

Antibiotic Losses and Development of Antimicrobial Resistance from Manure Application

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Satish Gupta

Dept. Soil, Water, & Climate
University of Minnesota

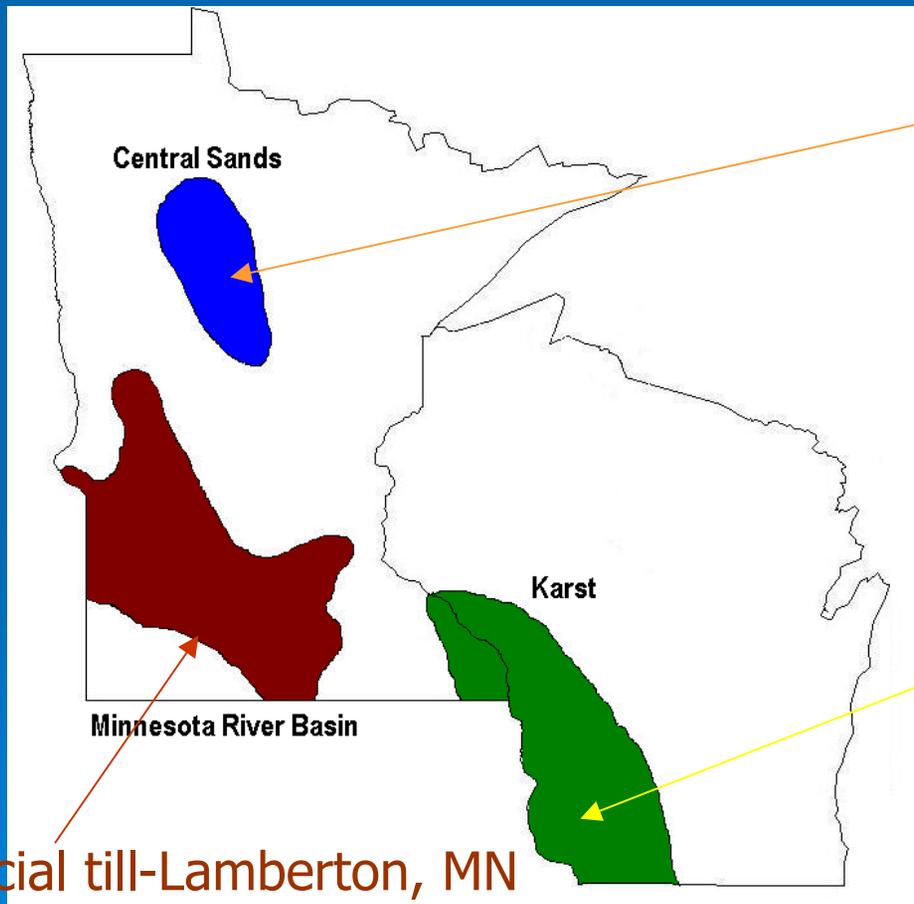
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Collaborators

Kuldip Kumar¹, Yogesh Chander²,
Holly Dolliver², Ashok Singh³,
and Sagar Goyal³

- ¹MWRD, Chicago
- ² Dept. Of Soil, Water, & Climate
- ³Dept. Veterinary Population Medicine

Manure Application Impacts on Water Quality



Kumar et al.

Central Sands- Staples, MN
Turkey and Hog manure

Dolliver et al.

Karst -Lancaster, WI
Beef and Hog manure

Glacial till-Lamberton, MN
Hog manure

Antibiotic Losses from Sandy Outwash Soils-Staples Study



Antibiotic Losses from Sandy Outwash Soils-Staples Study

Treatments

- Two Manure Types
 - Liquid Hog Manure- 5000 gallons/acre (Fall 2004)
 - Solid Turkey manure-3 tons/acre (Fall 2004)
 - Urea (Spring 2005)
 - No Fertilizer
- Antibiotics Monitored: Chlortetracycline, Tylosin, Virginiamycin

Antibiotics Losses by Leaching 2005

| Manure | CTC | TYL | VIR |
|------------------------|-----------|-----|-----|
| | % Applied | | |
| Hog Manure | 0.2 | 0.5 | - |
| Hog Manure (spiked) | 1.7 | 2.6 | - |
| | | | |
| Turkey Manure | 1.5 | - | 2.6 |
| Turkey Manure (spiked) | 5.0 | - | 3.2 |

CTC=Chlortetracycline

TYL=Tylosin

VIR=Virginiamycin

Antibiotics Losses in Runoff 2005

| Manure | CTC | TYL | VIR |
|------------------------|-----------|-------|-------|
| | % Applied | | |
| Hog Manure | 0.004 | 0.003 | - |
| Hog Manure (spiked) | 0.002 | 0.002 | - |
| | | | |
| Turkey Manure | 0.007 | - | 0.0 |
| Turkey Manure (spiked) | 0.014 | - | 0.005 |

CTC=Chlortetracycline

TYL=Tylosin

VIR=Virginiamycin

Antibiotic Losses from Loess Soils Lancaster, WI Study



Fractured Bedrock

Tillage Treatment

Chisel plow



No-till



Antibiotic Losses from Loess Soils - Lancaster Study

Treatments

- Hog manure (liquid)
 - Tylosin
 - Chlortetracycline

- Beef manure (solid)
 - Tylosin
 - Monensin

- Control-Urea
 - No antibiotics



Tylosin Losses through Leaching

| | Frequency of Detection | | Peak Conc. $\mu\text{g L}^{-1}$ | | Mass Loss mg ha^{-1} | |
|------|------------------------|---------|---------------------------------|---------|-------------------------------|---------|
| | Chisel | No-till | Chisel | No-till | Chisel | No-till |
| 2004 | 0 | 7 | 0 | 1.0 | 0 | 0-0.8 |
| 2005 | 0 | 6 | 0 | 1.1 | 0 | 0-1.0 |
| 2006 | 3 | 3 | 1.2 | 1.0 | 0-2.2 | 0-2.0 |

Mass losses are all $<0.1\%$ of applied

Dolliver et al., 2007

Monensin Losses through Leaching

| | Frequency of Detection | | Peak Conc. $\mu\text{g L}^{-1}$ | | Mass Loss mg ha^{-1} | |
|------|------------------------|---------|---------------------------------|---------|-------------------------------|---------|
| | Chisel | No-till | Chisel | No-till | Chisel | No-till |
| 2004 | 3 | 5 | 7.4 | 33.4 | 0-6.6 | 0-27.8 |
| 2005 | 2 | 3 | 13.4 | 40.9 | 0-23.0 | 0-7.8 |
| 2006 | 3 | 1 | 39.6 | 11.4 | 0-84.8 | 0-23.5 |

Mass losses are all <0.1% of applied

Chlortetracycline Losses through Surface Runoff

| | Frequency of Detection | | Peak Conc. $\mu\text{g L}^{-1}$ | | Mass Loss mg ha^{-1} | |
|------|------------------------|---------|---------------------------------|---------|-------------------------------|---------|
| | Chisel | No-till | Chisel | No-till | Chisel | No-till |
| 2004 | 0 | 2 | 0 | 0.5 | 0 | 0-0.4 |
| 2005 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2006 | 0 | 2 | 0 | 0.4 | 0 | 0-3.3 |

Mass losses are all <0.1% of applied

Tylosin Losses through Surface Runoff

| | Frequency of Detection | | Peak Conc. $\mu\text{g L}^{-1}$ | | Mass Loss mg ha^{-1} | |
|------|------------------------|---------|---------------------------------|---------|-------------------------------|---------|
| | Chisel | No-till | Chisel | No-till | Chisel | No-till |
| 2004 | 2 | 0 | 0.7 | 0 | 0-0.6 | 0 |
| 2005 | 1 | 16 | 0.9 | 6.0 | 0 | 0-419 |
| 2006 | 10 | 8 | 1.9 | 3.8 | 0-0.3 | 0-19.5 |

Mass losses are all <0.1% of applied

Dolliver et al., 2007

Monensin Losses through Surface Runoff

| | Frequency of Detection | | Peak Conc. $\mu\text{g L}^{-1}$ | | Mass Loss mg ha^{-1} | |
|------|------------------------|---------|---------------------------------|---------|-------------------------------|---------|
| | Chisel | No-till | Chisel | No-till | Chisel | No-till |
| 2004 | 3 | 0 | 14.7 | 0 | 0-15.2 | 0 |
| 2005 | 5 | 17 | 13.4 | 34.3 | 0-2508 | 0-2470 |
| 2006 | 8 | 2 | 53.8 | 10.9 | 0-14.1 | 0-2.6 |

Mass losses are all <0.1% of applied

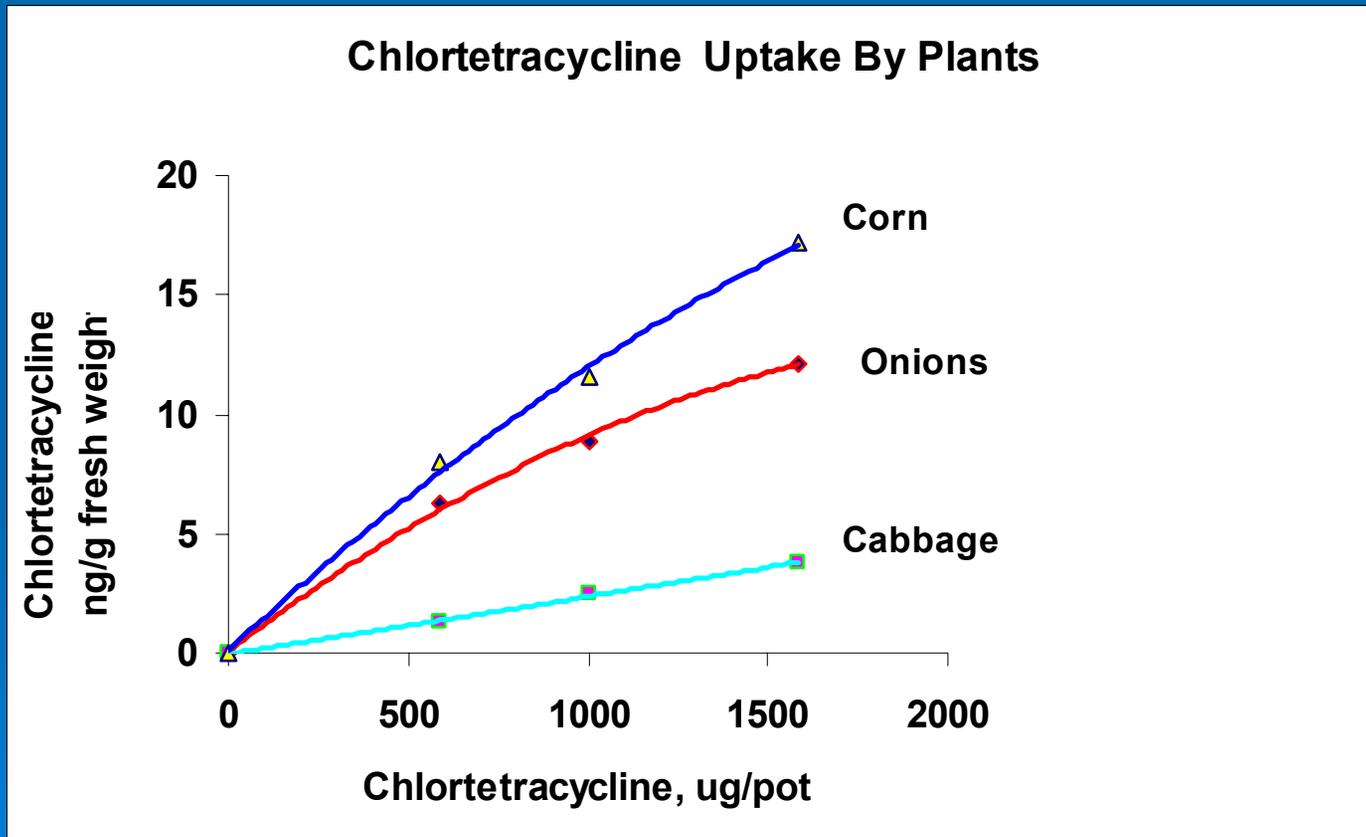
Plants Uptake of Antibiotics



Corn
Lettuce
Potato

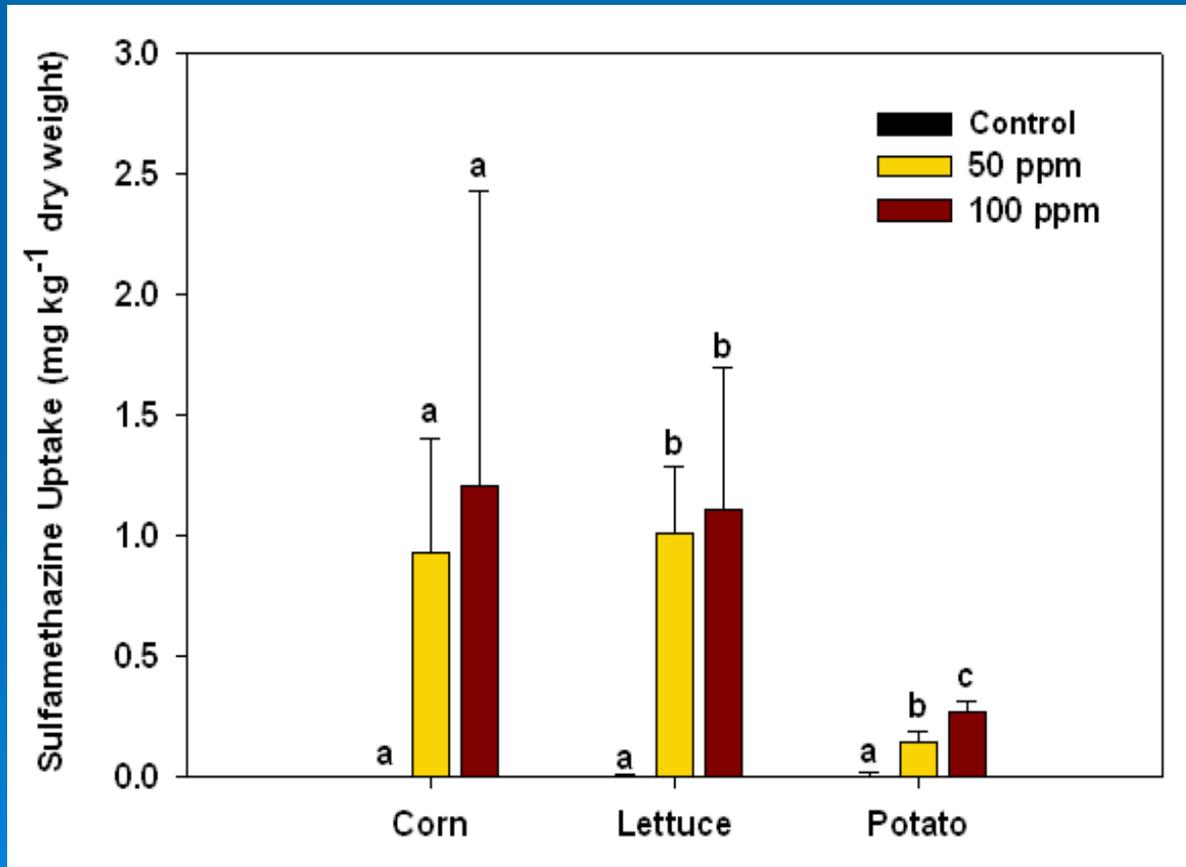
(Holly Dolliver's Experiment)

Chlortetracycline Uptake by Plants (Kumar et al. 2005)



No uptake of tylosin by plants

Sulfamethazine Uptake by Vegetable Plants (Dolliver et al.)



Degradation of Antibiotics in Swine Manure (Kumar & Dolliver)

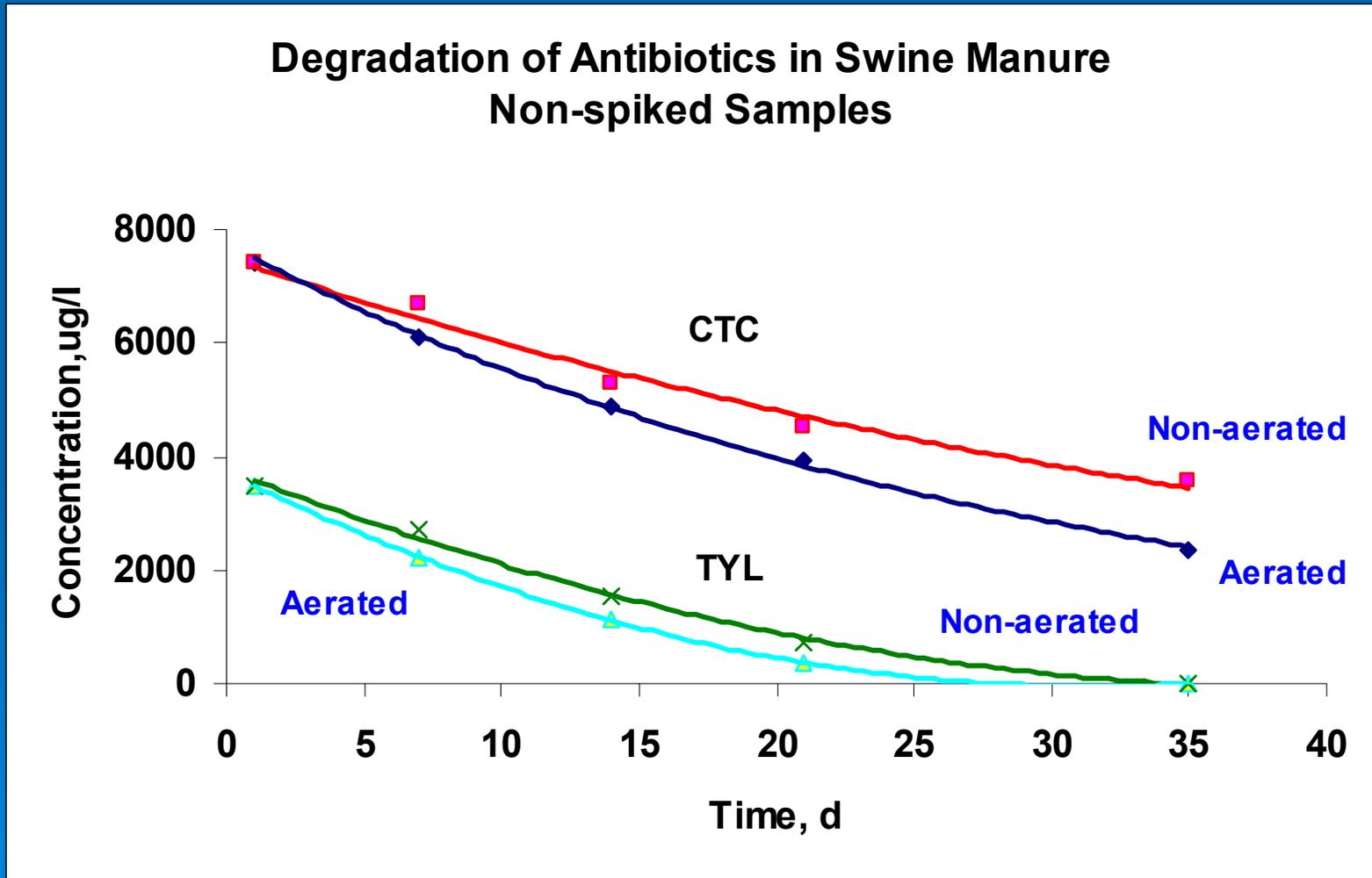


Non-aerated

Aerated

Pump

Antibiotic Degradation in swine Manure



Half-life (Days) of Chlortetracycline and Tylosin

| Samples | CTC | | TYL | |
|------------|----------------|---------|-------------|---------|
| | Non-aerated | Aerated | Non-aerated | Aerated |
| | -----Days----- | | | |
| Non-spiked | 30 | 22 | 10 | 8 |
| Spiked | 28 | 16 | 6 | 10 |

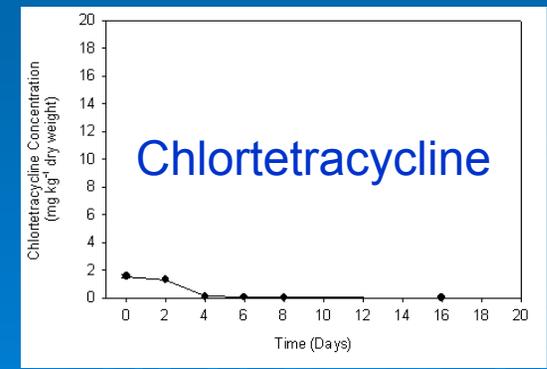
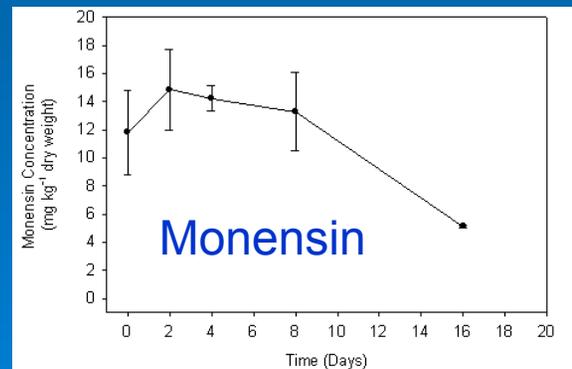
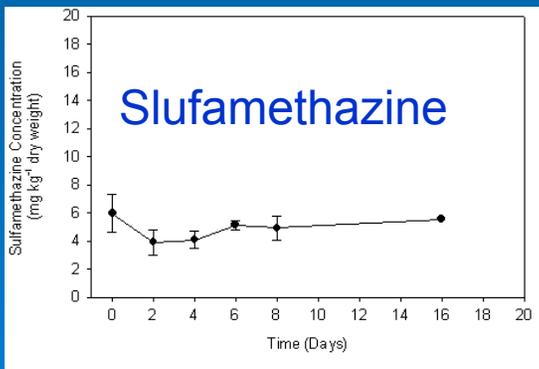
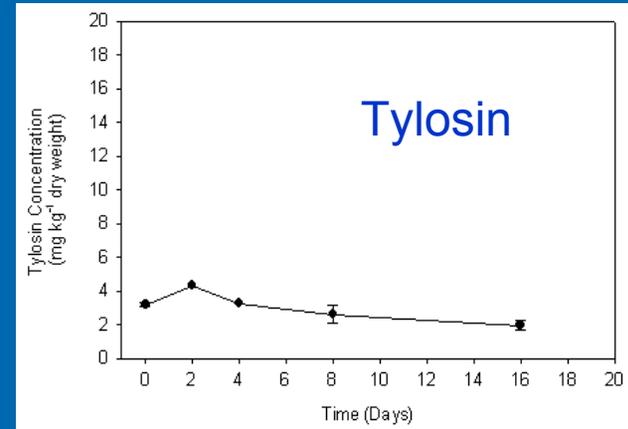
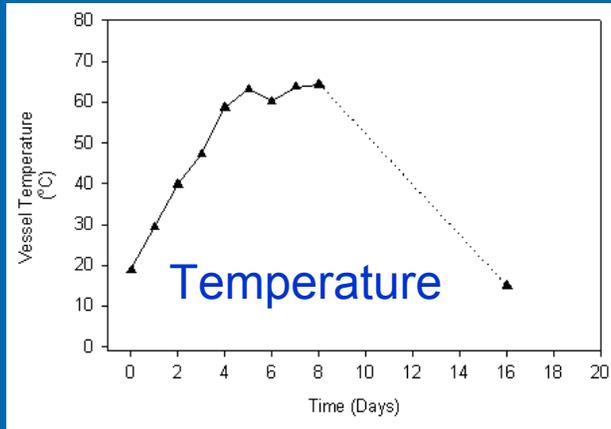
Non-spiked CTC=7.4 mg/L; TYL=3.5 mg/L
 Spiked CTC=151 mg/L; TYL= 83.5 mg/L

Composting in a Vessel



Dolliver et al. 2007

Antibiotic Degradation during Vessel Composting



Composting in Manure Piles



Dolliver et al. 2007

Thank you

