Managing manure in no-till

Peter Kleinman
USDA ARS

Douglas Beegle
Penn State

Joel Myers
USDA-NRCS (retired)
Advantages to No-till

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

![Graph showing soil loss and residue comparison between plow, chisel, and no-till methods. The graph indicates lower soil loss and higher residue percentage in the no-till method.]
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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

<table>
<thead>
<tr>
<th>Planned Manure Application Management</th>
<th>Nitrogen Availability Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Poultry Manure</td>
</tr>
<tr>
<td>Incorporation the same day</td>
<td>0.75</td>
</tr>
<tr>
<td>Incorporation within 1 day</td>
<td>0.50</td>
</tr>
<tr>
<td>Incorporation within 2-4 days</td>
<td>0.45</td>
</tr>
<tr>
<td>Incorporation within 5-7 days</td>
<td>0.30</td>
</tr>
<tr>
<td>Incorporation after 7 days or no incorporation</td>
<td>0.15</td>
</tr>
</tbody>
</table>

From Penn State Agronomy Guide
Nutrient Management

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![Graph showing nutrient management impact over years](image)
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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 and 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

Chesapeake Bay
Watershed
State College, PA

Princess Anne, MD

Shallow disk
Aeration infiltration
High pressure
Chisel
Broadcast

PENNSTATE
After Application

- Shallow Disk
- Surface
- High Pressure
- Aerator
After Application

- Shallow Disk
- Surface
- High Pressure
- Aerator
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
Evidence from existing studies – \( \text{NH}_3 \) 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)
Nitrate Leaching Measurements
Nitrate-N Loss

- No manure
- Plowed in
- Pressure inj.
- Disk inj.
- Aeration
- Broadcast

Most

Not available

Least
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
Field runoff plots with natural rainfall

Earthen berm perimeter

Sunken runoff collection house
Total Phosphorus Runoff

Most

Least

No manure
Plowed in
Pressure inj.
Disk inj.
Aeration
Broadcast

Most

Least
Total Phosphorus Runoff

Most

A lot of runoff, "clean"

Low runoff, some dissolved P

High runoff, some dissolved P

Moderate runoff, some dissolved and part. P

Low runoff, high dissolved P

Almost no runoff, high dissolved P

Least

No manure

Plowed in

Pressure inj.

Disk inj.

Aeration

Broadcast
Odor intensity

After chisel plowing

Oh that “dairy air”

Penn State odor panel

The graph shows the odor intensity 1 hour after application of different methods:
- No manure
- Plowed in
- Pressure inj.
- Disk inj.
- Aeration
- Broadcast

The y-axis represents odor intensity, with the least intense at the bottom and the most intense at the top. The x-axis lists the different methods of application.
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

Bar charts showing:
- Nitrate
- NH₃
- Odor

Comparison of N losses and P losses.
Integrated Farming Systems Model (IFSM)

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

- Adoption Costs vs. Environmental Benefits

**Costs of adopting technology**
- $$$$$$
- Time
- Competing objectives

**Benefits of technology**
- Lower ammonia loss
- Erosion control
- Decreased runoff
- Less Odor

Integrated Farming System Model (IFSM)
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
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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