



# **Non-nutritive Aspects of Manure Utilization**

Winter Webinar #2 - February 13, 2013

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# Today's Topics

- organic carbon
  - biological, physical and chemical properties
- greenhouse gas production
- disease-prevention or treatment compounds
- residuals from crop protection chemicals used in production of animal feed



# Manure: A Heterogeneous Material

- a mixture of metabolic waste & solid waste from the digestive system
  - metabolic waste is soluble
    - urea (mammals), uric acid (birds), soluble materials
  - feces is a mixed bag
    - undigested feed
    - microbes, including human pathogens
    - cell wall debris from animal gut
  - feces or urine can contain growth promoting substances, hormones, chemicals from feed



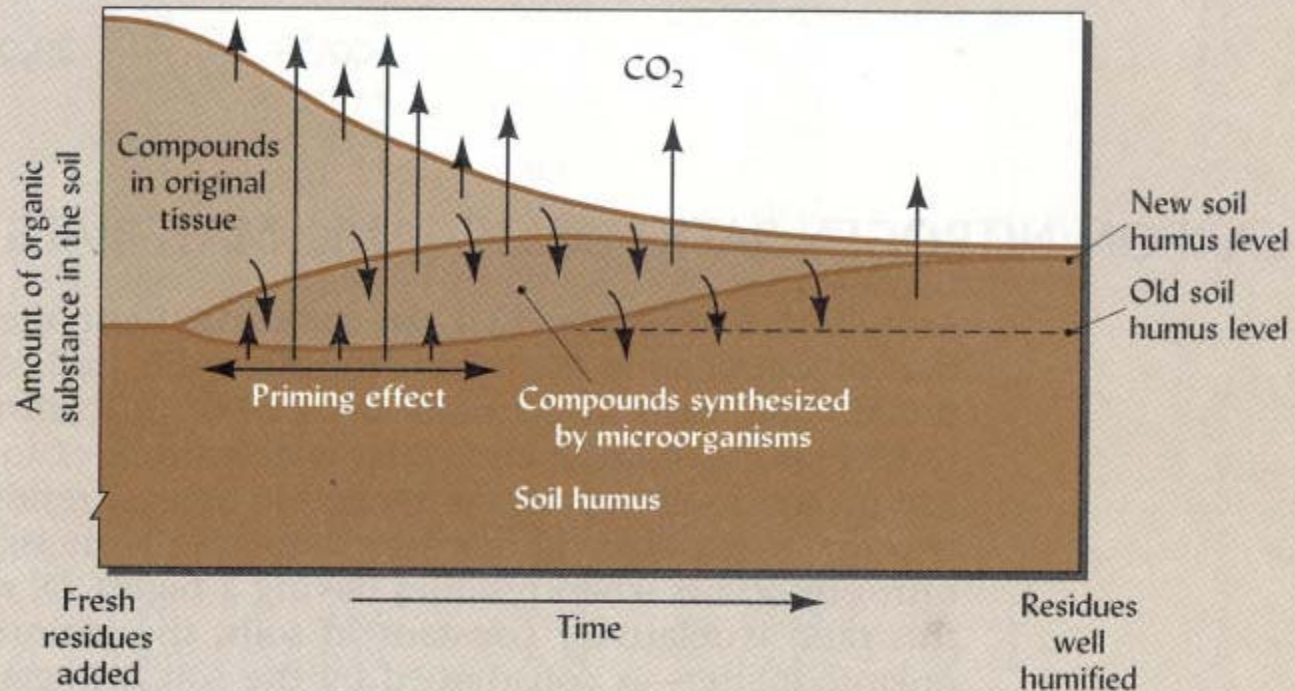
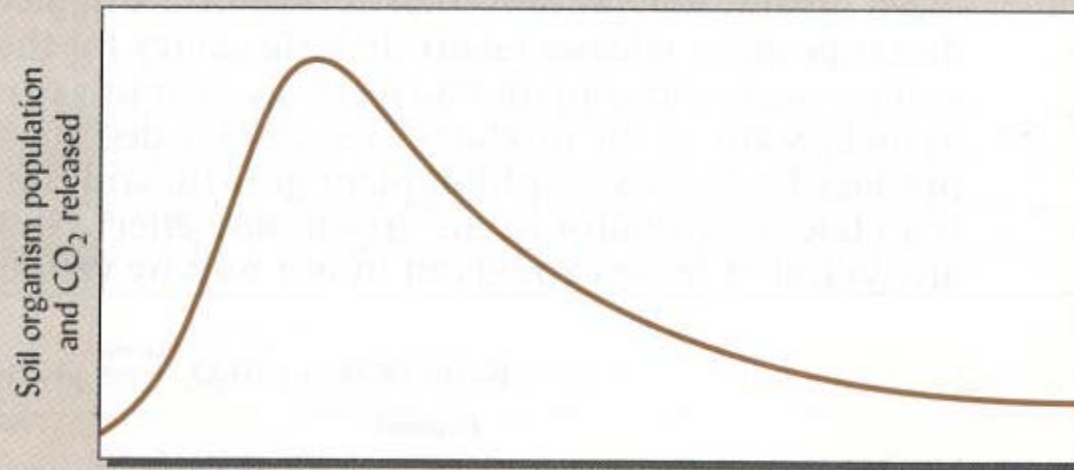
# Organic Carbon (OC)

- organic carbon additions with manure use
  - 2 tons poultry litter provides 3/4 ton OC
  - 20 ton dairy manure provides 3.2 tons OC
- compared to 1.3 tons of OC for corn stover from a 170 bu/C grain crop



# Impacts of Organic Carbon Additions

- cascading series of benefits from organic inputs
  - stimulates biological activity
    - feeds the semi-starving microbes
  - crop roots and microbes exude binding agents
    - plant and microbial mucilages
  - increase in large aggregates/improve soil structure
  - decrease in bulk density/increase in pore space
  - increase in infiltration rate and hydraulic conductivity
  - improve soil tilth or soil quality





# Microbial Biomass

- Alabama, 10 years of poultry litter (PL)
- Decatur silt loam
- commercial fertilizer and PL at comparable rates of N, phosphate and potash



# Microbial Biomass N (Particulate Organic N or PON)

	<b>Microbial Biomass N (MBN)</b> (pounds per acre)	<b>PON</b> (T/acre)
commercial fertilizer	176	2.4
poultry litter	231	2.8

PON is a measure of coarse undecomposed organic N and is believed to be a labile pool (0.53mm screen)





# Genetic Look at Organisms

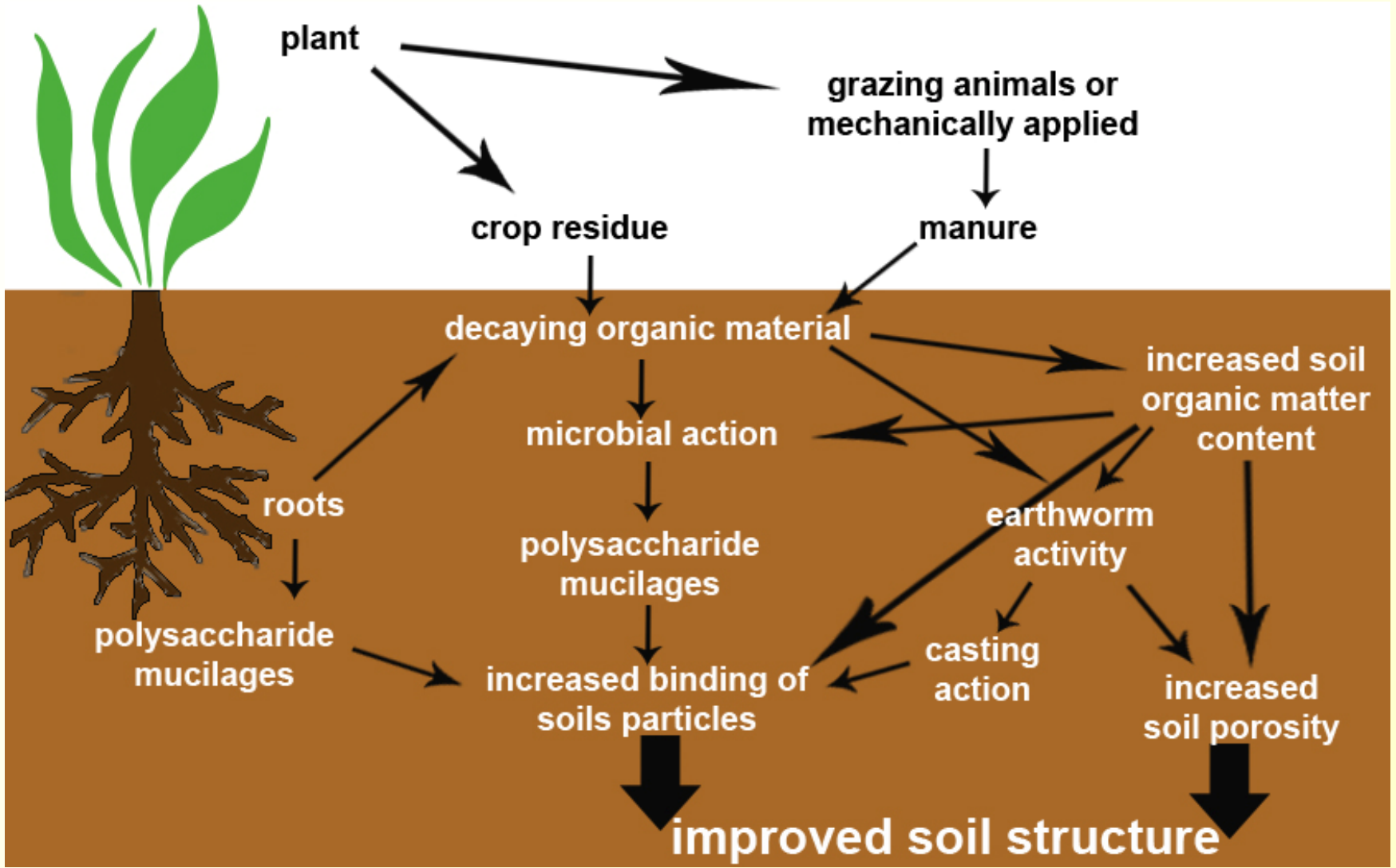
- Liu et al. NCSU (2007, SBB)
  - several organic amendments
  - Orangeburg sandy loam
- soils treated with litter and other organic sources had more diversity and richness among microbes
- ability to use a wider array of substrates as energy/food source



# Soil Respiration (CO<sub>2</sub> Evolution)

<b>N source</b>	<b>CO<sub>2</sub> evolved (mg CO<sub>2</sub>/kg soil)</b>
ammonium nitrate	26
poultry litter	36
green manure (V&R)	29

Equivalent amounts of PAN in commercial fertilizer and organic amendment treatments, NC State, Lui et al., SBB, 2007; average of year 5 & 6 of experiment; amendments in mid-May; tomatoes planted in late May; measurements taken in August



Adapted from Haynes & Naidu, 1998, NCA-E



# Aggregate Stability

- ability of aggregates to withstand disruption
  - attempt to disrupt aggregates
  - measure quantity of aggregates that are intact
- dairy manure and commercial fertilizer on alfalfa – CMREC Clarksville
  - high manure rate > low manure rate > fertilizer > control



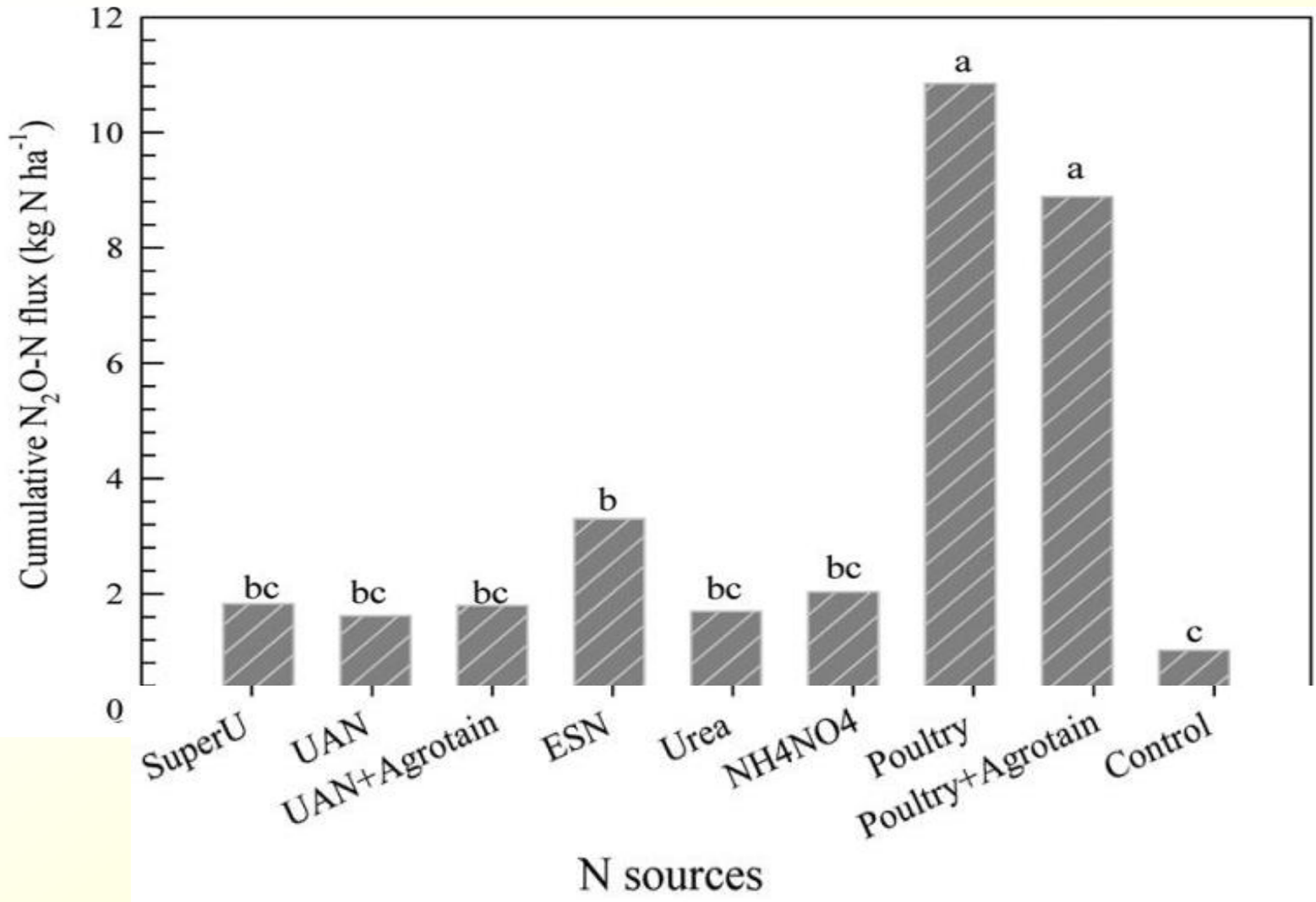
# Manure and Greenhouse Gases

- $\text{CO}_2$ ,  $\text{CH}_4$  (methane),  $\text{N}_2\text{O}$  (nitrous oxide)
  - $\text{CH}_4$ 
    - 20 times as potent per molecule as  $\text{CO}_2$
  - $\text{N}_2\text{O}$ 
    - is 300 times as potent per molecule as  $\text{CO}_2$
    - “laughing gas”
- $\text{N}_2\text{O}$  is a product of denitrification
  - occurs under anaerobic conditions
  - heterotrophic organisms convert  $\text{NO}_3^-$  to and to  $\text{N}_2\text{O}$  and/or  $\text{N}$

# Nitrogen Sources and N<sub>2</sub>O

- field experiment in Kentucky
- Crider silt loam
- all N sources applied at 150 pound per acre rate
  - urea, ammonium nitrate
  - EEFs & additives
  - poultry litter
- static chambers
- 2-3 times a week extracted gas from chambers







# N<sub>2</sub>O per unit Grain Yield

<b>N Source</b>	<b>g N<sub>2</sub>O-N per bu</b>
Super U	7.0
UAN	6.0
UAN Agrotain Plus	6.9
ESN	12.6
urea	6.2
NH <sub>4</sub> NO <sub>3</sub>	8.0
poultry litter	41.1*
poultry litter Agrotain Plus	37.4*
control	5.1





# No surprises here!

- litter supplied labile C, not just N
- soils went anaerobic during the season
- heterotrophs used the larger labile C supply to denitrify more nitrate
- replicated in many locations over last 15 years
- CH<sub>4</sub> was not impacted by N sources



# Veterinary Pharmaceuticals

- antibiotics and ionophores
  - antibiotics – usually anti-bacterials
    - some used for both human and veterinary populations
  - ionophores – used only for animals
- pass through the animal unmetabolized
- impact soil organisms
- uptake by plants

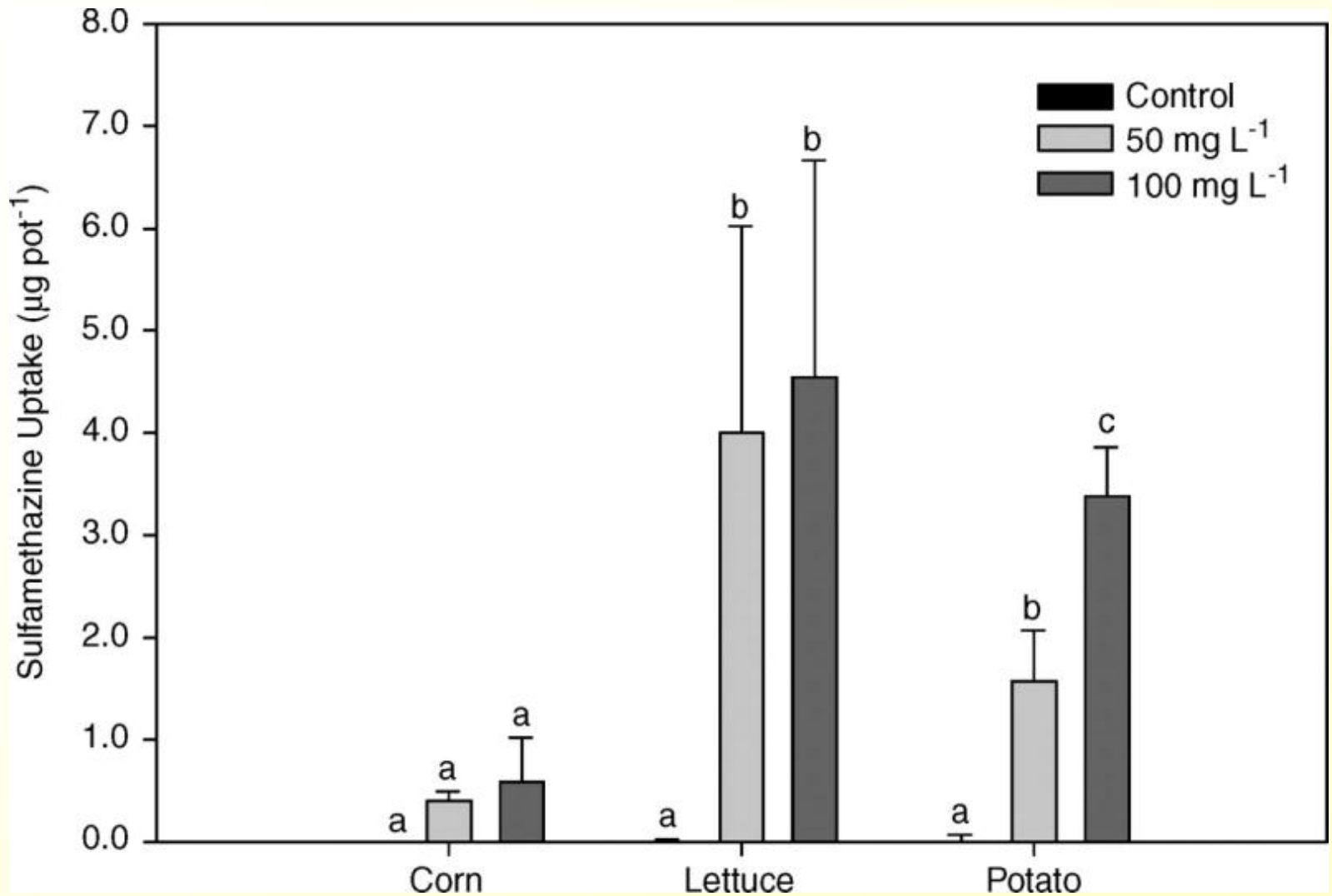


# Veterinary Pharmaceuticals in Animal and Plant Products

- Average Daily Intake (ADI)
- Maximum residue levels
  - established for animal products by JECFA
- less than the amount that would trigger allergic reaction in sensitive folks
- amount that could be ingested daily with no lifetime health risks



# MN, Kumar and Dolliver, greenhouse, swine manure, sulfamethazine





# Sulfamethazine Uptake by Vegetables

- maximum residue level in animal products of 0.1 mg/kg fresh weight
- average of 3 vegetables was 0.05 mg/kg
- $ADI_{\text{sulfamethazine}} = 5\text{mg/kg}$  of body weight per day
- even with a vegetable-based diet, daily intake would not exceed ADI



# Herbicide Carryover

- manure may contain active ingredients from herbicides used for weed control in crops subsequently fed to animals
  - pyridine carboxylic acid family
  - clopyalid, picloram, fluoroxytypyr, triclopyr
    - Stinger, Reclaim, Forefront, Milestone
  - broadleaf weed control in pastures, hay fields and golf courses
  - not metabolized by herbivores
  - excreted in manure
  - not readily altered by composting



# Pyridine Carboxylic Acid Family

- clippings from treated urban lawn caused severe plant damage to users of yard waste compost in several major cities
- manure from animals fed hay or grazing pastures
- auxin-like chemicals
- severe deformation, stunting or death of plants



Ohio State Extension

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# Questions or Comments?

