic conditions like soil, N<sub>2</sub>O increased
  - Lagoon storage increases losses
- Composted manure sequesters more C




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### What are the limitations?

- Benefits are greater than limitations in most cases but limitations hinder increased land application.
- Manure Variability
- Transportation and handling costs
- Ease of finding and using
- Public perception and odor




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### Pathogens

- Drinking water concern
- Food Quality and Safety
- Land application/storage limits pathogen transfer.
- Pathogen white paper, webcasts
- Hormones receiving more attention



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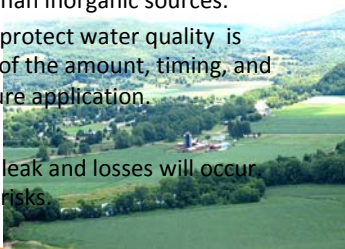
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### Water Quality and Land Application

- Manure nutrients are less soluble and less prone to losses than inorganic sources.
- The best way to protect water quality is through control of the amount, timing, and location of manure application.
- Natural systems leak and losses will occur. BMP's minimize risks.



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### Fertility Sources

- **Organic**
  - improves soil properties
  - availability and support limited
  - uncertainty in nutrient content
  - improves water quality
- **Inorganic**
  - cheaper to store and transport
  - known nutrient content and availability
  - depends on energy inputs to produce

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### Must recognize value

- Economic value of non-fertility impacts
- Reductions in Runoff and Erosion
- Impacts on soil microbiology
- Off-farm use to control NPS pollution
- Educational efforts on manure and sustainability



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### Summary: Is Manure Good or Bad?

- Source of pathogens and oxygen demanding substances that harm water or a source of plant nutrients that can save energy and money
- Our largest source of water quality impairment or a source of organic matter that improves soil quality
- Source of odor and emissions that harm neighbors or a means to reduce carbon dioxide emissions that cause global warming.
- Our Management determines which it is!



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