Manure on Forage Crops: Benefits and Challenges

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Manure Application on Perennial Forages: Alfalfa, Grass Forages

Why apply manure on alfalfa? What are the benefits?

- Alfalfa has high nutrient need (P, K, S, and micronutrients, especially B) → Manure is good source of those nutrients.
- May be increased yield

Alfalfa has high nutrient need

Nutrient Removal

Nutrient	lb/dry ton	lb/acre (4 T/A)	lb/acre (6 T/A)
N	55	220	330
P_2O_5	17	70	100
K_2O	55	220	330
S	6	24	36

Adapted from Beegle, 2011; Kelling, 2000

Manure is good source of P, K, S, and micronutrients

Typical Manure Nutrient Content

Wisconsin, 1998-2012

Species	DM	N	P_2O_5	K_2O	S
	%	lb/1000 gal			
Dairy – liquid (<4.0%DM)	2	14	4	14	1.1
Dairy – liquid (4.1-11.0%DM)	6	23	8	21	2.3
Beef	3	16	7	15	1.6

These are average values. Actual nutrient content can vary greatly. Sample and analyze manure!

A2809; Laboski and Peters, 2012

Manure on Alfalfa: 3 Application Strategies/Times

- Preplant: before alfalfa seeding
- Following last harvest/at termination of stand
- Topdress on established alfalfa

Preplant Dairy Manure and Alfalfa Yields

Seeding Year Yields

- MN: Rosemount (3000-12,000 gpa; high soil test P, K)
  - Manure > Non-fertilized Control
  - Manure >= Fertilizer (P, K)
- MN: Waseca (3000-12,000 gpa; low/med soil test P, K)
  - Manure = Control (compaction problem)
  - Fertilizer > Manure and Control
- WI: Marshfield (12,000-24,000 gpa; low/med soil test P, K)
  - Manure > Control
  - Manure >= Fertilizer

First full production year

- Manure > Control at all locations
- Manure > Fertilizer

Kelling and Schmitt, 2003

Preplant Liquid Dairy Manure and Alfalfa Yields: Summary

Rosemount and Waseca, MN; Marshfield, WI

- Manure increased yields vs nonfertilized control in seeding year and first production year
  - Low/medium soil test P, K (2 sites); high P, K (1 site)
  - Except where severe compaction (Waseca) ; no yield increase in seeding year
- Yields from manure sometimes > P, K fertilizer
  - Sulfur and micronutrients in manure
  - Manure N in seeding year (?)
  - Soil physical and/or microbial effects
- Manure sometimes increased weeds (seeding year)
- Preplant manure is a viable option

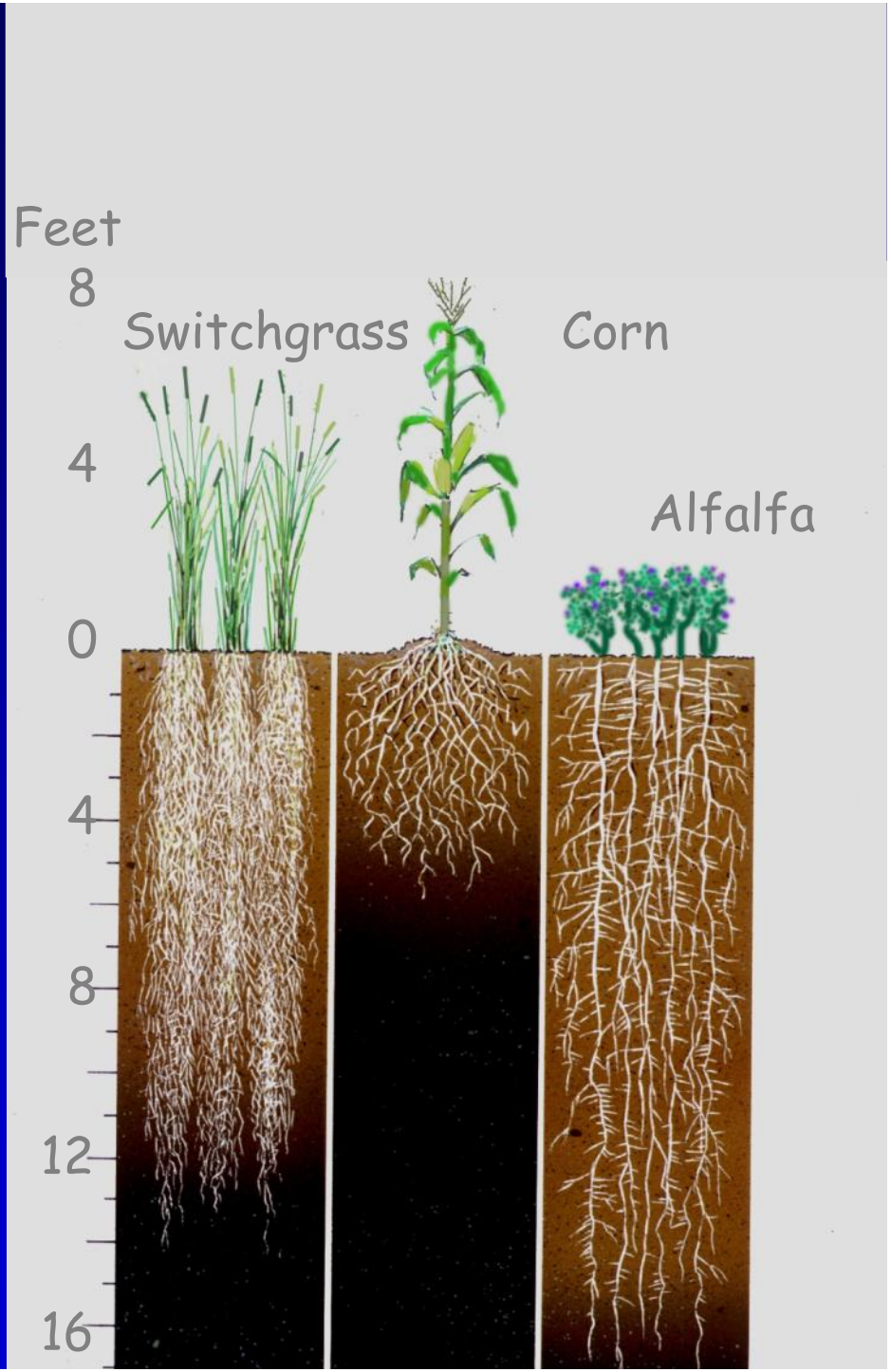
Kelling and Schmitt, 2003

Other Benefits of Manure on Alfalfa

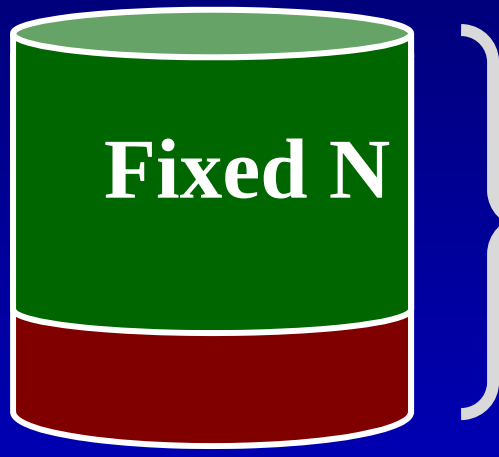
- Alfalfa has high nutrient need: P, K, S, and micronutrients (especially B)
- Manure is good source of P, K, S, and micro (B)
- May be increased yield
- Multiple windows of time for application
- Increases acreage available for spreading
- Remove excess soil nitrate
- Symbiotic N_2 fixation buffers N supply

Alfalfa removes excess soil nitrate

- Deep roots
- High N uptake



What happens to added (manure) N?

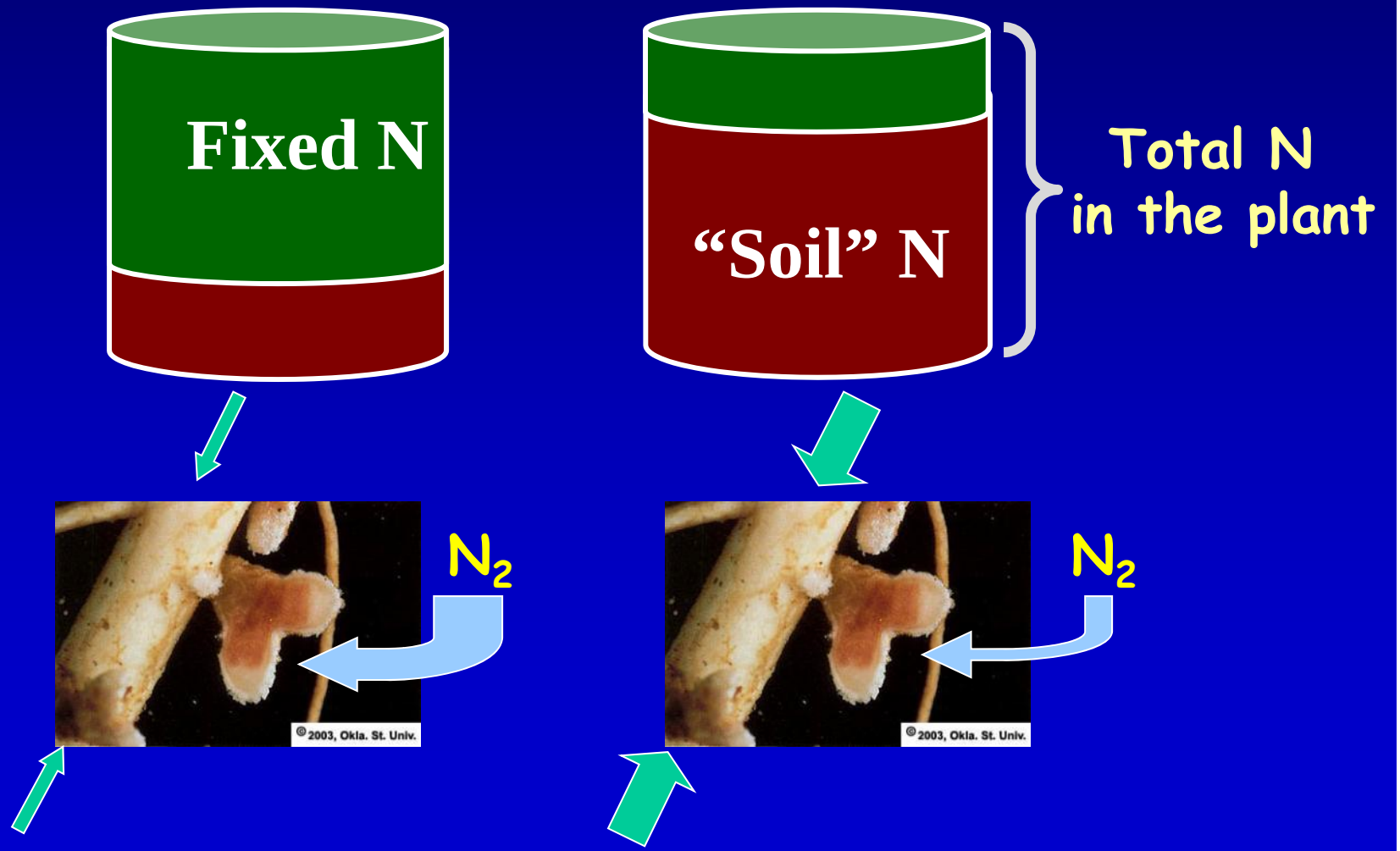


Total N
in the plant

N_2

Slide Credit: M Russelle, USDA-ARS, St. Paul

Symbiotic N_2 fixation is (usually) reduced by external N Buffers N supply



Topdressed Manure on Established Stands

Benefits

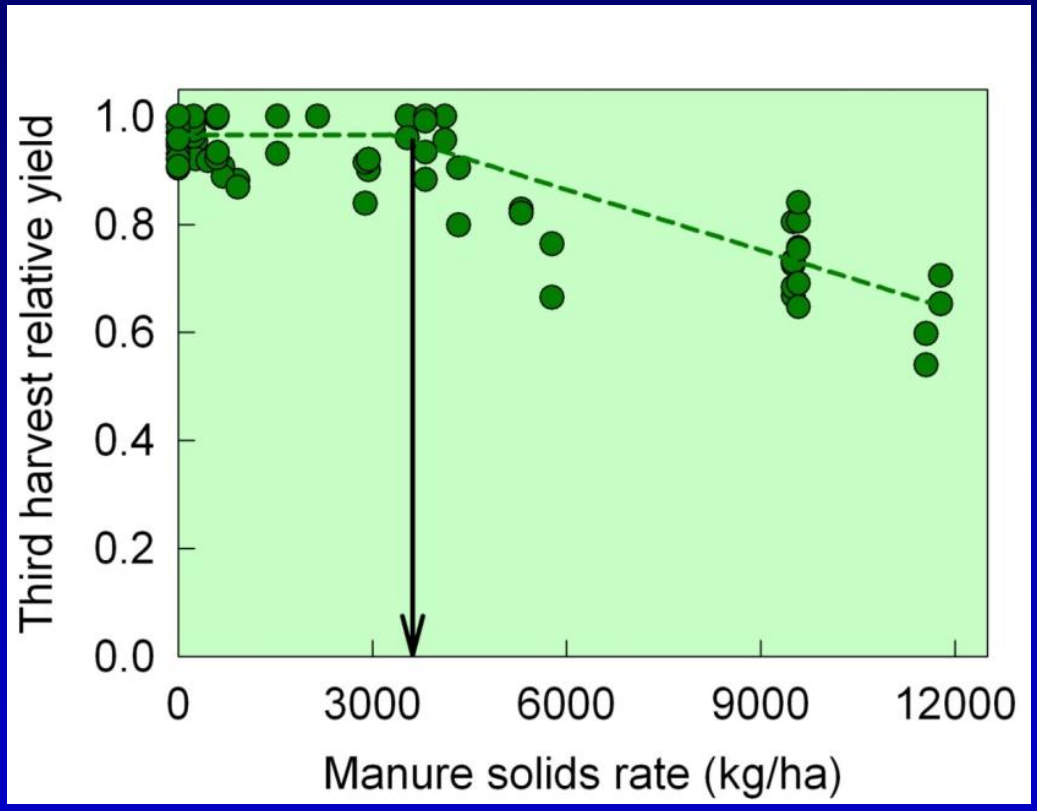
- Another window for application
- May be yield increase, especially if nutrient need

But also challenges, potential problems

Challenges and Limitations of Manure on Established Stands

- Possible stand damage and/or yield loss
  - Manure coating of leaves
  - Spreader traffic
- No N requirement so no economic value from manure N
- May be uneven application
- Nutrient runoff, especially late fall or winter application
- Pathogens

Manure solids can coat leaves and excessive rates can reduce yield



Lamb et al., 2005

Swine manure slurry broadcast within 4 days after 2nd harvest

Avoid excessive rates of manure solids

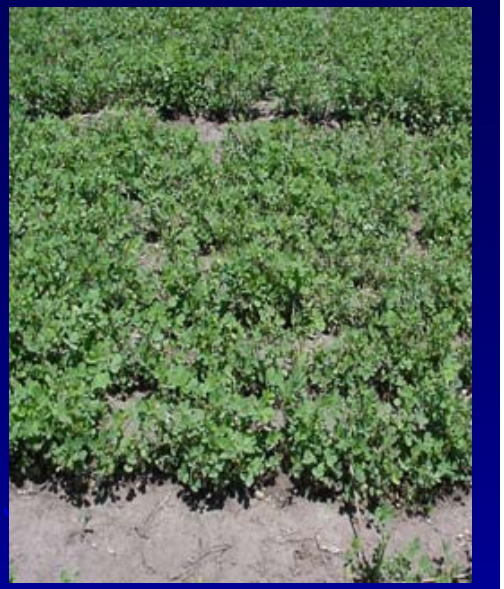
Slide Credit: M Russelle, USDA-ARS

Wheel traffic affects yields

(disease, reduce shoots produced)

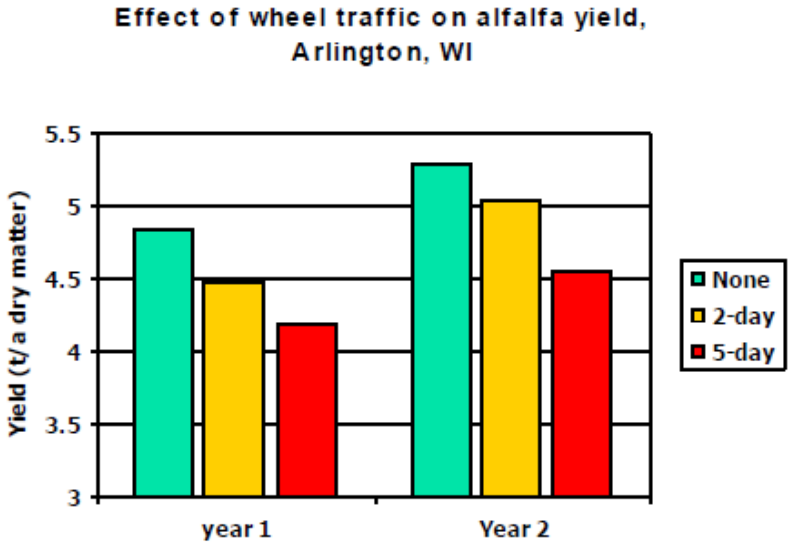
- Break regrowing shoots

D Undersander, 2008



Wheel traffic 5-day

No traffic



Recommendations to Reduce Yield Loss from Wheel Traffic

- Plant tolerant varieties
- Use smaller tractors to reduce compaction
- Avoid unnecessary trips over field
- Consider wider harvesting equipment
- Avoid tractors with duals
- Apply manure immediately after harvest
- Avoid wet soil conditions

D Undersander, 2008

Manure often carries pathogens

- Several zoonotic pathogenic bacteria:
  Salmonella, Listeria, E. coli
- Several protozoa that affect human and animal health (including *Giardia* and *Cryptosporidium*)
- Wide variety of viruses
  some persist > 6 months in manure

No manure on hay or pasture from diseased livestock!

Slide Credit: M Russelle, USDA-ARS

Johne's disease

Johne's Disease

- About 25% of US dairy herds are infected
- Young stock are more susceptible than mature animals
- Manure is the most common source of the bacteria
- Bacteria are susceptible to low pH (good silage), high pH (topdressed limestone), sunlight, desiccation, & time

	Topdress manure?	
Forage	Young stock	Cows
Pasture	No	Avoid
Dry hay	Avoid	Avoid
Good silage	OK	OK
Greenchop	Avoid	Avoid

E.D. Thomas, Miner Inst., 2006

Slide Credit: M Russelle, USDA-ARS

Alfalfa Yields from Topdressed Manure on Established Stands

- Dairy slurry on alfalfa, alfalfa-grass (MD)
  - Applied 3 or 4 x/yr for 2 yrs
  - Manure = Fertilizer = Nonfertilized Control
- Pig slurry on alfalfa (Italy)
  - Slurry applied 4 x/yr for 2 yrs; low soil test P
  - Manure > Control in 2 years when manure applied and 2 residual years
- Liquid dairy manure (WI)
  - 1200 gpa after each cutting
  - Yield: 20% decrease in Yr 1; no effect in Yr 2
  - More weeds with manure topdress

Kelling and Schmitt, 2003 Min et al 1999 Ceotto and Spallacci, 2005

Alfalfa Yields from Topdressed Manure on Established Stands

- Banded liquid dairy manure (Ontario)
  - 4500 gpa after 1st and 2nd cut for 3 yrs
  - Yield response varied by cultivar (49) but all increased vs control (fertilized based on soil test)
    - 6 to 32% increase; 14.5% average
- Summary: Topdressed Manure
  - Yield increase, esp. if nutrient need (P, K, other); also may be other factors
  - May be no yield effect or sometimes decrease
  - Depends on balance: Nutrient response, negative effect

Kelling and Schmitt, 2003 Bowley et al., 2009

Topdress Manure Timing for Alfalfa
Stratford, WI

- Liquid dairy manure at 4500 gpa
- Application treatments
  - No manure
  - Stubble immediately after harvest
  - 1 week regrowth
  - 2 weeks regrowth
- Ensiled as wrapped balage

Coblentz et al., 2014

Research supported in part by grant from Midwest Forage Association

Results

- No effect on yield
- Little/no effect on forage quality
- Silages well fermented, no undesirable odor
- *Clostridium* Cluster 1
  - Increased with manure appl.
  - Greater increase with delayed manure application
  - No indications of clostridial fermentation
- Lower risk with application to stubble

Alternatives to Surface Broadcast

Drop-hose

Banded/Trailing Foot

Shallow Injection

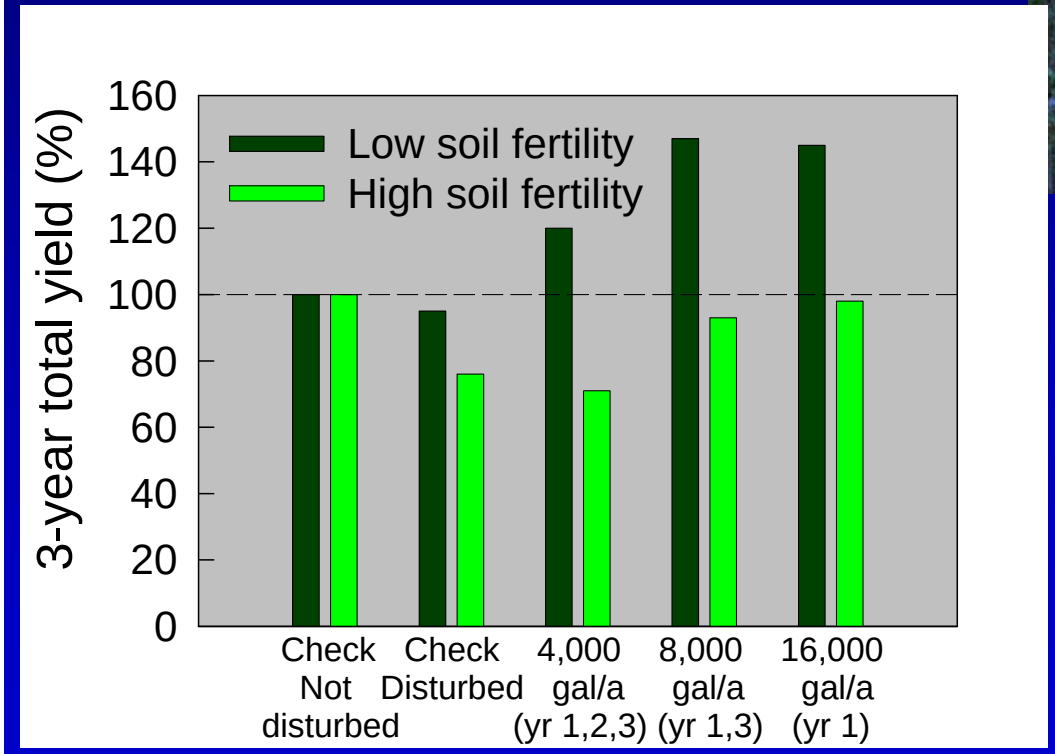
Banded with Aerator

Compared to surface broadcast, "Improved" application methods may result in:

- Reduced ammonia loss
  - Potential economic (yield, esp. grass forage), environmental benefits
- More uniform spreading
- Less contamination of forage
- Decreased runoff of nutrients, pathogens
- Less odor

…but also may cause damage and reduce yield.

Slurry injection into established alfalfa



Prairie Agricultural Machinery Institute, Saskatchewan

- Injector caused damage and reduced yield (high fertility site)
- Manure increased yield (low fertility site)
- Yield effect depends on balance

Slide Credit: M Russelle, USDA-ARS

Application Methods for Alfalfa
Liquid Dairy Manure, Marshfield, WI

Treatments

- Control (no manure; P, K as needed)
- Broadcast manure
- Surface banded
- Aerator/banded manure
- Shallow injection

Preliminary Yield Results

(1 harvest after 1 manure application)

- Manure = Control
- No differences among manure application methods

Marshfield, WI; Jokela et al.

What about manure on grass forages?

- Additional benefit: Yield response to manure nitrogen

Grass Yield Increase from Liquid Dairy Manure

Orchardgrass – 2-yr avg, VT

Broadcast manure (5000 gpa x 3) =
Fert N (50 lb/a x 3)

- 90% yield increase vs Control (no N)
- Manure = N fertilizer (92 to 108%)
- Banded manure (vs broadcast)
  - Year 1: no yield effect
  - Year 2: 12% increase
  - 50% reduction in NH_3 loss

Pfluke, Jokela, and Bosworth, 2011;
Carter, Jokela, and Bosworth, 2010

Topdressed Liquid Dairy Manure and Grass Forage Yields

- Reed canary grass (MN, WI, IA)
  - Manure: Yield increase of 150 to 260% vs no N Control
  - Fertilizer: Yield increase of 200 to 290% vs Control
- Tall fescue, 7 yrs, surface banded manure (BC)
  - Yield increase of 100% vs Control
  - Manure = fertilizer N (equal total N rates)
- Summary: Topdressed manure on grass
  - Large yield increases from liquid manure
  - Yields similar to those from fertilizer N

Schmitt et al., 1999; Bittman et al., 2007

Recommendations for Pre-plant Manure Before Seeding

- Low fertility soils
- Can apply 2 to 3 years worth of P and K (but avoid excess N)
- Till/mix thoroughly with soil to avoid manure-seed contact
- Avoid high salt and NH_3 levels
- Test forage for K
- Chop nurse crop to avoid lodging

Kelling and Schmitt, 2003; others

Recommendations for Manure Applications at Termination of Stand/Before Plowdown

- Limit to N need of succeeding crop (with legume credit)
- Apply to fields with poorest stands, least regrowth (lowest N credit)
- Apply immediately before tillage to minimize nutrient runoff loss potential
- Use Pre-sidedress Nitrate Test (PSNT) next year to assess N need for corn

Kelling and Schmitt, 2003

Recommendations for In-season Topdressed Manure Applications

No serious disease in herd or manure

- Where nutrients needed
- Low-moderate rates
- As soon as possible after harvest
- Older stands
- Poorer/higher grass stands
- Apply uniformly; not chunks
- Firm soils
- Consider alternatives to surface broadcast

Kelling and Schmitt, 2003; others