Managing manure in no-till

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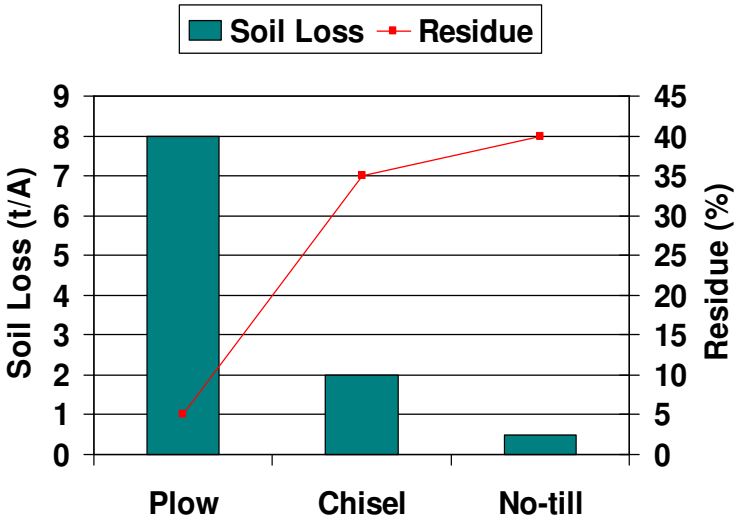
Advantages to No-till

- **Reduced soil erosion**
- More biological activity
- Moisture Conservation
- Better soil quality
- Residue on the surface



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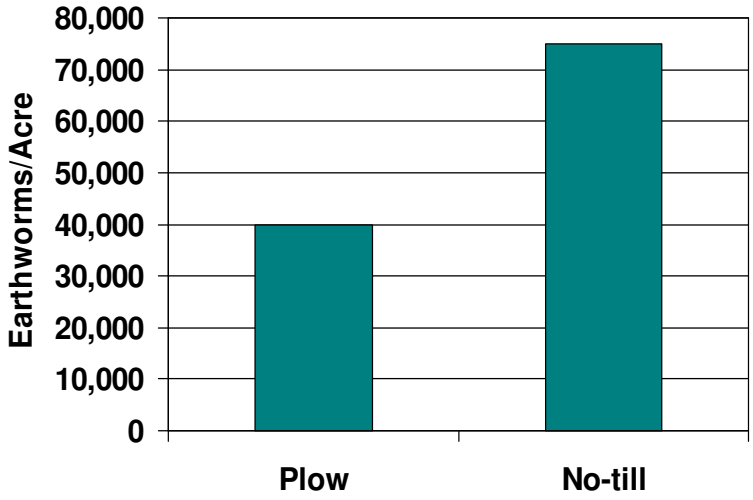

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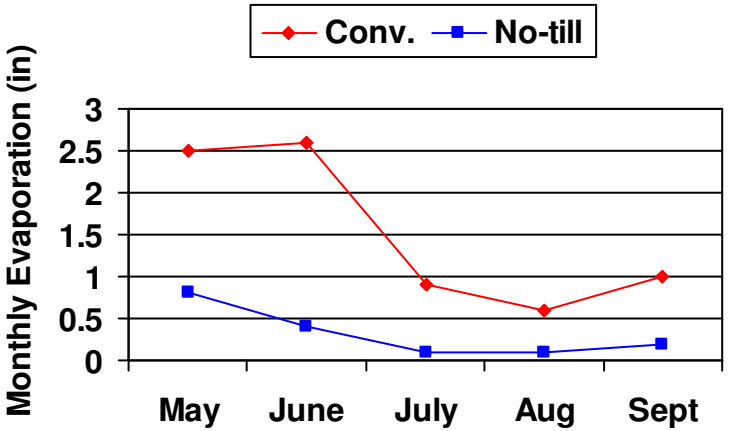

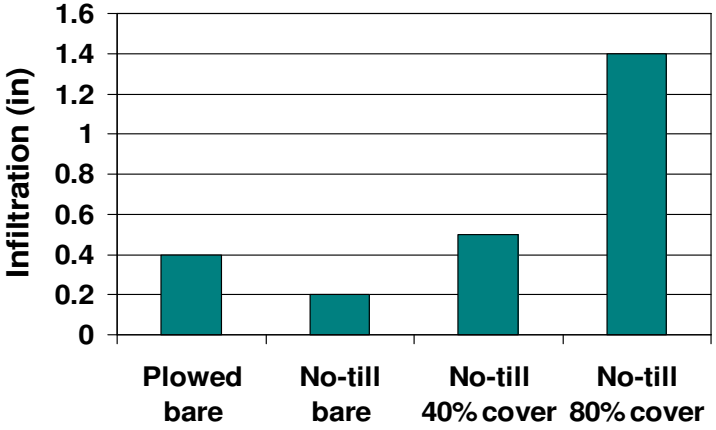

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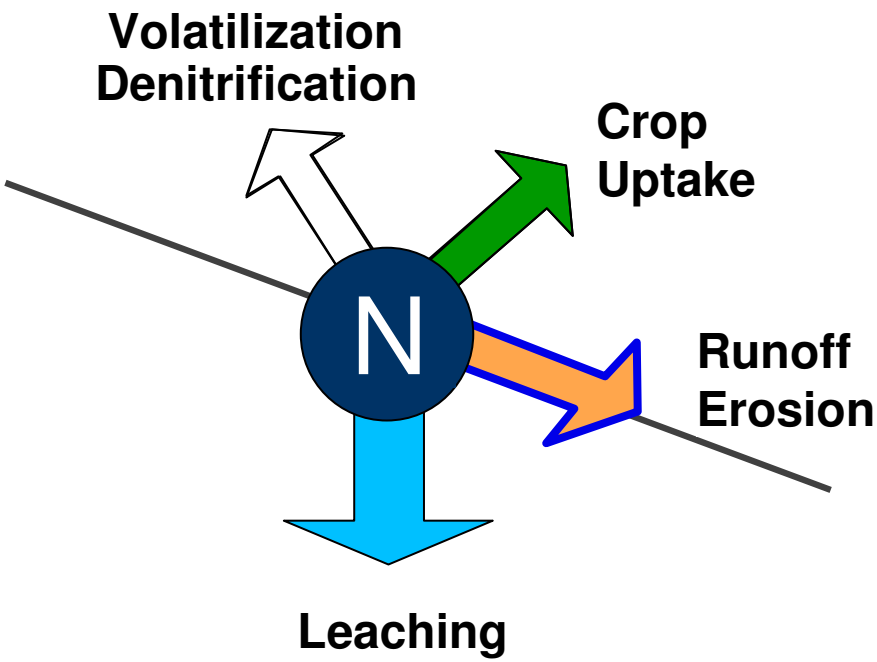
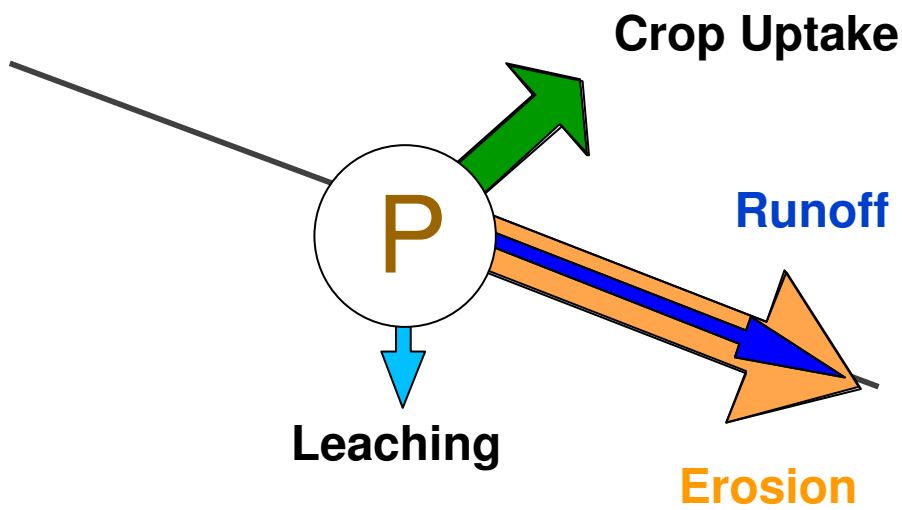
What does this mean for nutrients?





Nutrient Management

- Not Incorporating manure
  - **Increases ammonia volatilization**
  - Decreases the risk of P loss with erosion
  - Increases the risk of dissolved P loss
  - May impact nitrate leaching
  - More odor issues

From Penn State Agronomy Guide

Planned Manure Application Management	Nitrogen Availability Factor		
	Poultry Manure	Swine Manure	Other Manure
Incorporation the same day	0.75	0.70	0.50
Incorporation within 1 day	0.50	0.60	0.40
Incorporation within 2-4 days	0.45	0.40	0.35
Incorporation within 5-7 days	0.30	0.30	0.30
Incorporation after 7 days or no incorporation	0.15	0.20	0.20

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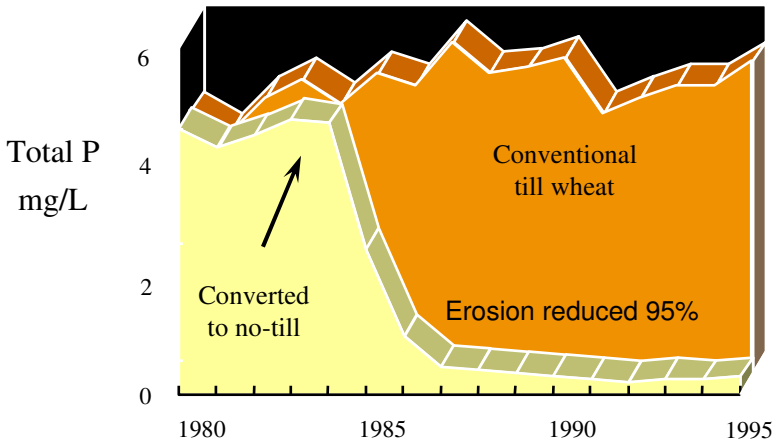

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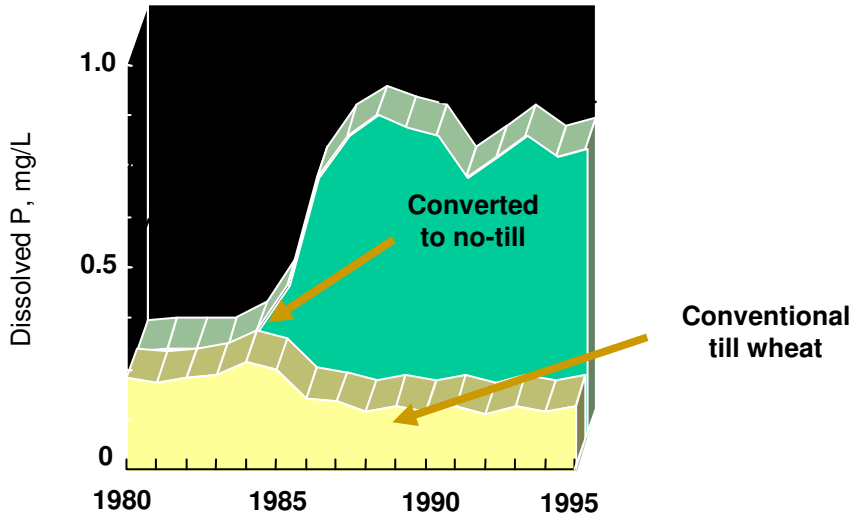

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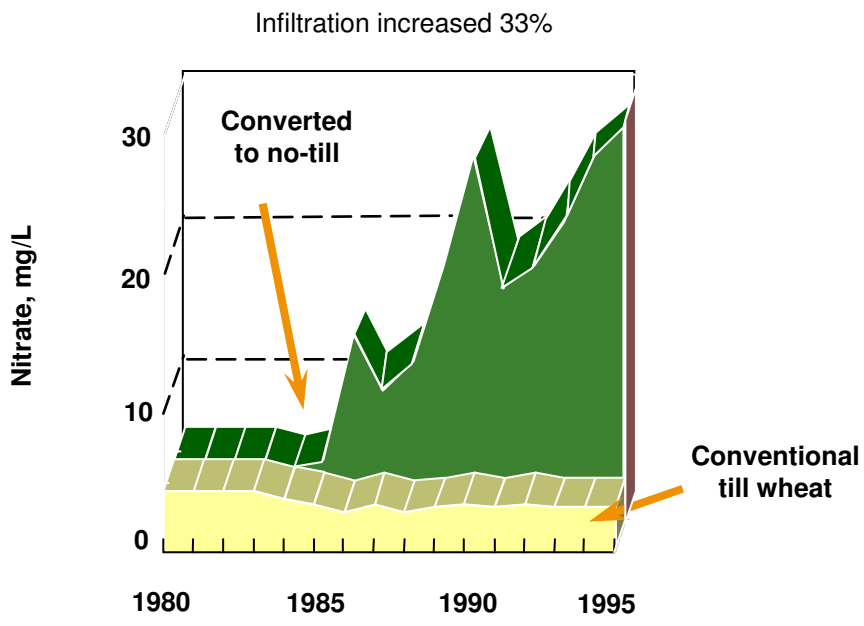

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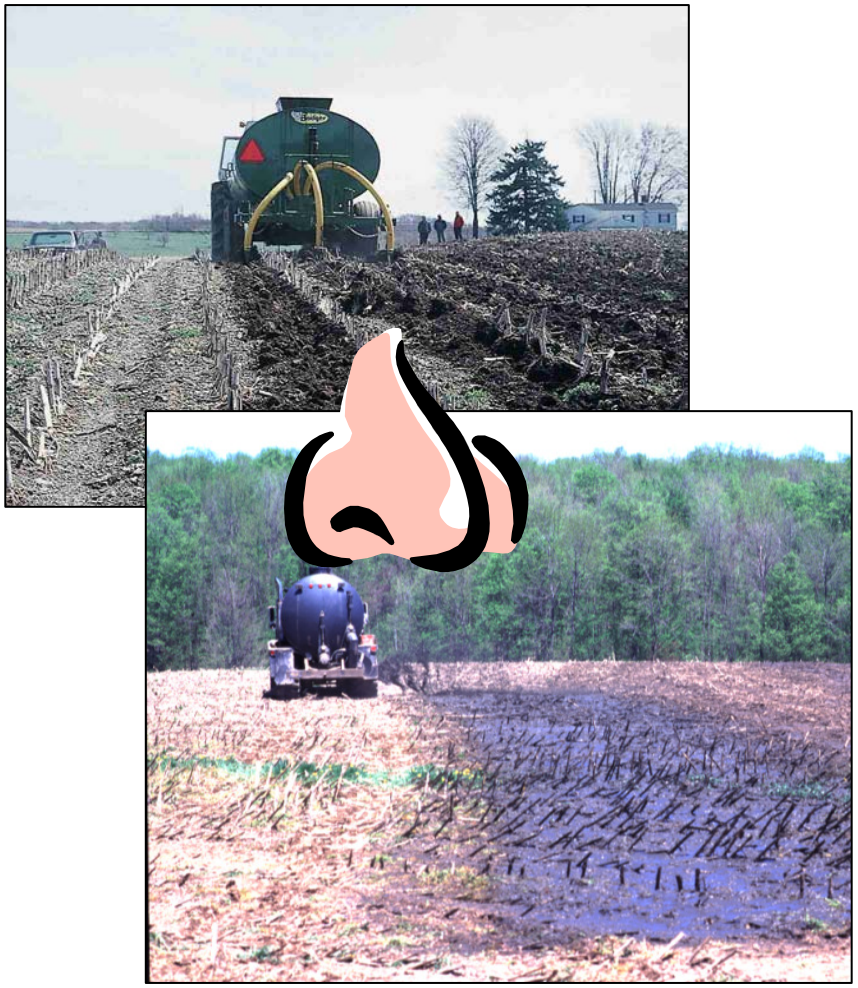


To till or not to till,
that is the question . . .”

- Tillage reduces N volatilization
- No till increases N volatilization

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

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

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

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

Research Questions:

- Is there a way to get the benefits of manure incorporation <u>and</u> retain the benefits of no-till?

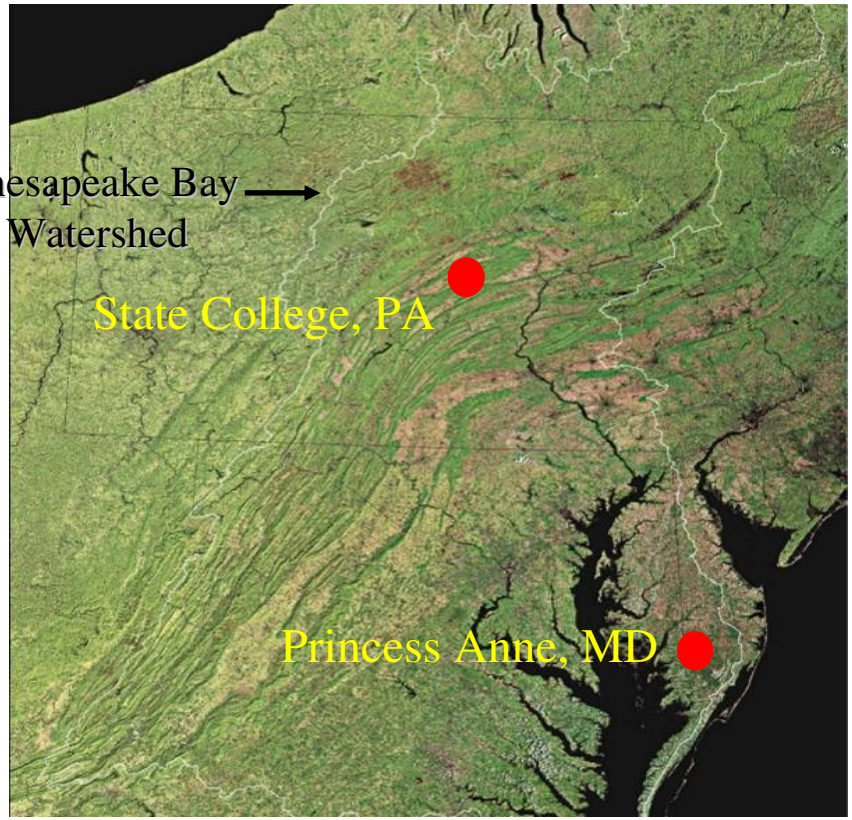
- What are the tradeoffs?

Manure Application

- No-till & Injection
  - Mutually exclusive?

6000 gal/A Dairy Manure

Liquid manure injection



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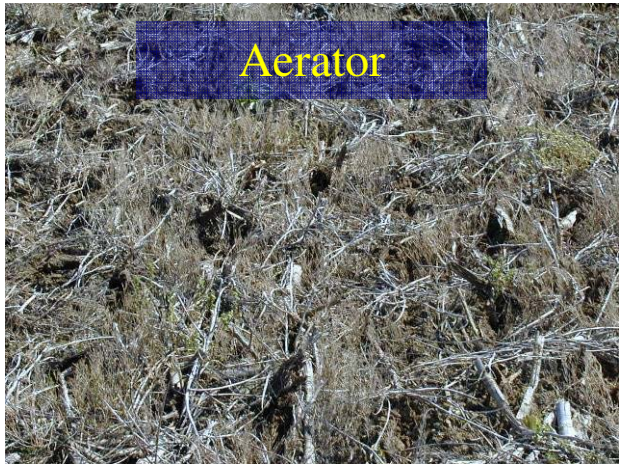
After Application



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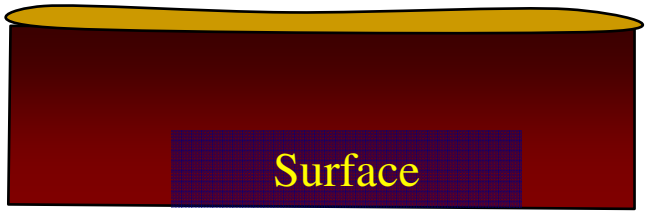
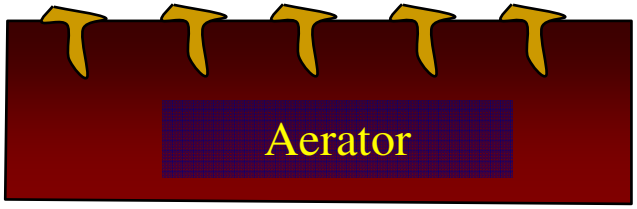
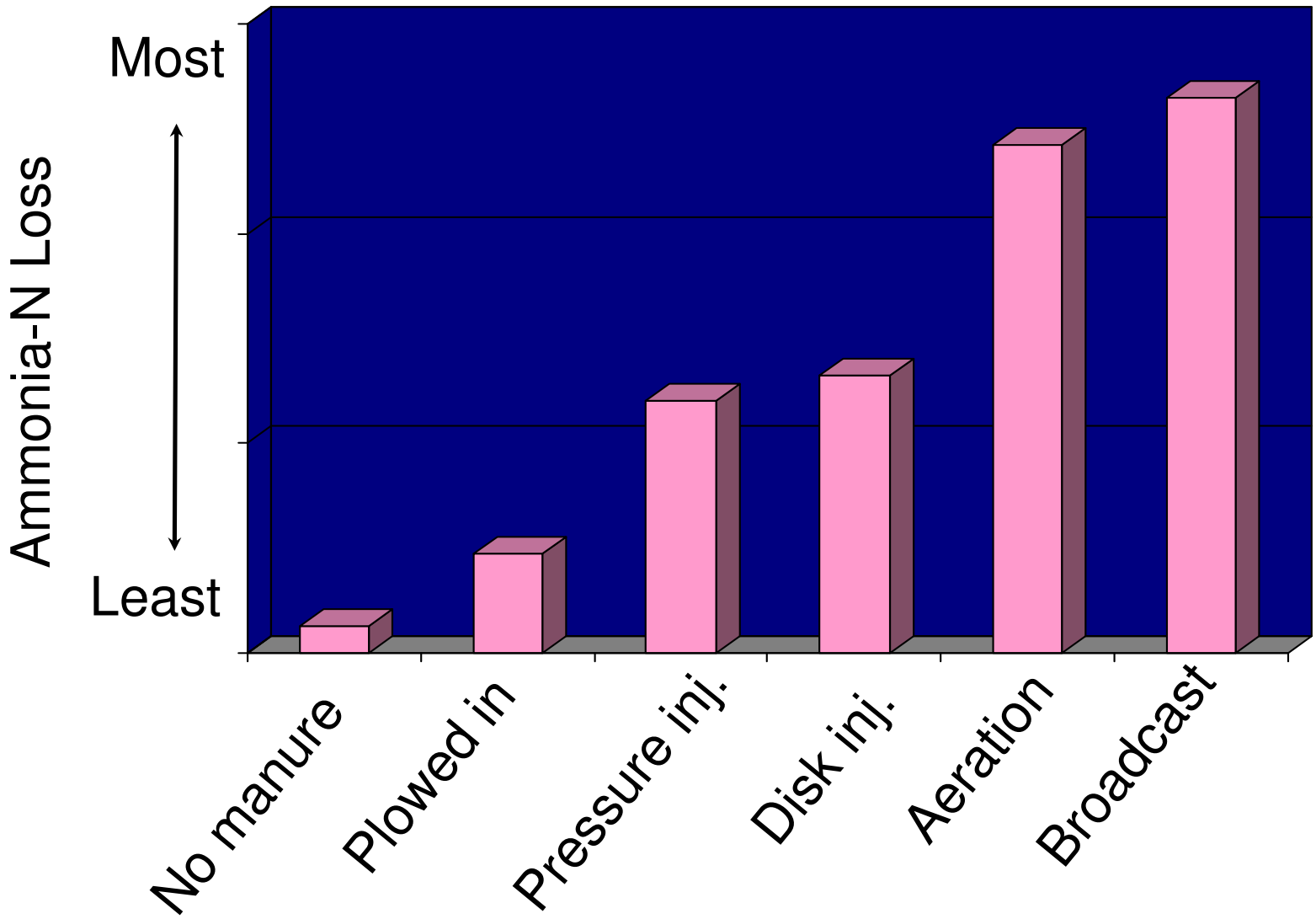




Impacts of alternative manure application methods in no-till

- Nutrient availability to crops
- N Volatilization
- N Leaching
- P Runoff
- P Erosion
- Odor
- Economics

Ammonia Volatilization Measurements


Most
Least
Ammonia-N Loss
No manure
Plowed in
Pressure inj.
Disk inj.
Aeration
Broadcast

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Evidence from existing studies – NH_3 loss

- Aerway SSD vs. Broadcast

  ~50% decrease (Bittman et al., 2003)
- Norwegian Pressure Injector (DGI) vs. Broadcast

  ~60% decrease (Morken and Sakshaug, 1995)
- Shallow disk vs. Broadcast

  ~70% decrease (Misselbrook et al., 2002)
- Knife Injector vs. Broadcast

  No difference, low emissions (Hanna, 2000)

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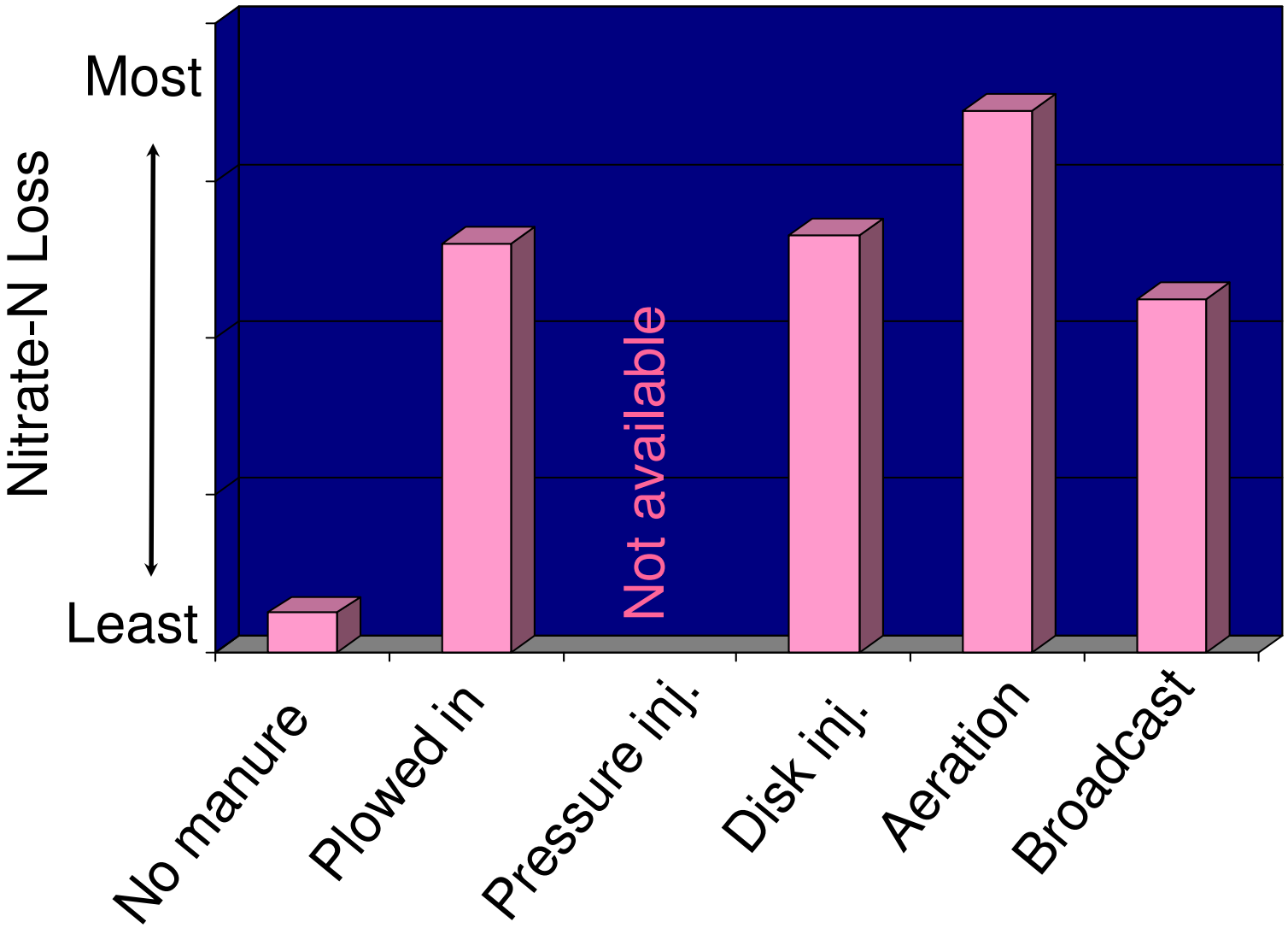
Nitrate Leaching Measurements


Most
Least
Nitrate-N Loss
Not available
No manure
Plowed in
Pressure inj.
Disk inj.
Aeration
Broadcast

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Evidence from existing studies – NO_3 leaching

- Knife Injector vs. Broadcast

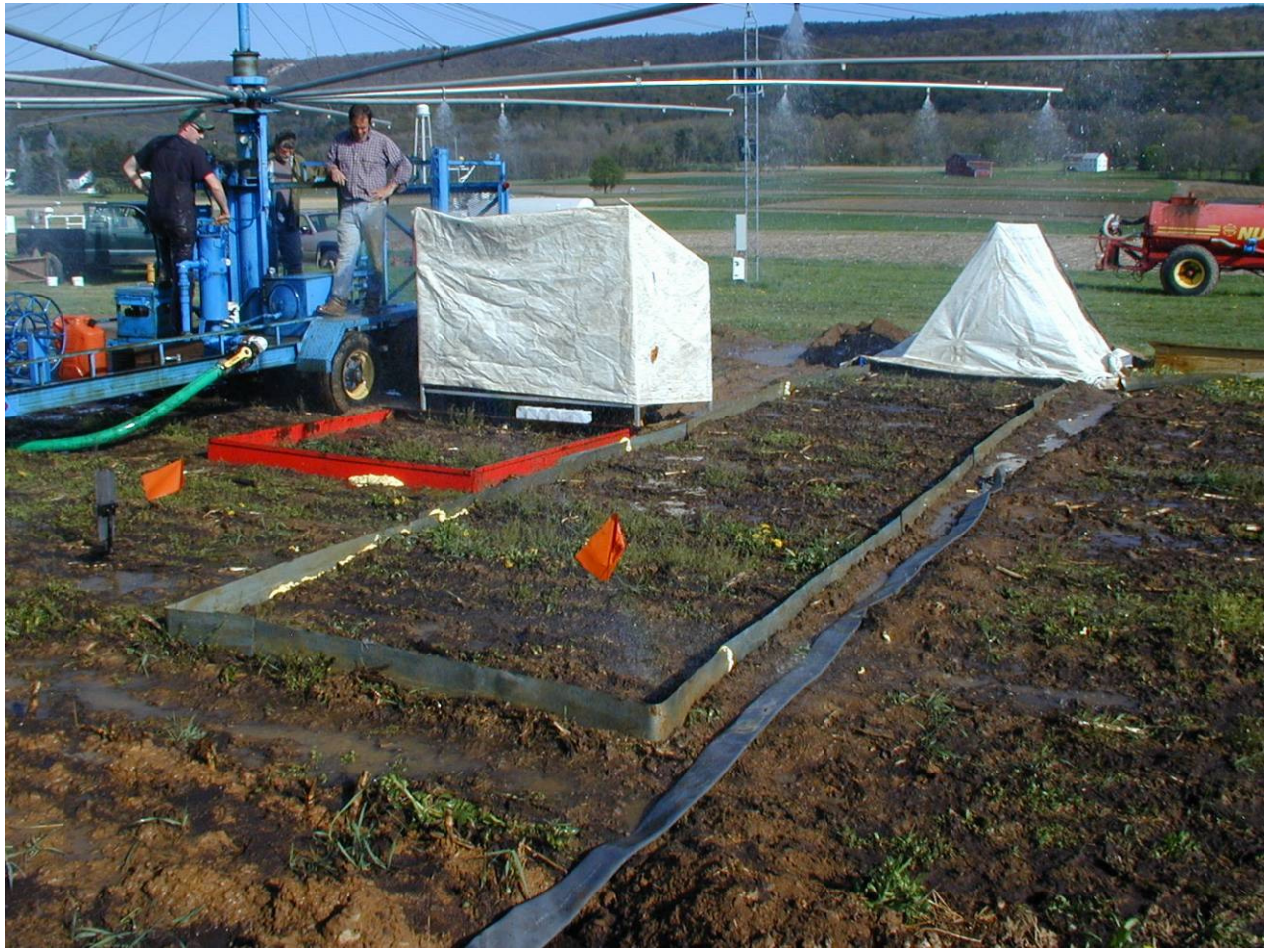
  ~20% increase in leaching due to deep injection (Weslien et al., 1998)

Rainfall simulations to measure P and Sediment runoff

Plot Scale Issues?

National P Project Protocol

Rainfall simulations to measure P and Sediment runoff



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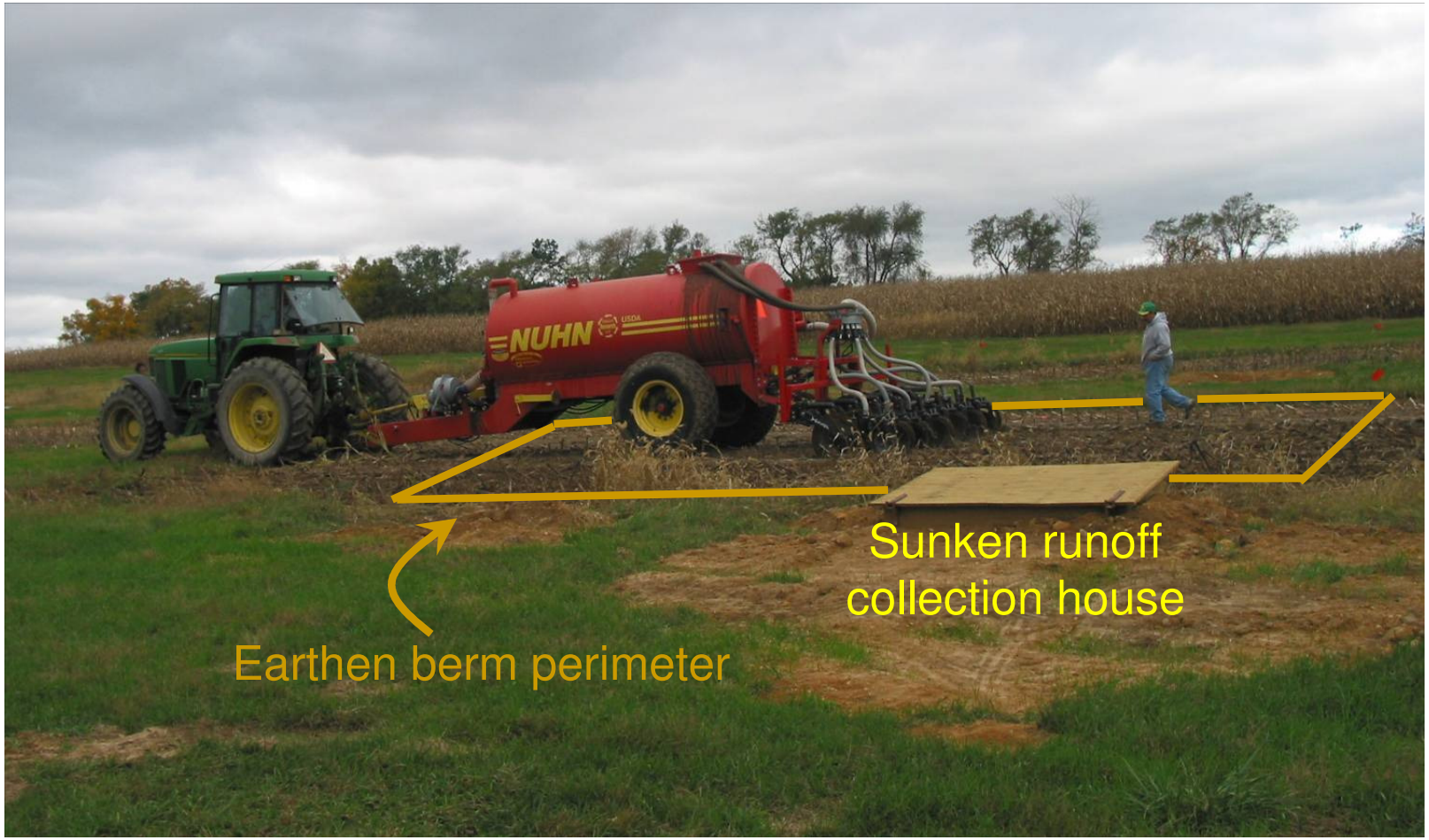
Field runoff plots with natural rainfall



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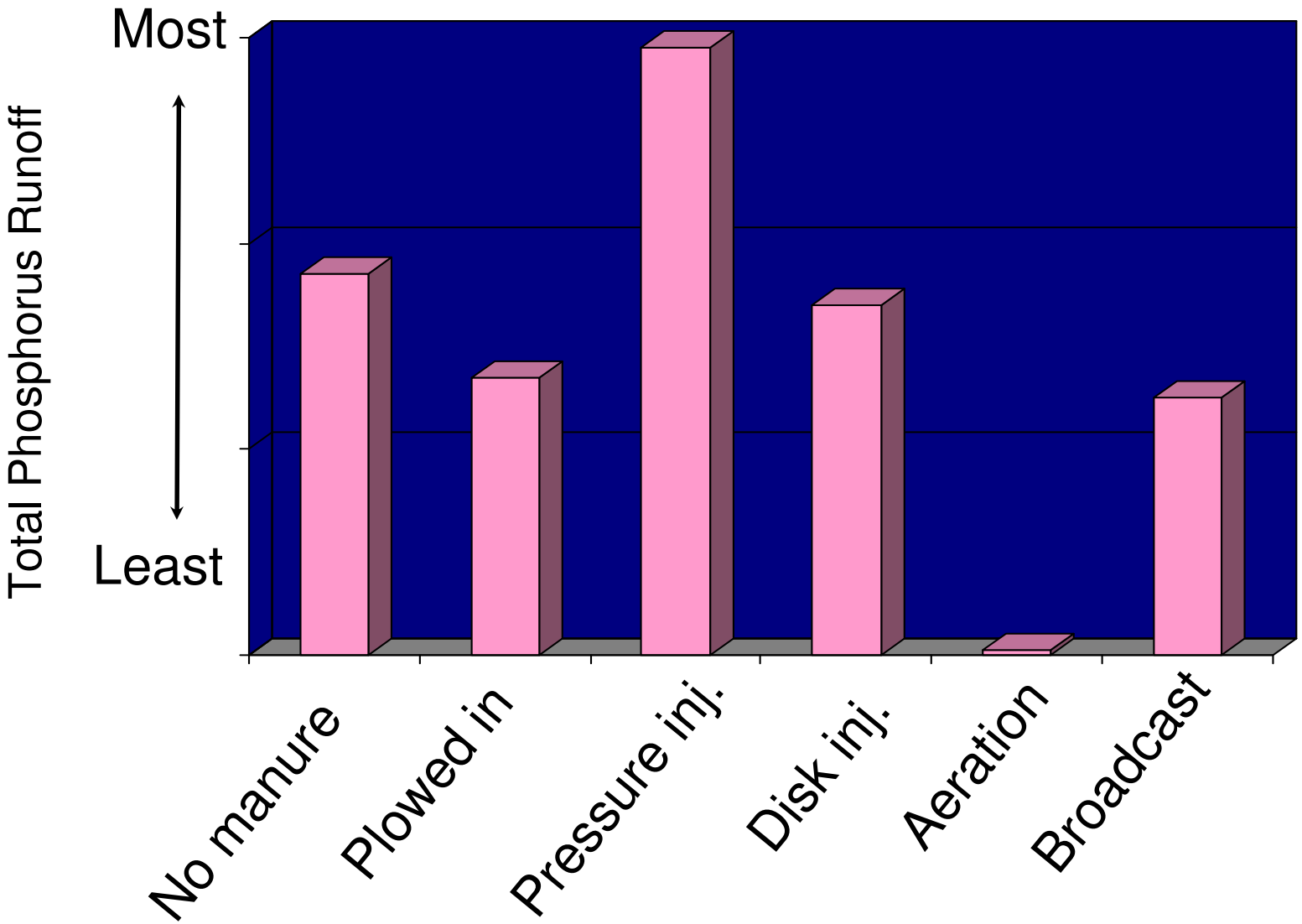
Most
Least
Total Phosphorus Runoff
No manure
Plowed in
Pressure inj.
Disk inj.
Aeration
Broadcast

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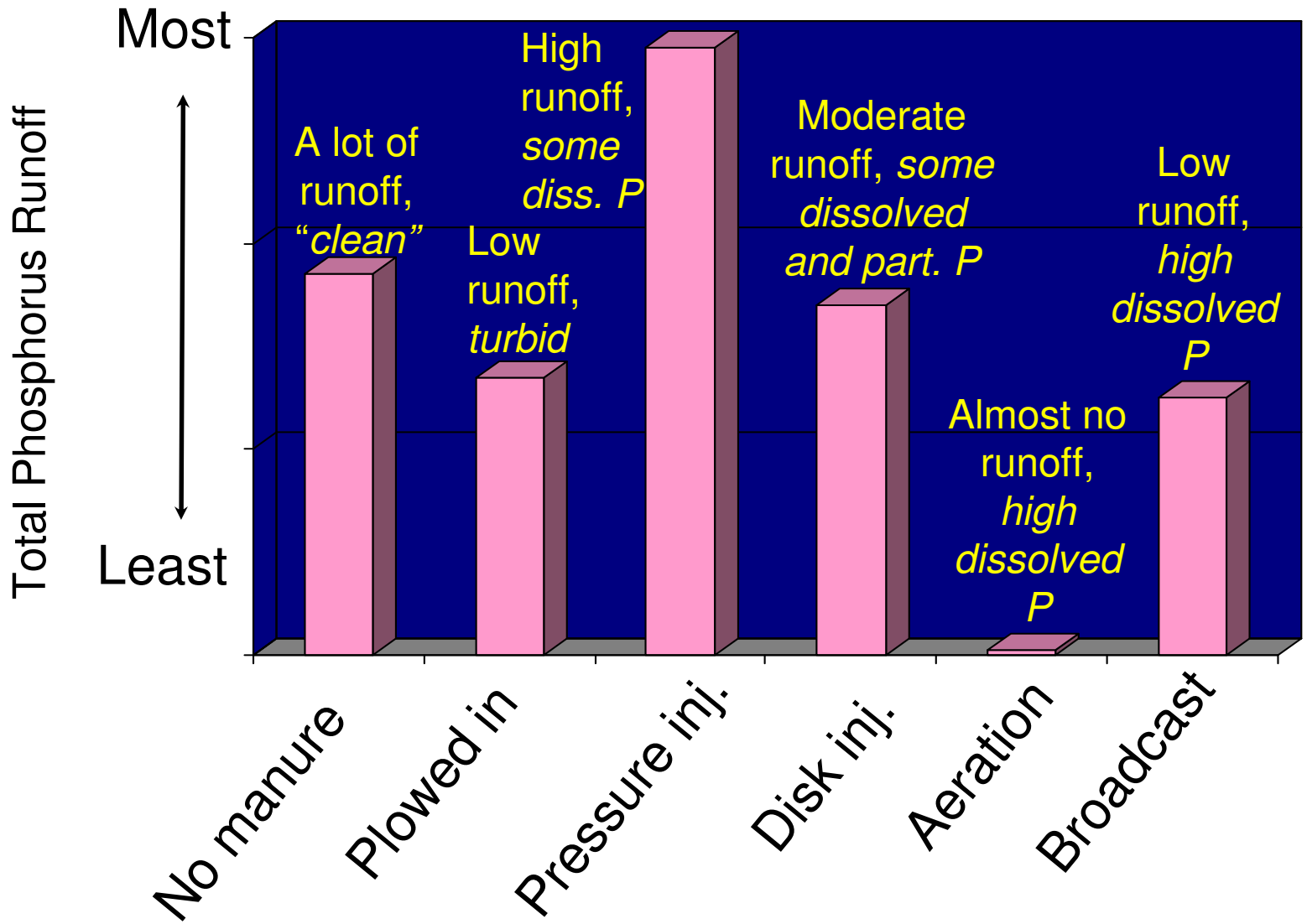
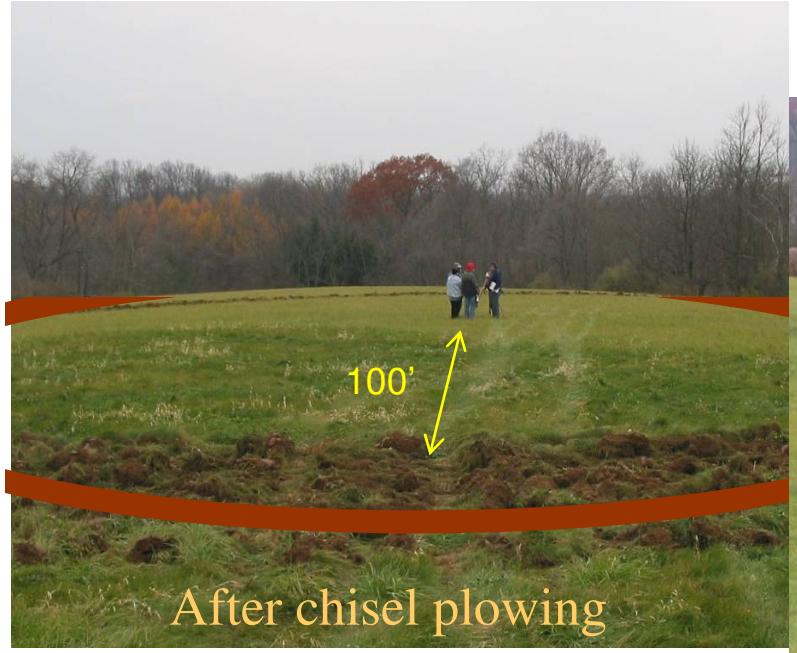
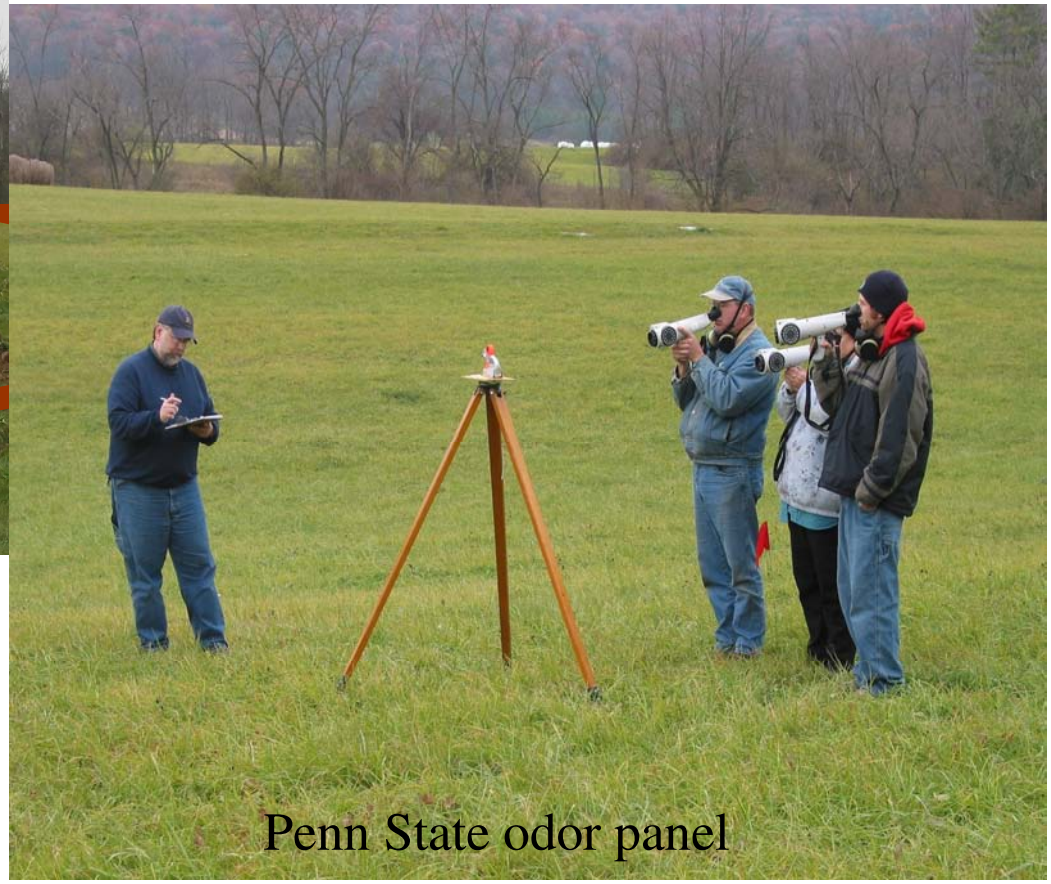

Most
Least
Total Phosphorus Runoff
A lot of runoff, "clean"
Low runoff, turbid
High runoff, some diss. P
Moderate runoff, some dissolved and part. P
Almost no runoff, high dissolved P
Low runoff, high dissolved P
No manure
Plowed in
Pressure inj.
Disk inj.
Aeration
Broadcast

Odor intensity

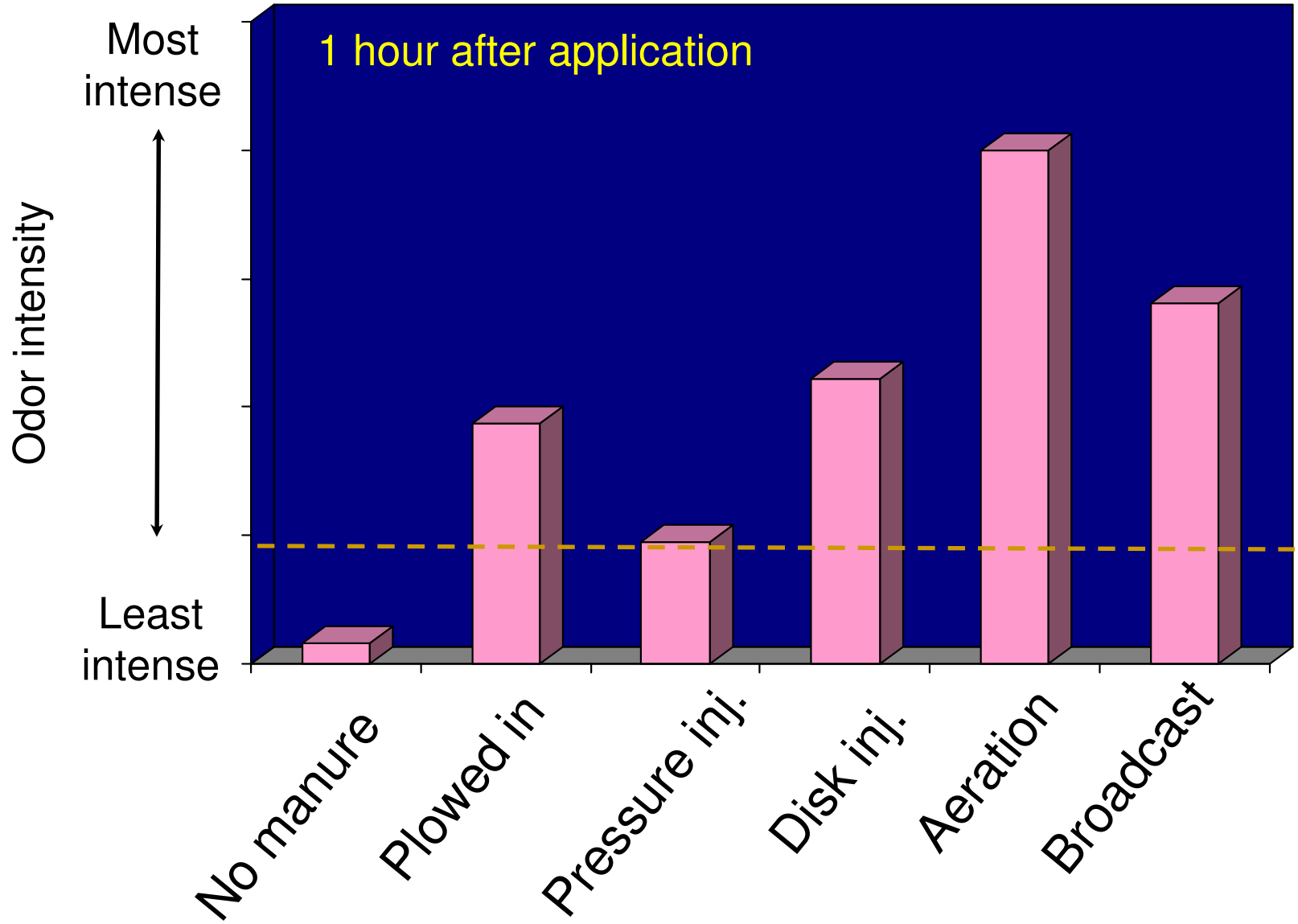
Oh that "dairy air"



After chisel plowing



Penn State odor panel


1 hour after application
Most intense
Least intense
Odor intensity
No manure
Plowed in
Pressure inj.
Disk inj.
Aeration
Broadcast

Evidence from existing studies – Odor

- Aerway SSD vs. Broadcast

  ~75% decrease (Bittman et al., 2003)
- Knife Injector vs. Broadcast

  ~40% decrease (Hanna, 2000)
- Unknown Injector vs. Broadcast

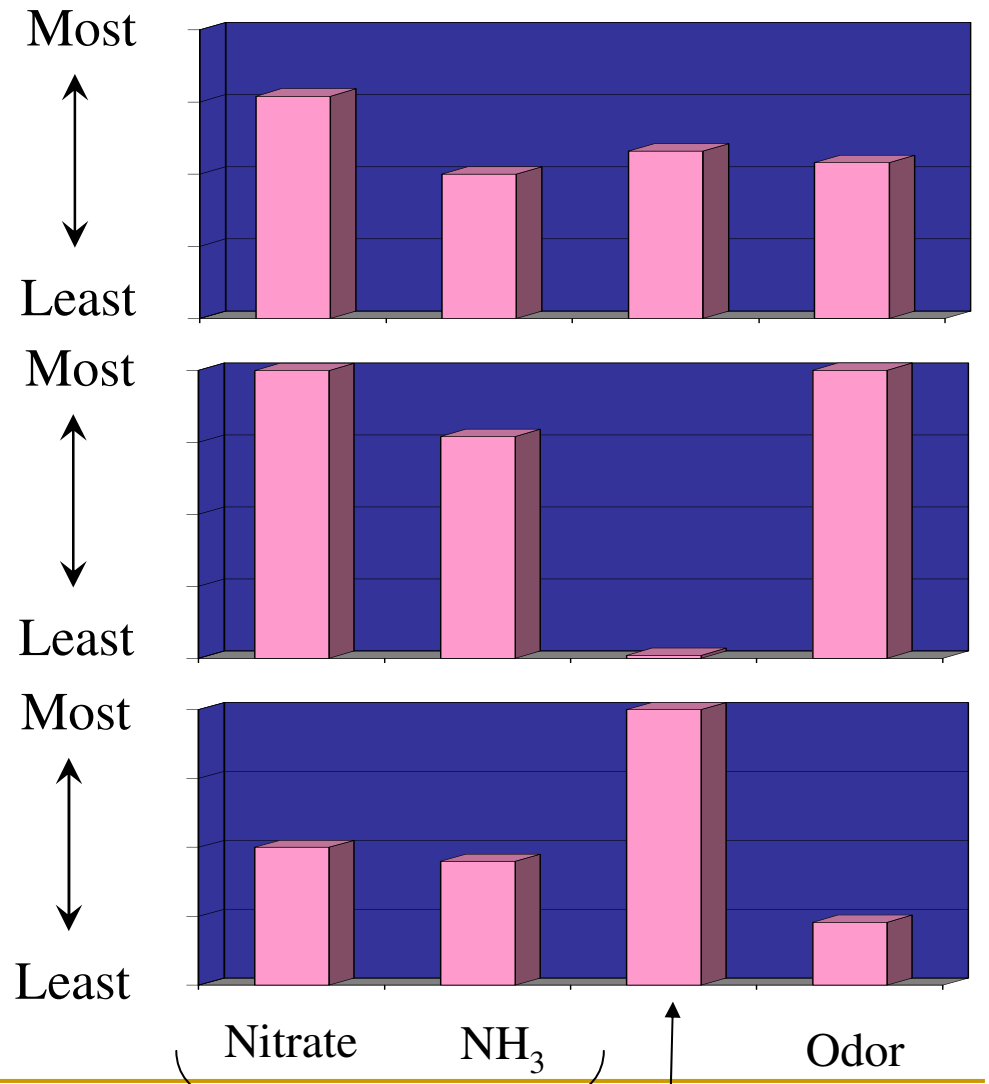
  ~75% decrease (Lorimor, 1998)

Indexing for site specific concerns

Shallow disk

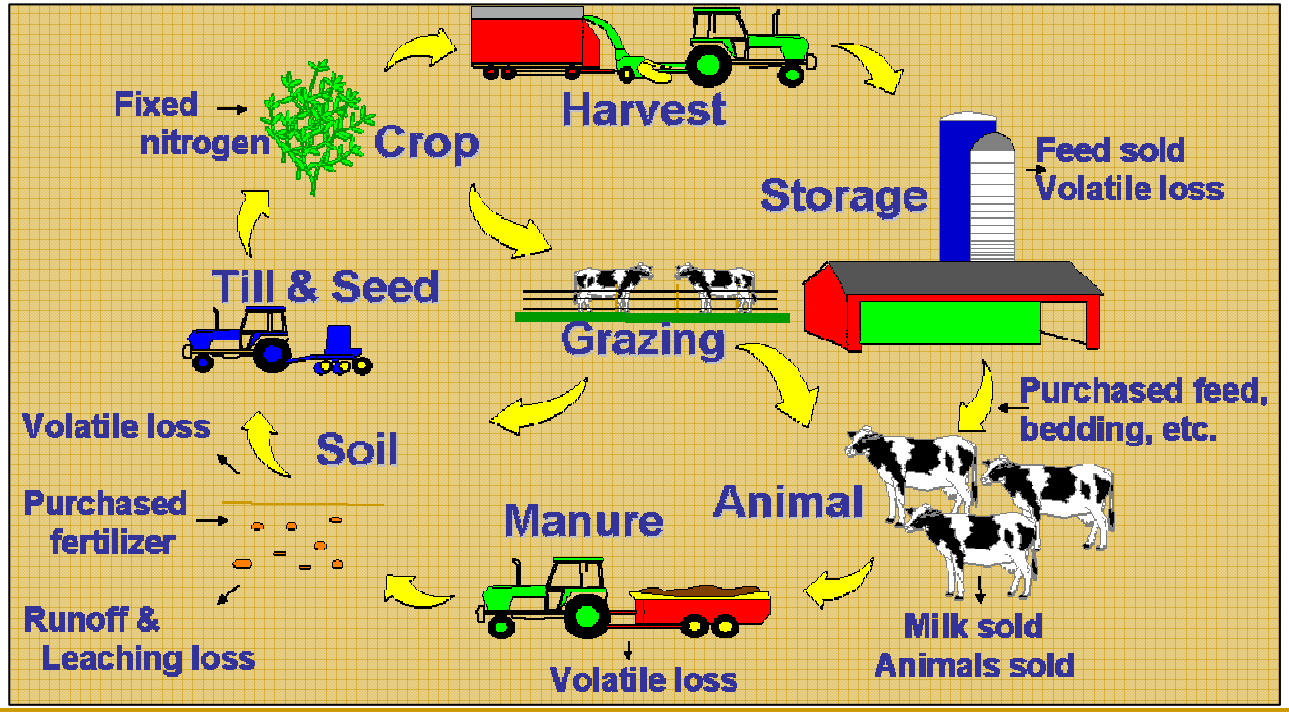
Aerator

Pressure injection



Integrated Farming Systems Model (IFSM)

- Evaluation of different manure application technologies.
  - Economics
  - Time and labor
  - Constraints to adoption



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Modeling feasibility of adoption

- Adoption Costs vs. Environmental Benefits

Benefits of technology

Lower ammonia loss

Erosion control

Decreased runoff

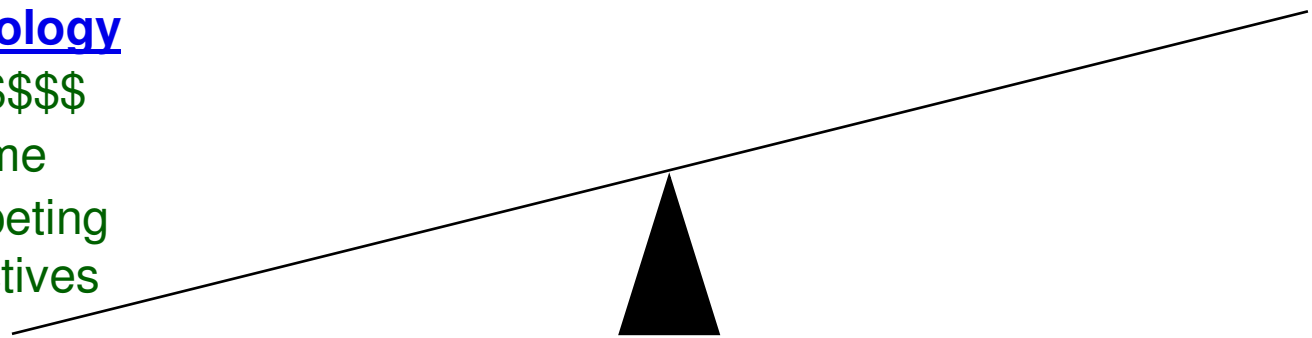
Less Odor

Costs of adopting technology

$$$$$$$

Time

Competing objectives



Integrated Farming System Model

(IFSM)

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Expected outcome

- Site specific recommendations for manure application equipment
  - Optimizing environmental benefits while addressing local needs/constraints
  - Transfer of new technologies for manure injection
- Improve P Index
  - No-till
  - Manure application methods
- Standardized approach to testing field BMPs

Acknowledgements

- USDA NRCS Conservation Innovation Grants
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- USDA-ARS Pasture Systems and Watershed Management Research Unit
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  - Sarah Marshal
  - Mike Reiner
  - David Otto

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Summary

- Conflicts exist between manure management and no-till
- Compromise is usually required
  - Prioritize concerns
- New technologies may improve the tradeoffs