Incorporating Manure in Reduced Tillage Systems

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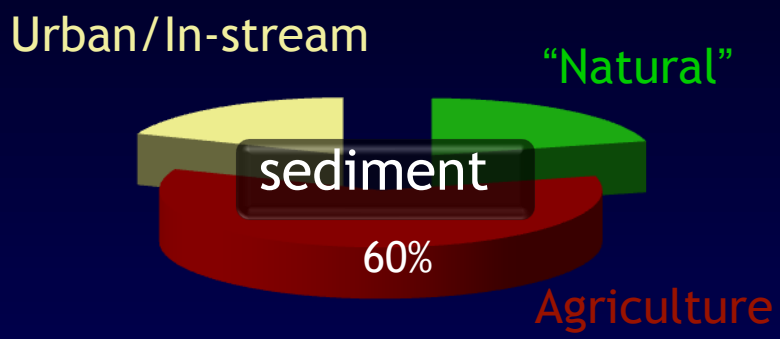
Manure trade-offs: To till or not to till?

Chesapeake Bay Loads



- Tillage reduces N volatilization
- No till increases N volatilization

- Tillage increases erosion P loss
- No-till reduces erosion P loss

- Tillage reduces soluble P loss
- No-till increases soluble P loss

- Tillage reduces odor
- No-till does not reduce odor

- Tillage can reduce leaching
- No-till can increase leaching

Getting manure off the surface without resorting to full blown tillage

Liquid manure applicators

Aeration

Disk injection

Anti-leaching sweeps

Pressure injection

Dry manure applicators

Solid injection

Subsurface applicators

Equipment for perennial forages

Sleight foot

Trailing shoe

Trailing hose

Aerator

Shallow injection

High pressure

Eco slit

Liquid manure application trials – no-till corn

PDA, USDA-CIG, PA Pork Producers grants

Broadcast

Tillage

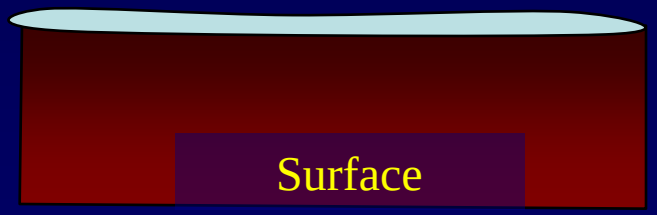
Aerator

Shallow disk

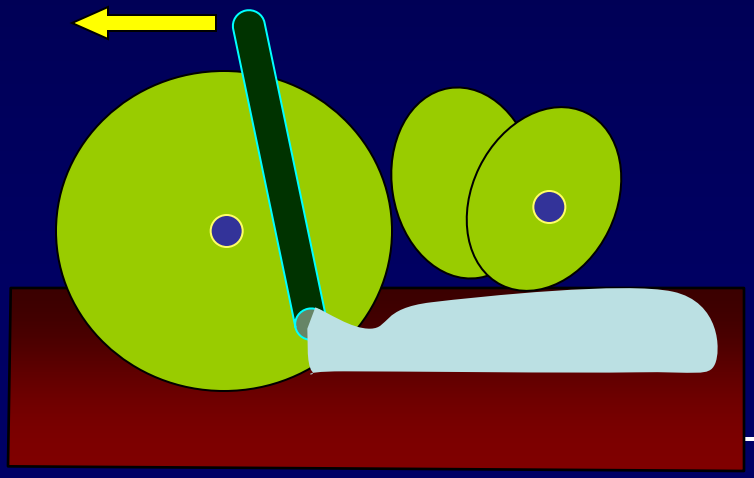
Anti-leaching sweeps

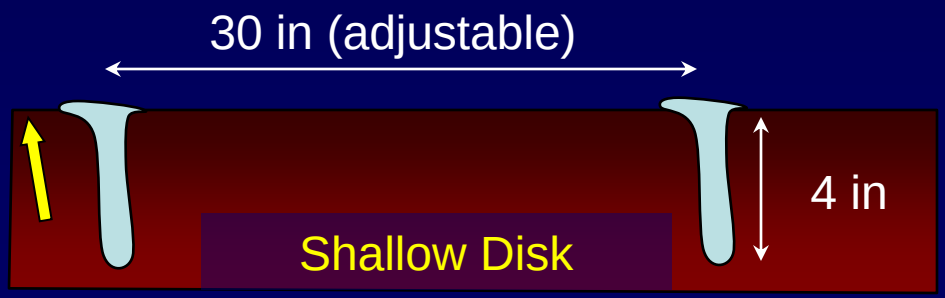
High pressure

Broadcast application

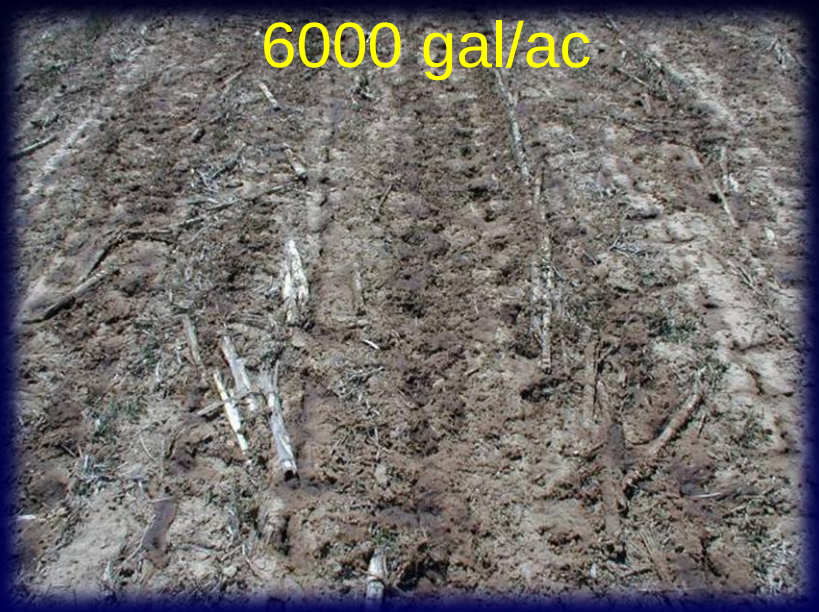


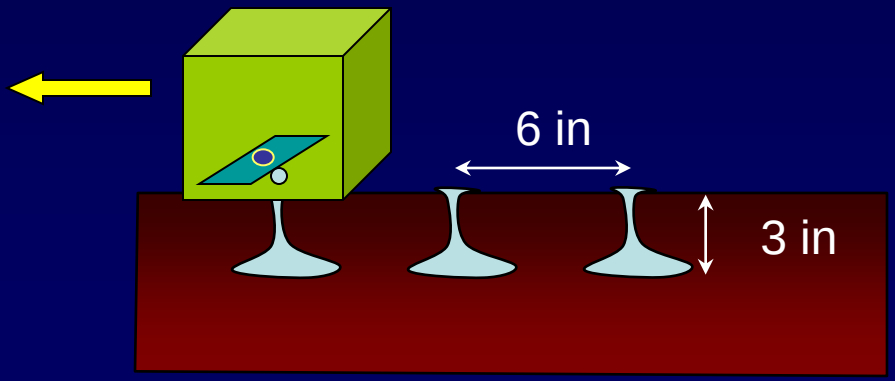
Shallow disk injection

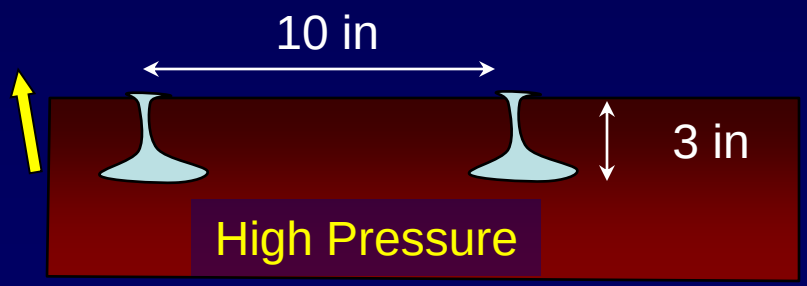




High pressure injection



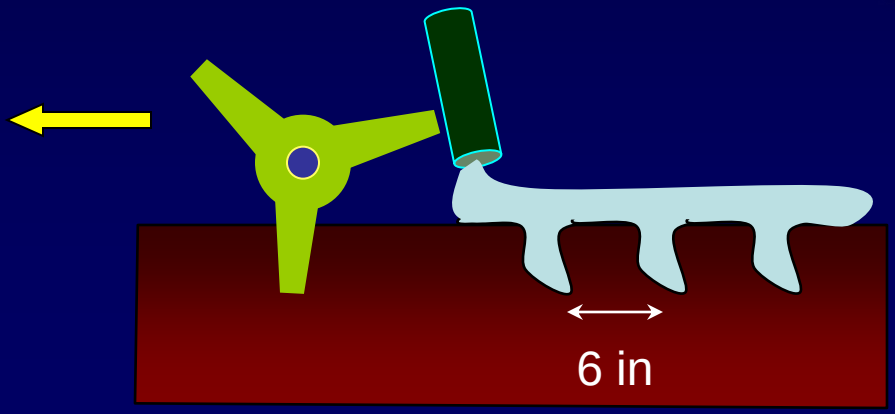


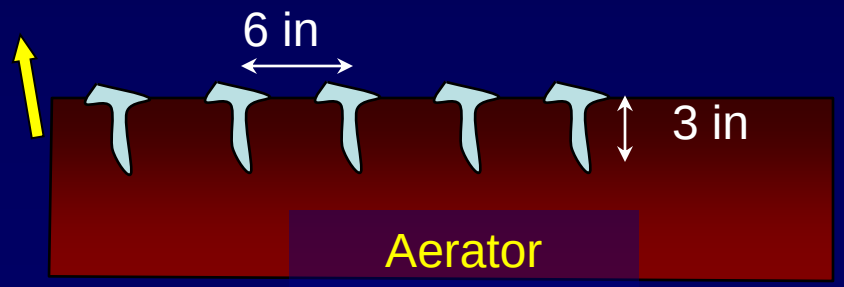


Aerator w/banded manure

No manure

6000 gal/ac





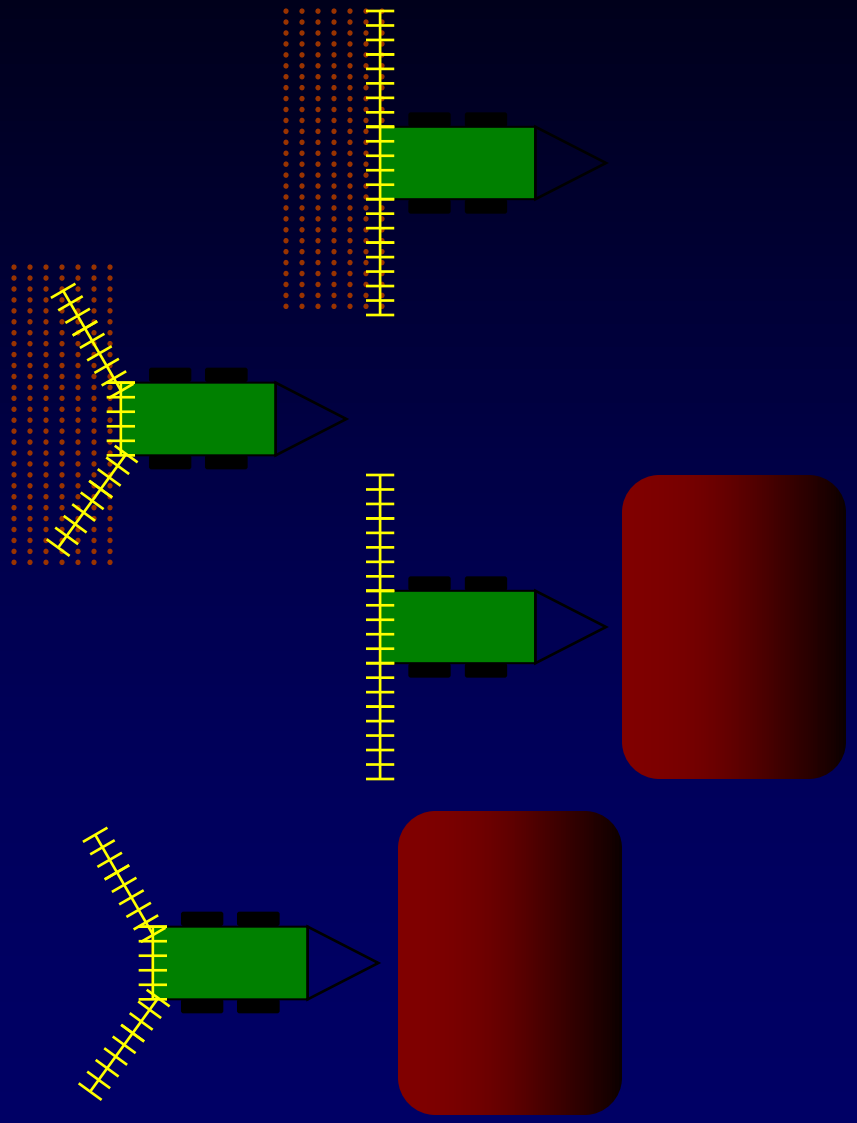
Aeration variations

Banded Manure After
Aerator at 0° angle

Banded Manure After
Aerator at 10° angle

Straight Manure Before
Aerator at 0°

Angled Manure Before
Aerator at 10° angle



Courtesy T. Myers, Penn State

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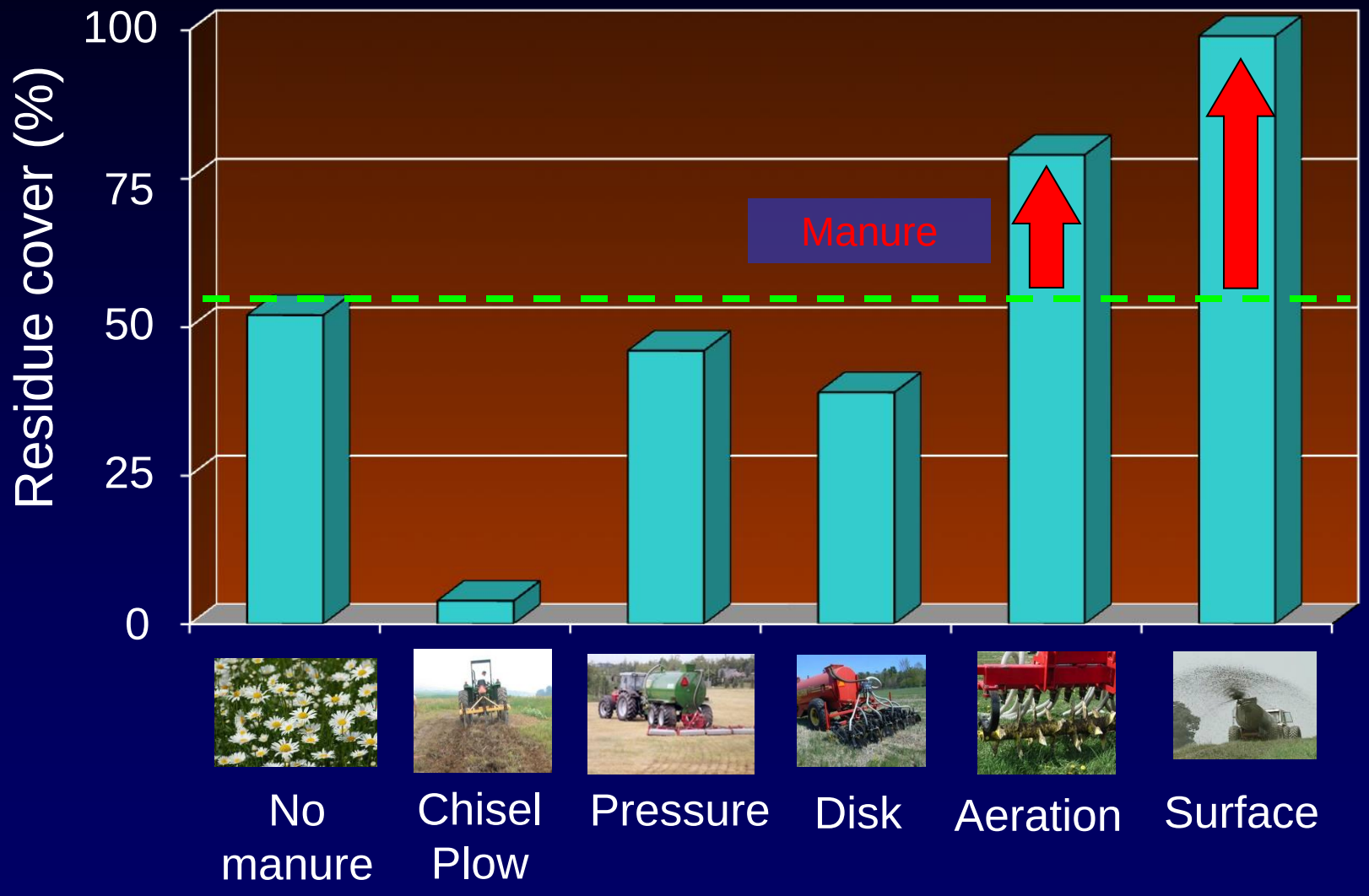
Rock Springs Trials (2006-2007 average)



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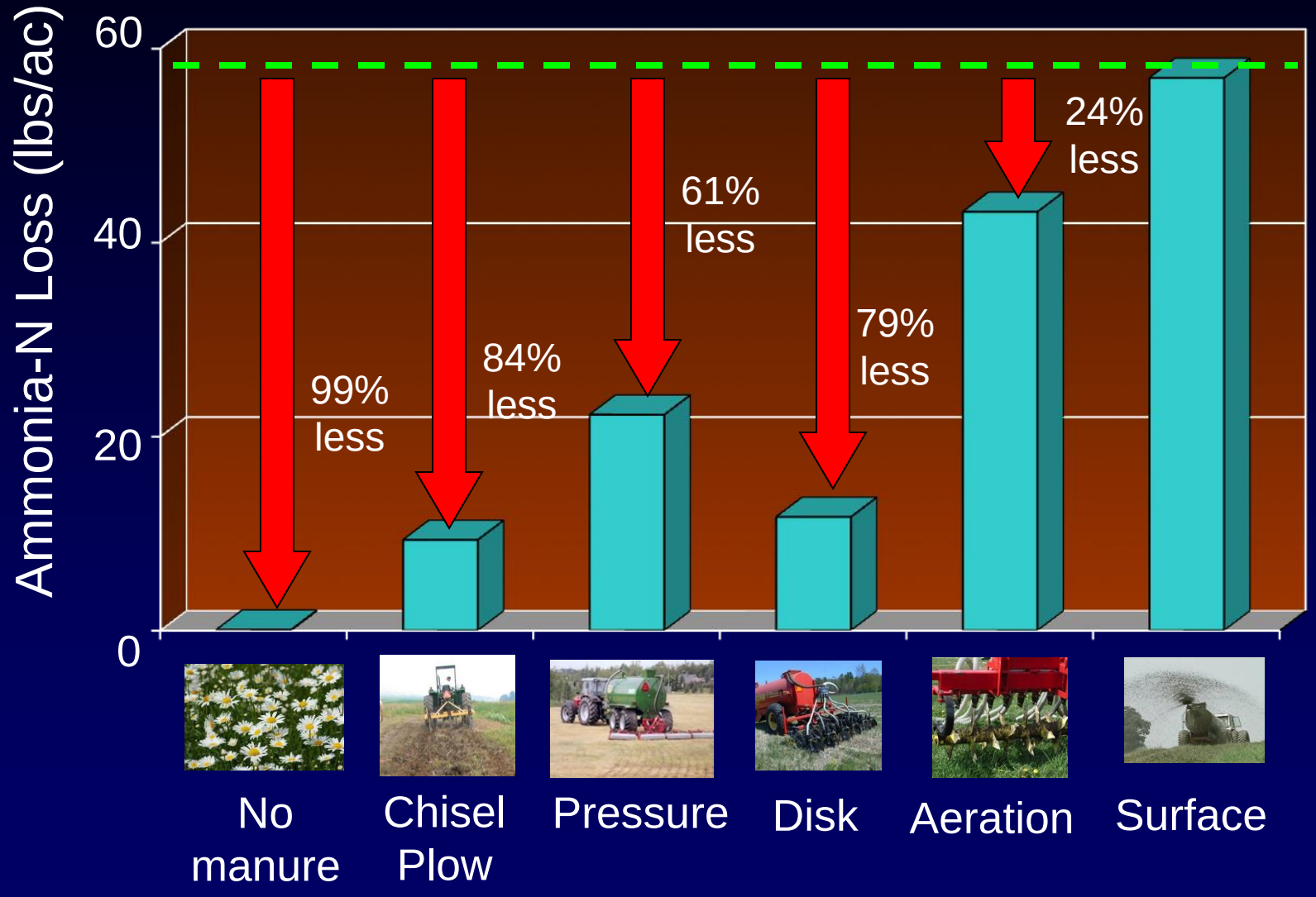

Data courtesy C. Dell, USDA-ARS

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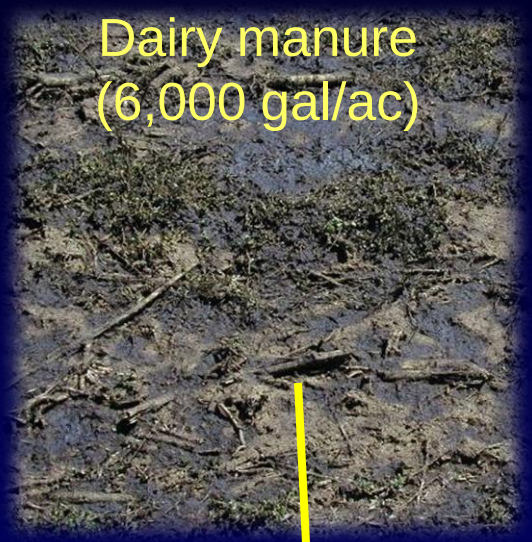
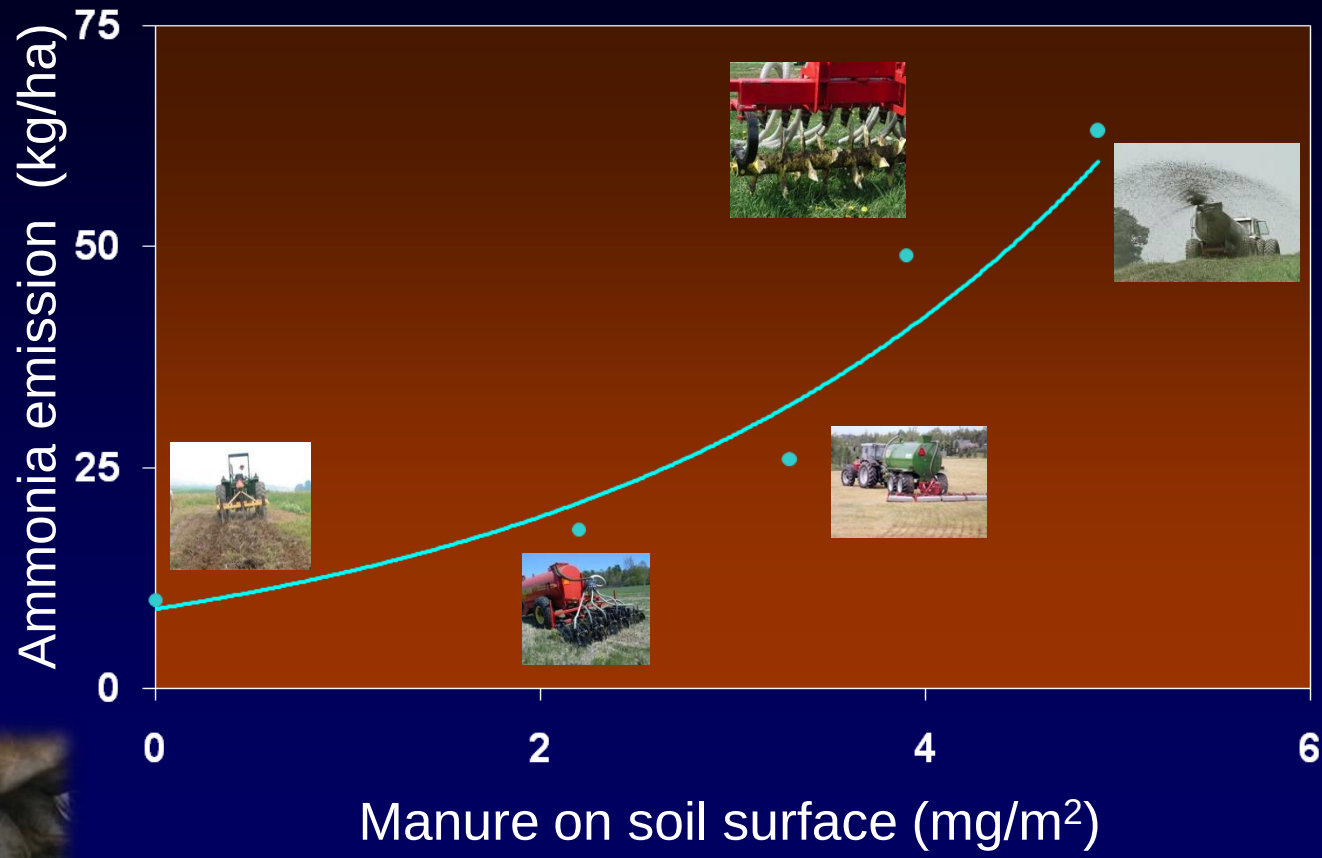
Ammonia: more manure on the surface, more ammonia emitted





Data courtesy C. Dell, USDA-ARS

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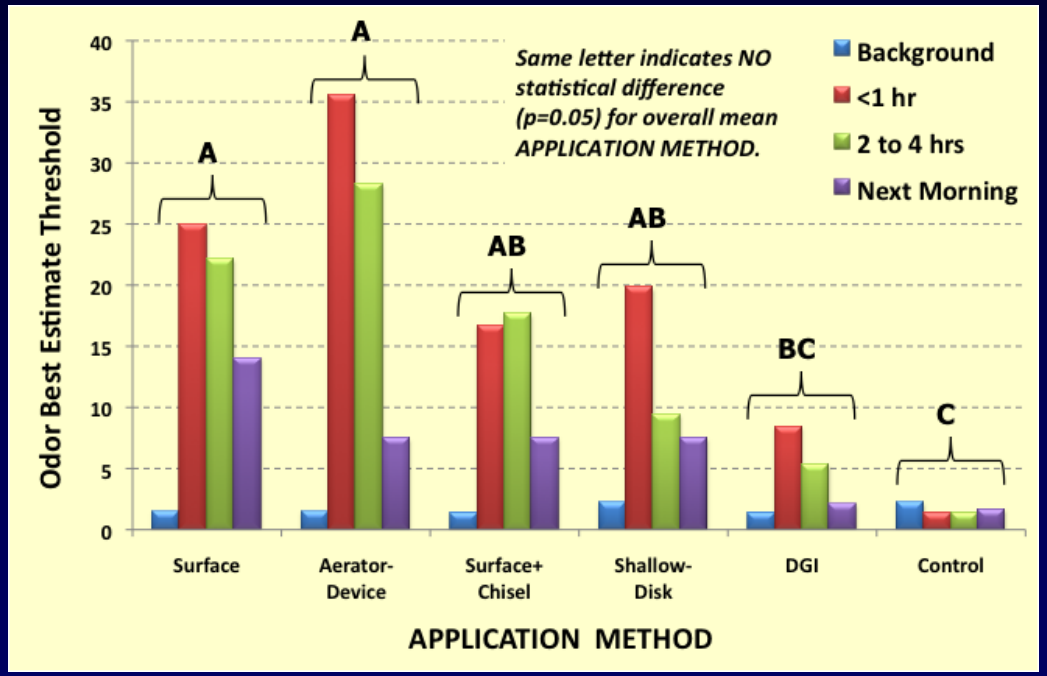
Odor – similar (but not identical) to ammonia


Penn State odor panel



R. Brandt, Penn State

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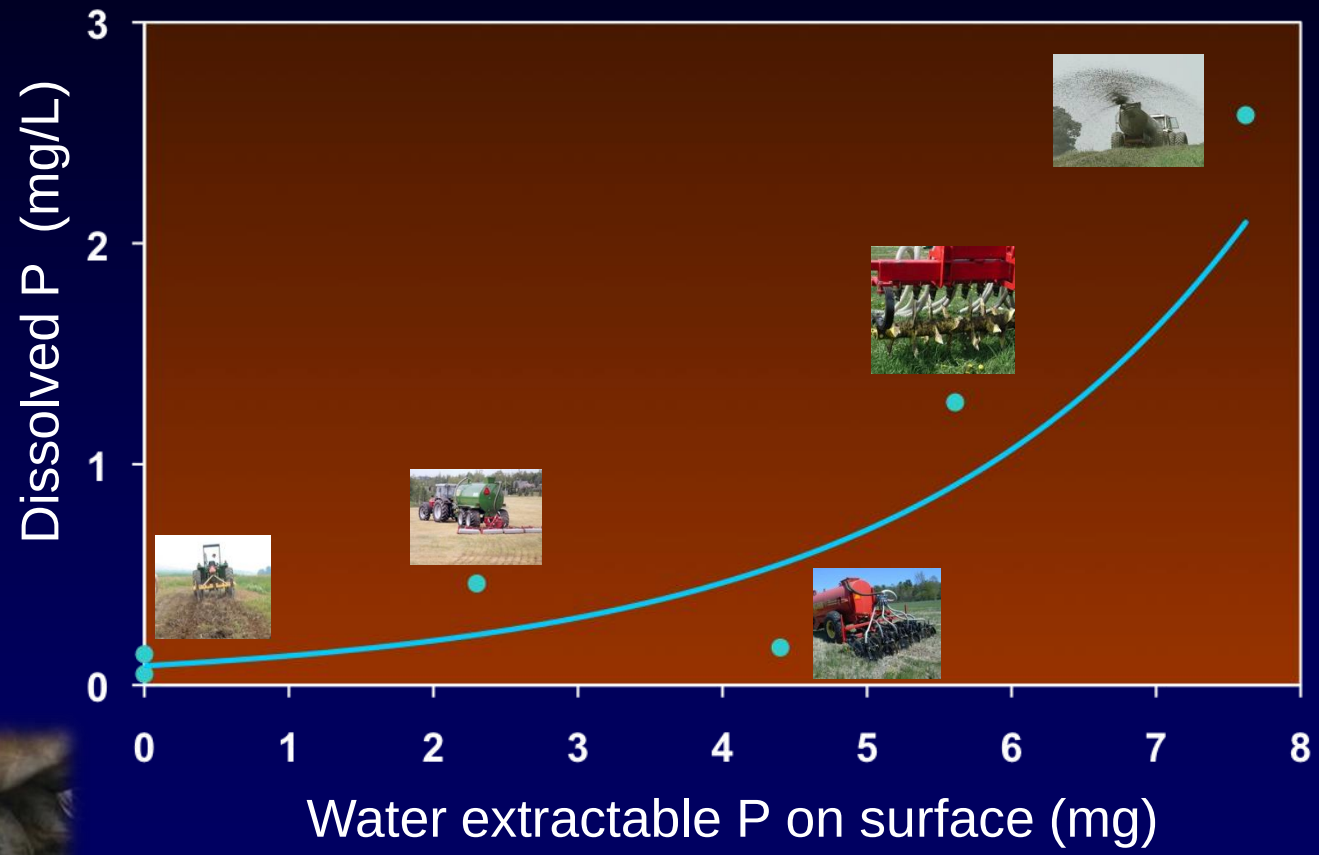
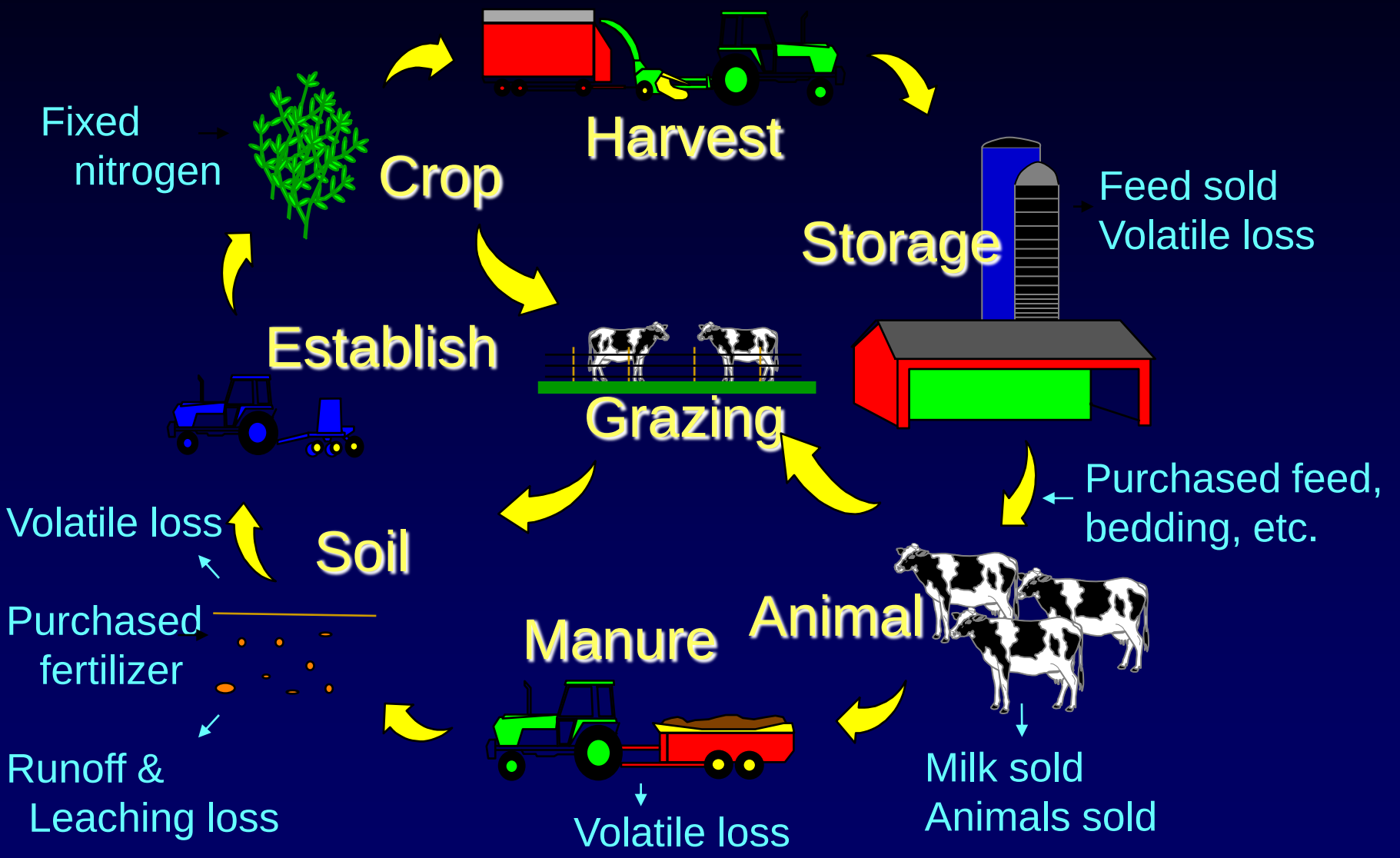
Phosphorus: more on the surface, more dissolved phosphorus in runoff



Integrated Farm System Model



Courtesy Al Rotz, USDA-ARS

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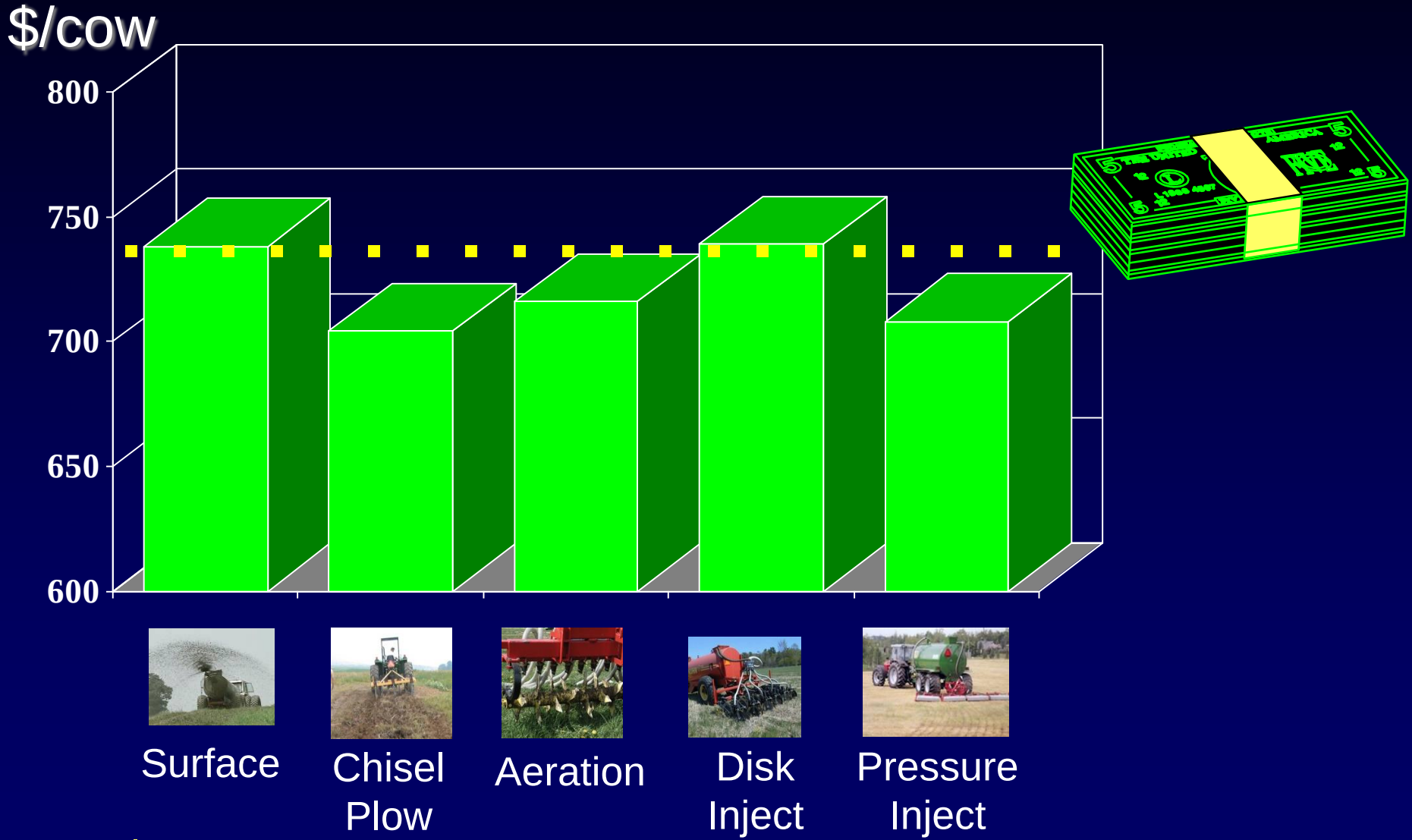
IFSM Simulation of Manure Applicators

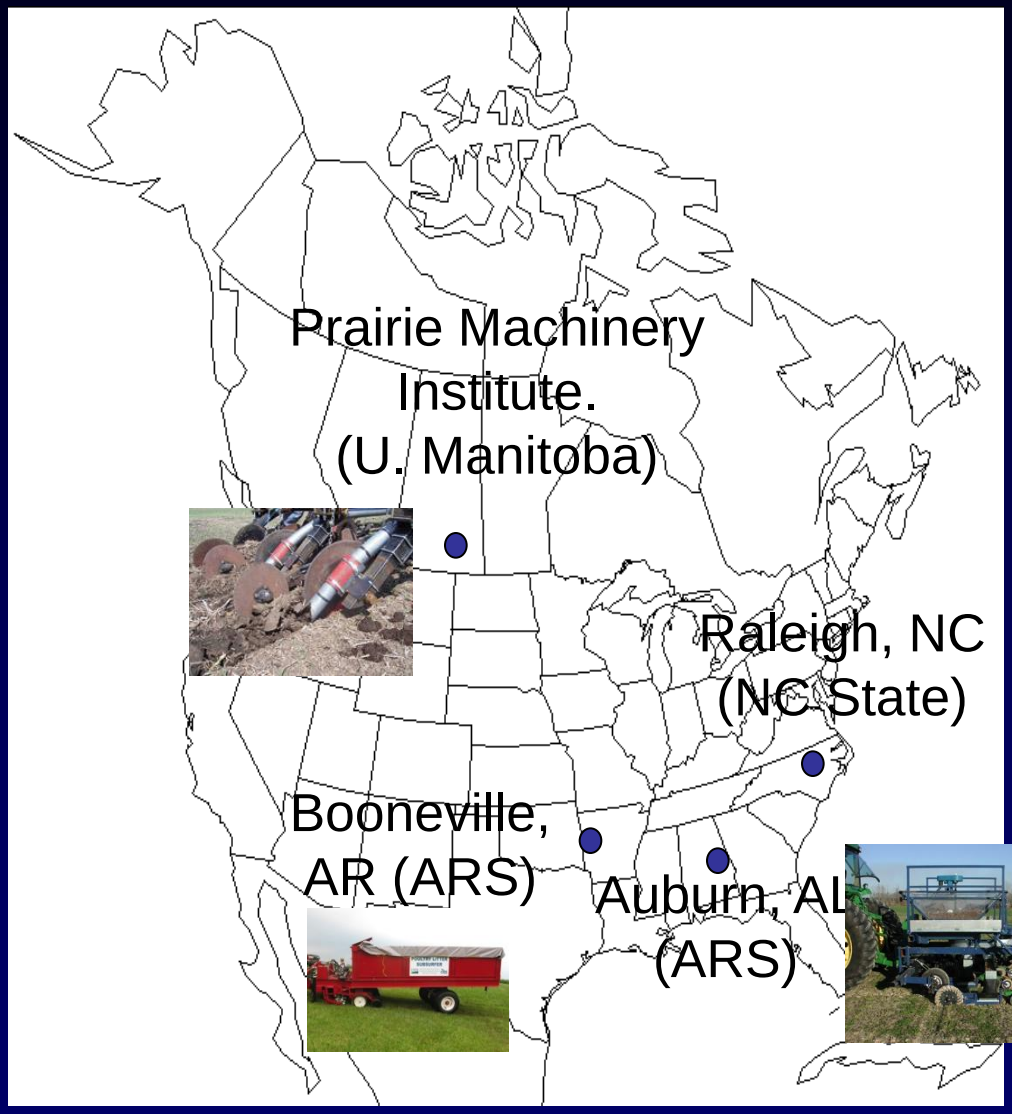
Net Return



Rotz et al., 2011

Making Manure Injection Work

Solid/semi-solid technologies (2005)



Prairie Ag Machinery Institute

Generation 1: ARS's Auburn litter applicator

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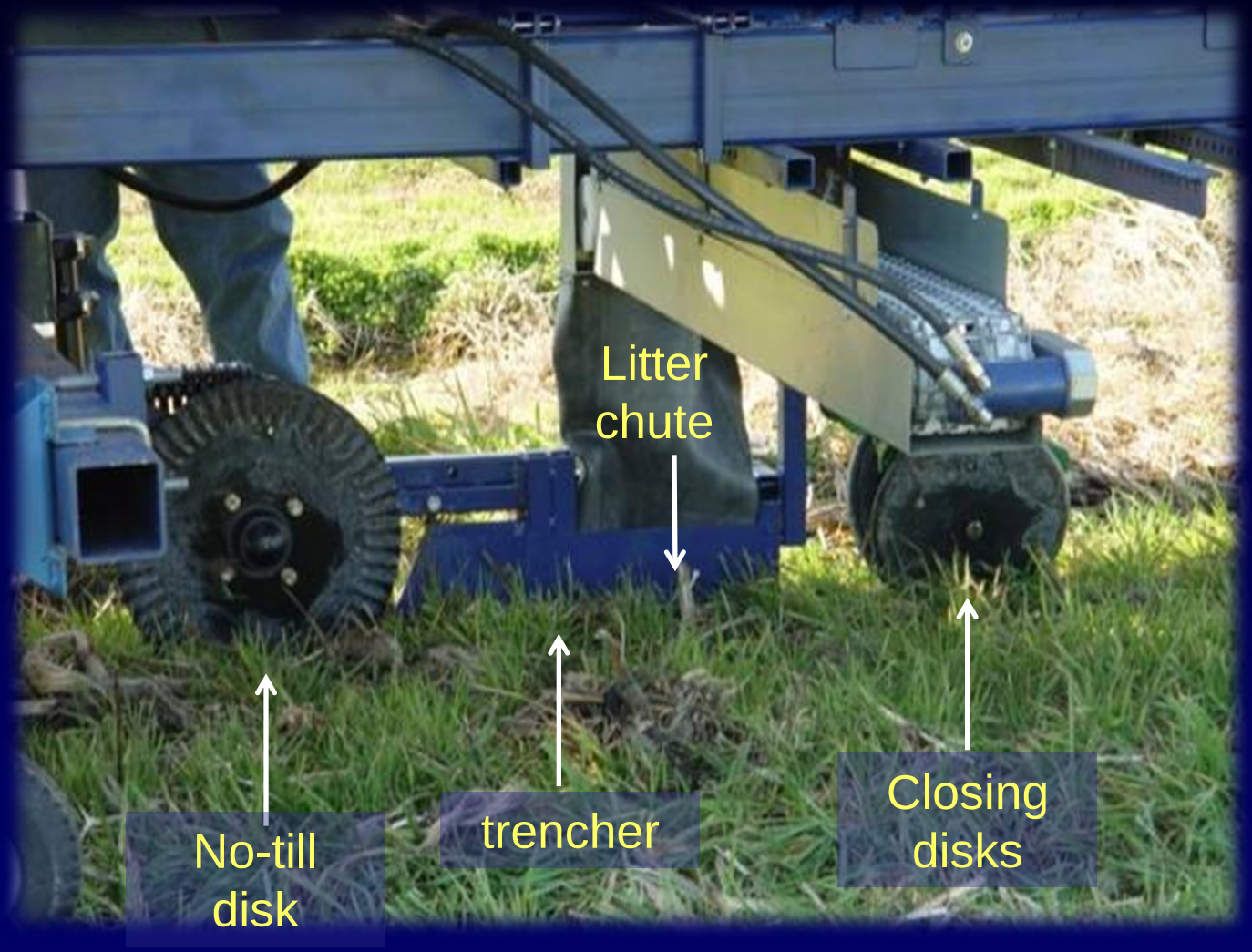


Application rate: <1 to 8 tons/acre

4” open trench (closing disks raised)

<u>Variable row spacing</u>

- *10-40”*
- *4-10 injectors*

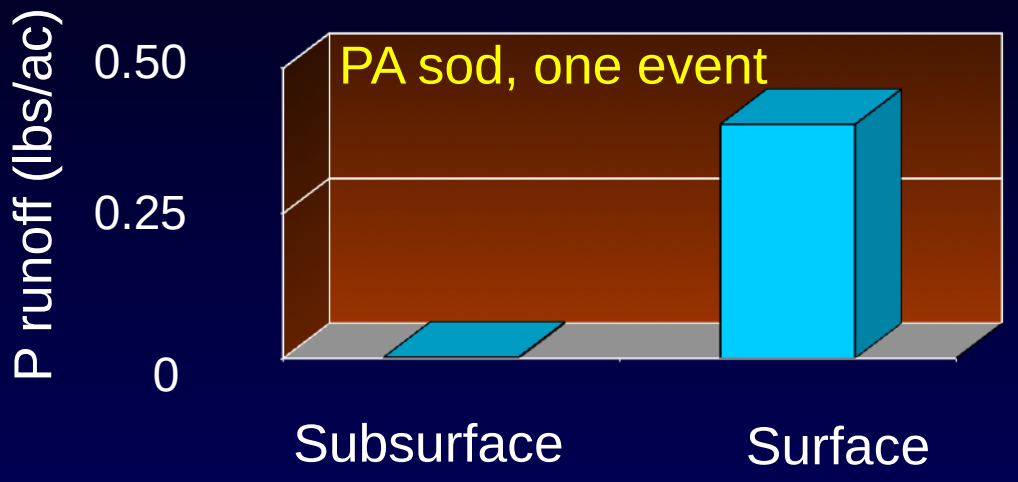
Generation I - Four years of development

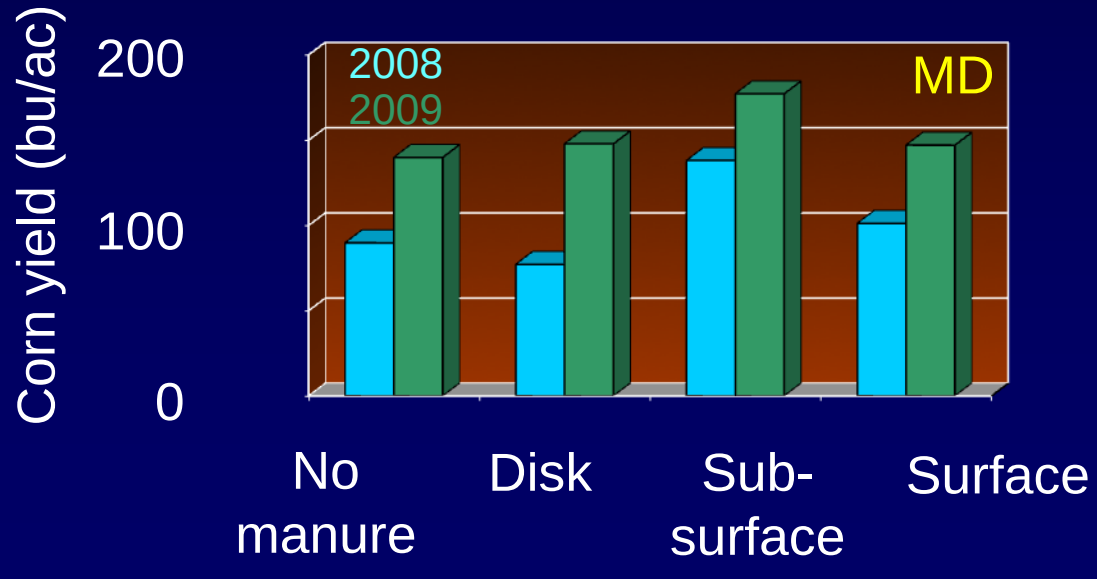
TN corn, AL cotton, AR pastures, MD corn

AR pastures (2-3 tons/a)
~90% reduction in P runoff
~99% reduction in NH_3 loss

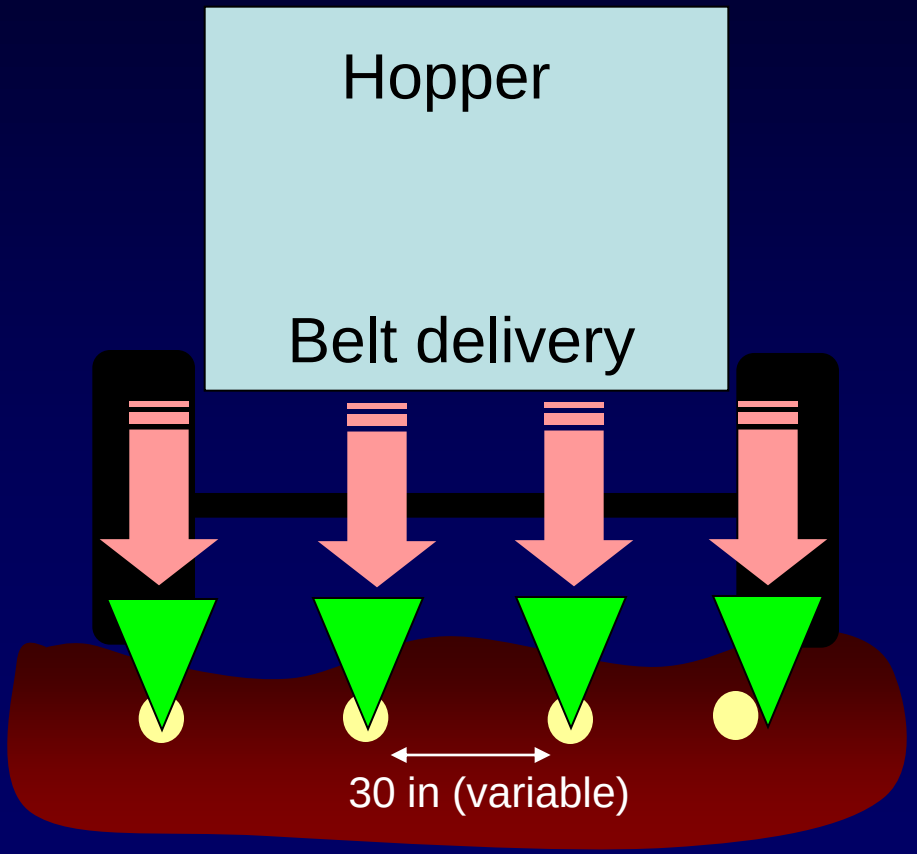
Subsurface application of dry manure in no-till and perennial forage soils

Generation 1 Subsurface applicator





USDA-ARS Soil Dynamic Laboratory Subsurface Applicator



A critical advancement

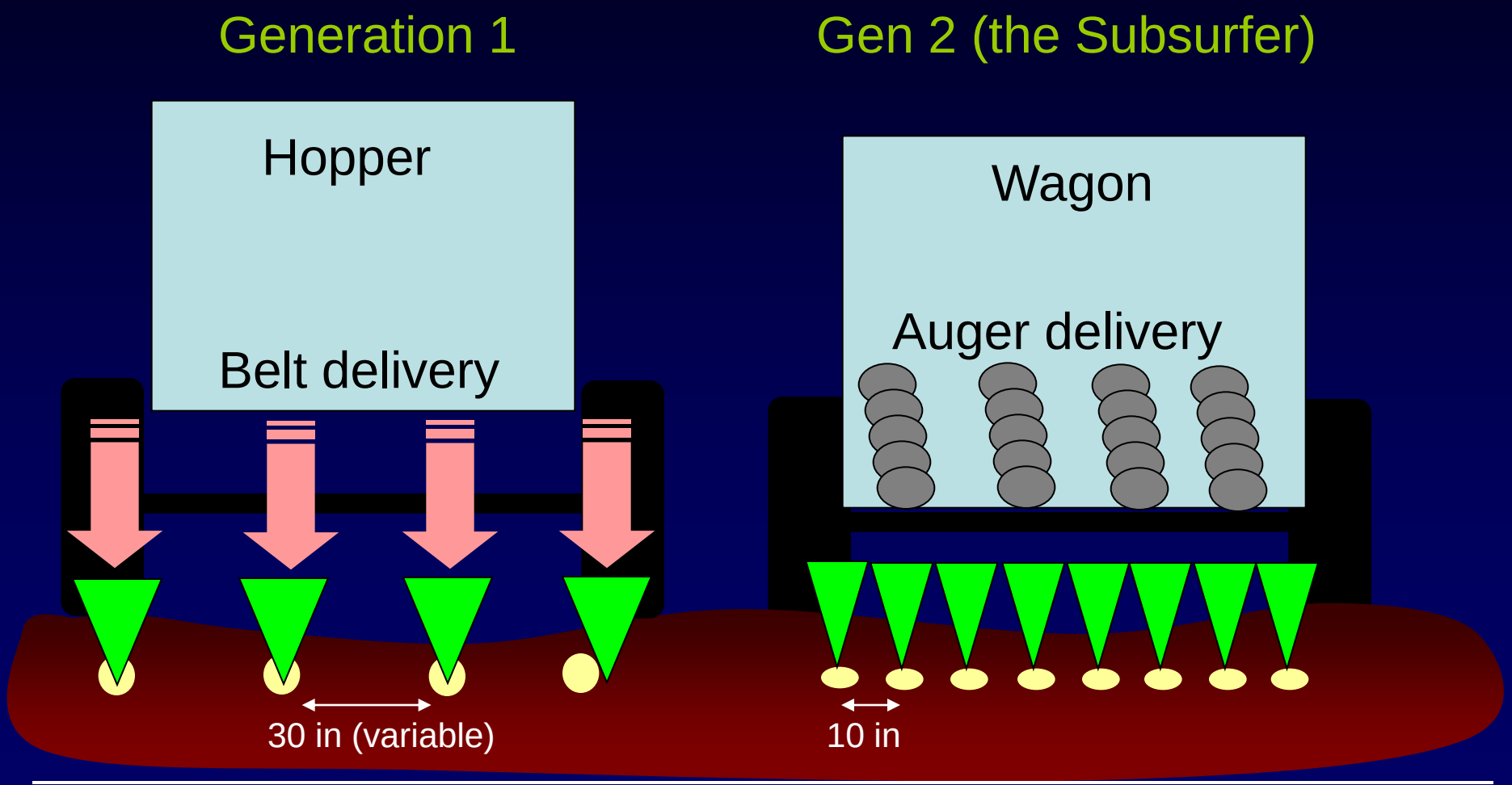
Soil scientist as mechanical engineer

Generation 1

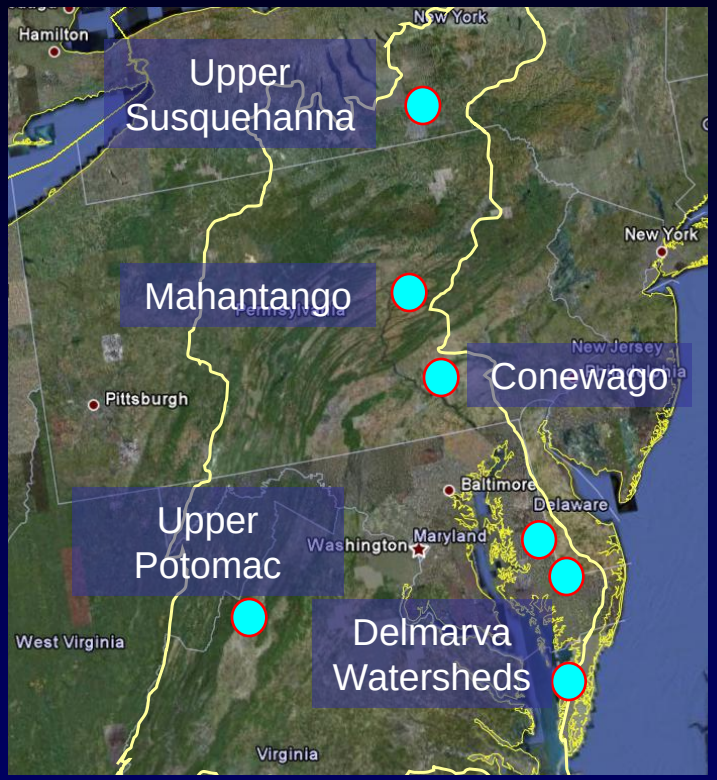
Gen 2 (the Subsurfer)

Dan Pote's creation

Change in furrow spacing and litter delivery system



The “Subsurfer” and the Chesapeake



Composted cattle manure

Litter

Build 5 Subsurfers (PA, NY, VA, MD/DE)

1. assess agronomic/environ. performance

2. engineering revisions by BBI Inc.

The “Subsurfer” and the Conewago

- Dauphin CD, Mike Hubler
- Looking for poultry farms
  - Litter or dry manure (25% moisture)
  - Spring corn trials on at least 5 farms
    - Compare surface applied litter with subsurface applied litter
  - Test driving opportunities
    - Run it through it’s paces for half a day
  - Fall trials

Equipment Costs

- Liquid (12’ toolbar)
  - Shallow disk ($9,000)
  - Aeration ($18,000+$5,000 SSD)
  - High pressure ($25,000)
  - Anti-leaching sweeps ($9,000)

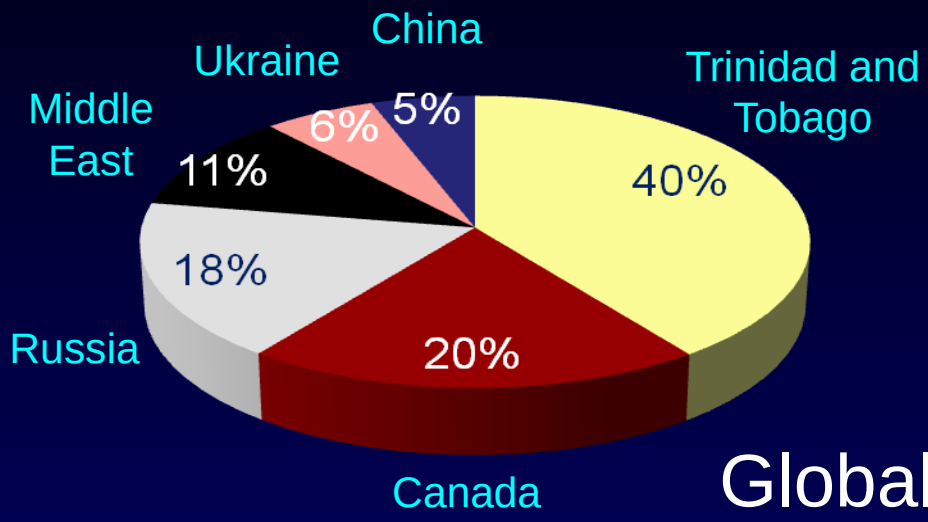
- Solid
  - Subsurfer ($44,000 custom build)

Alternatives to broadcasting manure in no-till

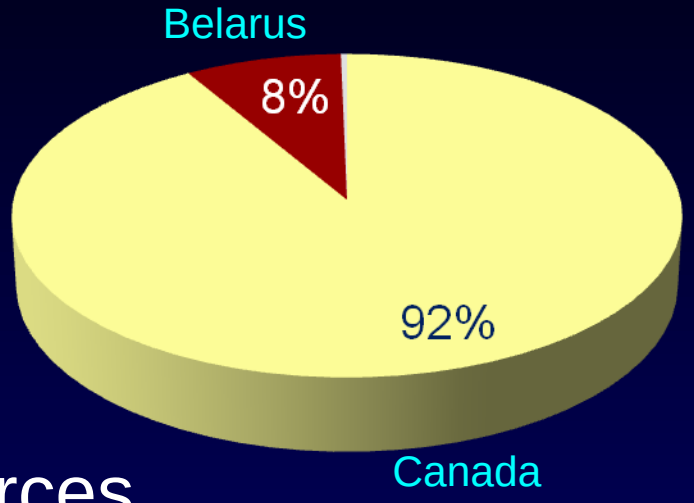
- slower
- require more horsepower (up to 30%)
- equipment costs more
- contract application with injectors costs more
- Greater nutrient use efficiency = lower application rates

Manure nutrients = sustainable livestock agriculture

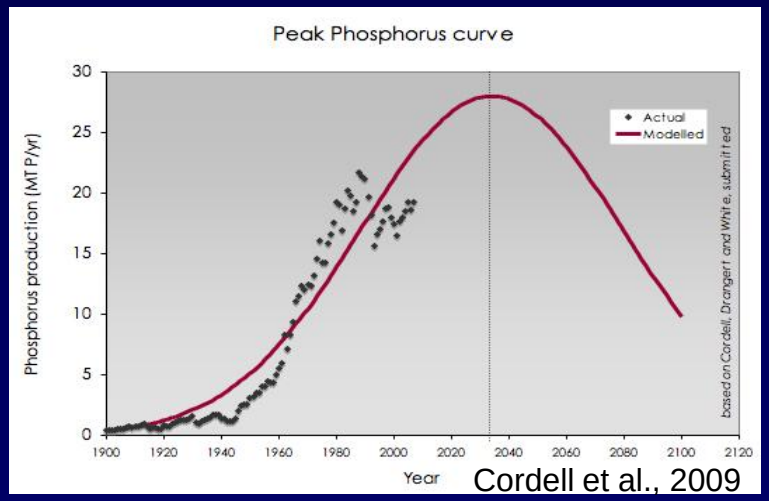
US Ag > 50% N imported



US Ag > 80% K imported



Global P sources



Cordell et al., 2009

Summary

- Improved application of manure can increase nutrient use efficiency and lower environmental losses
- New technologies are emerging
- Need to account for site-specific concerns
  - Manure application involves trade-offs