Dairy Manure N Availability as Influenced by Application Timing, Manure Treatment & Nitrification Inhibitor Use

MI SWCS Seminar

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DEPARTMENT OF SOIL SCIENCE
University of Wisconsin-Madison

UW Extension
University of Wisconsin-Extension

Nitrogen Availability

- Total N = NH_4-N + organic N

- Available N = NH_4-N that isn't lost

  +

  Mineralized N from organic N

N availability as affected by time of dairy slurry application

- Marshfield Ag Research Station
- Withee silt loam
  - Somewhat poorly drained, 0-2% slope
- Previous crop was corn
  - New site each year
- Plot size: 15’ x 50’

U.S. Dairy Forage Research Center

Research funded by Wisconsin Corn Promotion Board

Bill Jokea, Co-PI

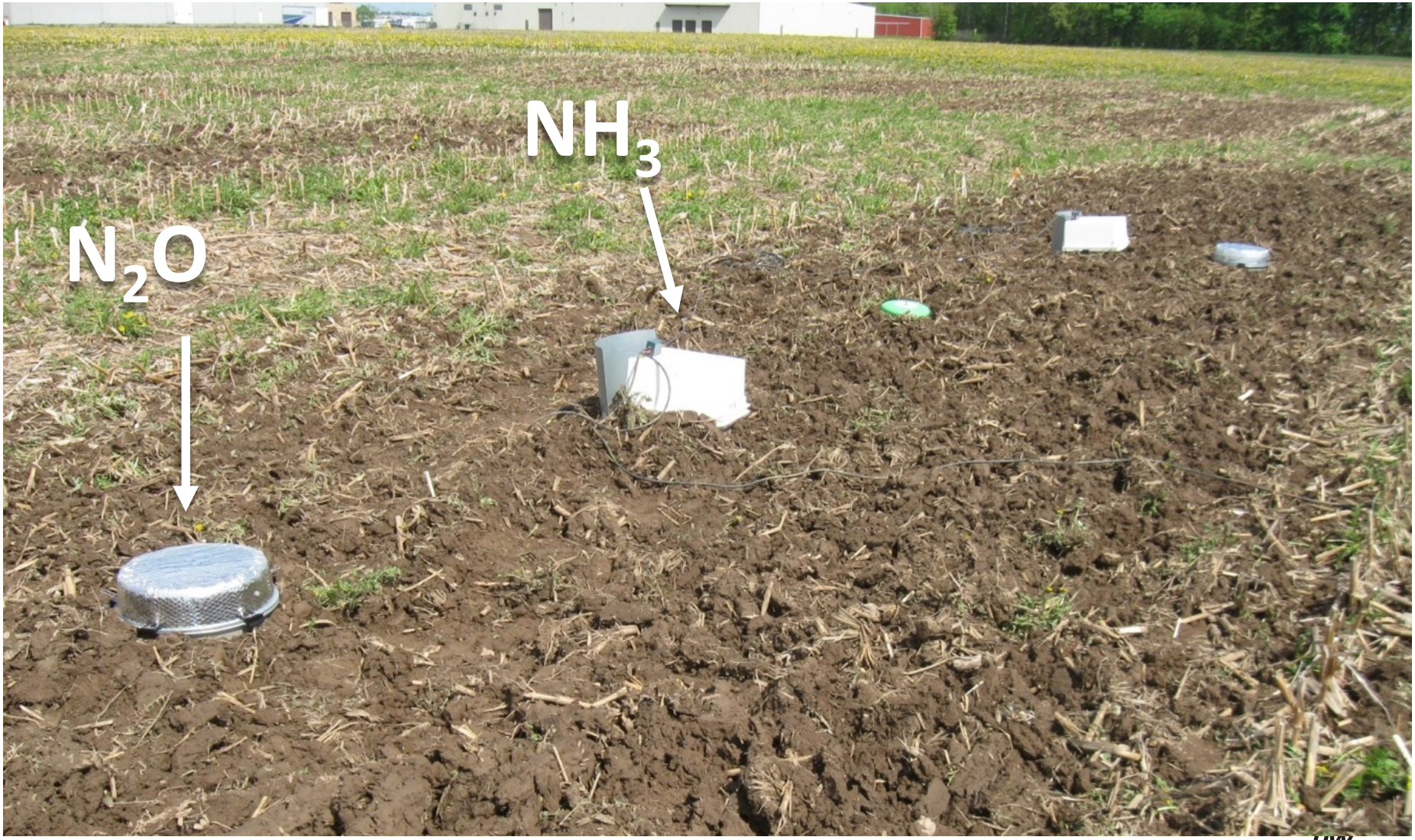
Treatments

- Pre-plant manure (mid to late May)
  - Surface application with disk incorporation
    - Immediate (<1 h)
    - 1-day
    - 3-day (surface)
  - Injection
    - S-tine (Kongsgilde Vibro-flex)
    - 15-inch spacing
    - 4-6 in. deep
  - All plots chisel plowed 3-5 days after manure application
- Sidedress manure (V5-V6)
  - Injection
    - S-tine (Kongsgilde Vibro-flex) with shields
    - 30-inch spacing
    - 4-6 inches deep
  - Surface (Yr 2 and 3)
- Fertilizer N
  - 6 pre-plant rates (0 to 200 lb/acre)

Manure Source

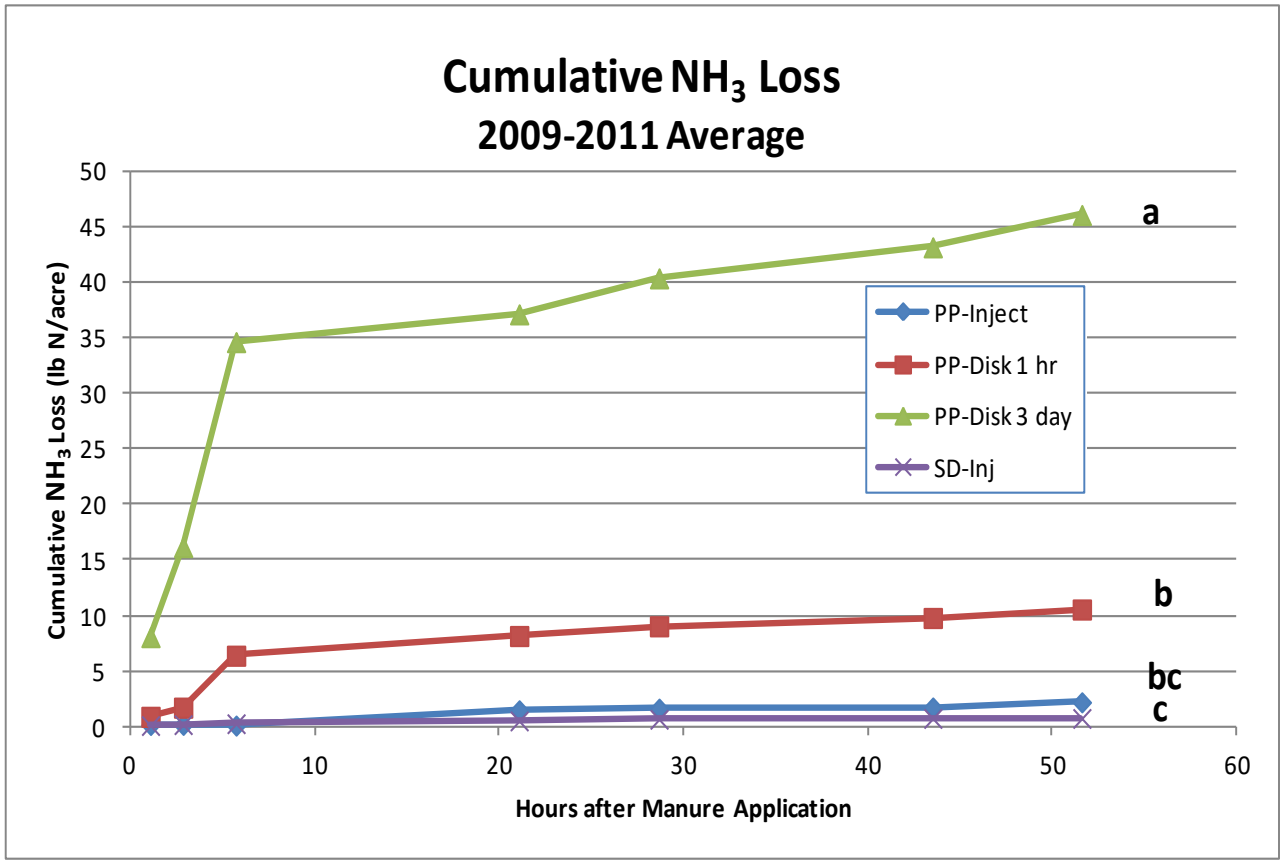
- Liquid dairy manure
  - 6,500 gal/acre (target rate)
  - Solids content: 14% (avg.)
  - Sand bedding
  - N application rate (avg.)
    - 2009-2012
      - 146 lb total N/a
      - 58 lb NH_4-N/a
      - ~ 40% of total N was NH_4-N
    - Large variability

Gas Measurements



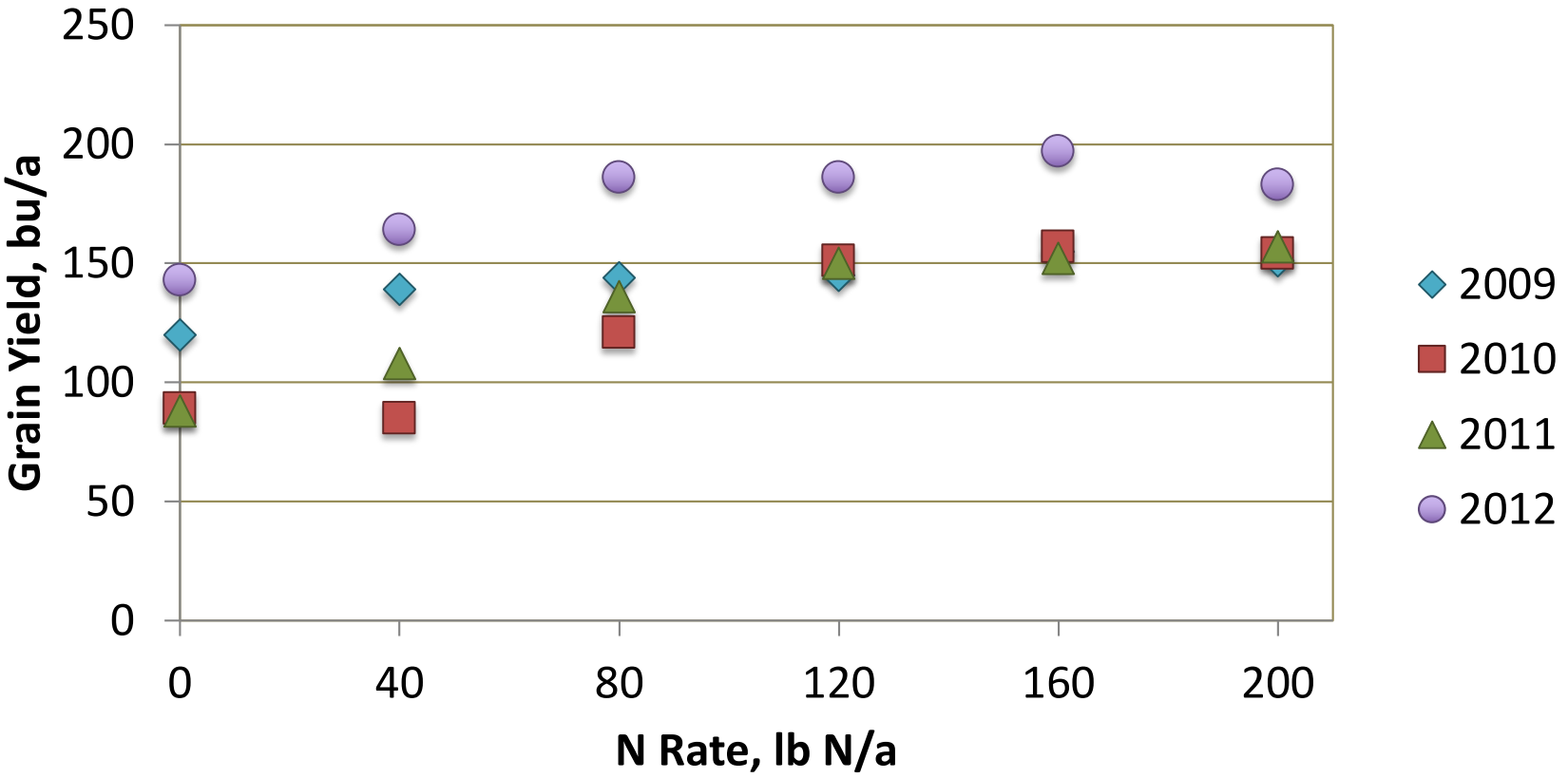
Results

2009-2011 Average NH_3 Emissions



- Most loss occurred 6 to 12 hours after application
- Total 3-day average losses were >40 lb/a for surface application
- Compared to PP-Disk 3 day:
  - PP-Injection reduced NH_3 loss by >90%
  - PP-Disk 1 hr reduced NH_3 loss by 75%

Grain response to preplant incorporated urea

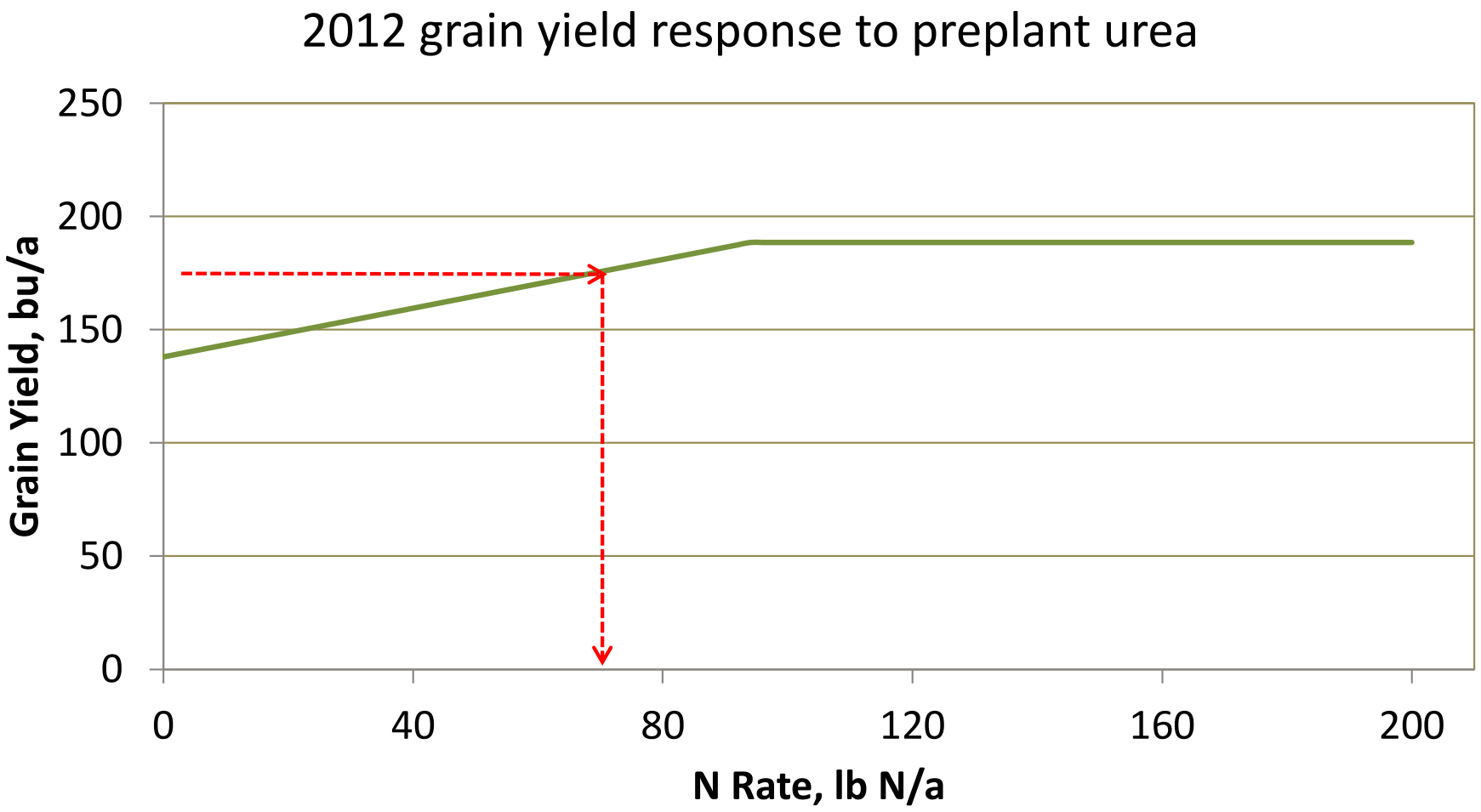


	N rate	2009	2010	2011	2012	Mean
$EONR_{0.10}$	N rate, lb/a	126	149	133	94	126
	Yield, bu/a	149	156	155	189	

Effect of manure application timing and method on grain yield

Timing	Method & days to incorp.	Grain yield			
		2009	2010	2011	2012
		---------- bu/a ----------			
Preplant	Injected	144 ab	123 a	107	179 a
	Surface broadcast (< 1 hour)	134 bc	124 a	110	158 bc
	Surface broadcast (1 day)	133 c	122 a	112	159 bc
	Surface broadcast (3 days)	137 bc	105 ab	103	166 ab
Sidedress	Injected	147 a	98 b	114	175 a
	Surface band (no incorporation)	-	89 b	108	150 c

Manure N availability calculated with the N fertilizer equivalence value (NFEV) of manure



% N availability = (NFEV ÷ total N applied) x 100

Manure N availability

Timing	Method & days to incorp.	Manure N Availability † 2009	2010	2011	2012	Mean
		% total N availability				
Preplant	Injected	48	53	38	63	51
	Surface broadcast (< 1 hour)	22	50	42	31	36
	Surface broadcast (1 day)	19	51	46	32	37
	Surface broadcast (3 days)	30	33	31	43	34
Sidedress	Injected	39	42	60	72	53
	Surface band (no incorporation)	-	26	48	23	32

† Manure N availability = (NFEV / total N rate applied in manure and starter) x 100

Conclusions

- Injection resulted in less NH_3 volatilization and greater N availability (50% of total N)
- For broadcast applications,
  - NH_3 volatilization for <1 hr incorporation was 75% less than incorporation at 3 days
    - But N availability did not always match this trend in individual years
  - Averaged over all years, general trend for lower availability with greater time to incorporation
    - ~30% of total N for no incorporation
- Weather conditions and actual manure N rate affected results in individual years
- Sidedress application of manure is a viable N source for corn
  - Another manure application window
  - May be lower N loss
  - Practical limitations
    - Equipment: Injection or direct incorporation preferred
      - Capture more N, reduce burning
    - Field issues: equipment turning, plant damage

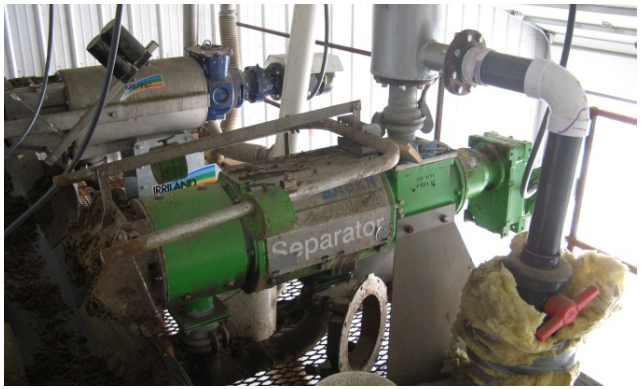
Manure Treatment Effects on Manure N Availability

Co-PI: Chris Baxter, UW-Platteville

Research funded by:
NC SARE
UW Consortium

Manure Treatment Systems

- Liquid-Solid Separation
- Anaerobic Digestion
- Composting



How Does Treatment Potentially Affect Availability?

- **Liquid/Solid Separation**
  - Large, fibrous particles removed
  - Decreases total C in liquid fraction
  - Solids have high C:N
  - Phosphorus tends to segregate with small-diameter solids
- **Anaerobic Digestion**
  - Some N- and P-containing organic compounds converted to available, inorganic forms
  - Can be affected by additional substrates (eg. food waste, restaurant grease, whey, creamery wastes)
- **Composting**
  - Variable with type of composting system/feedstocks
  - May increase N availability of materials with initially low available N
  - Has potential to reduce short-term N availability by converting readily available N to organic-N forms

Manures

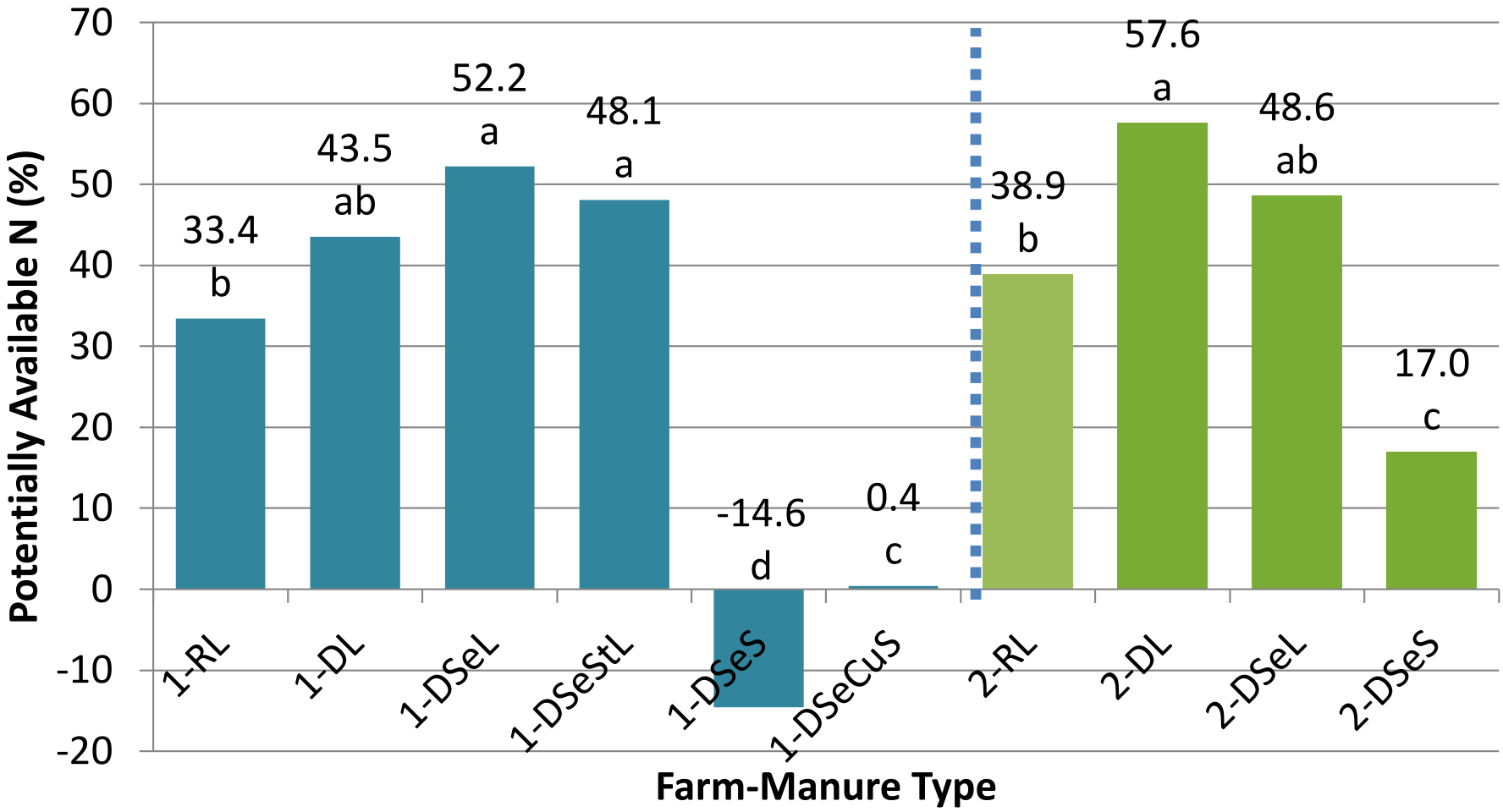
Manure type	DM	TN	NH_4	NH_4/TN	Total C: Total N	NDF
	%	lb/T or 1000 gal		%		%
Farm 1						
Raw liquid	6.7	21.0	9.0	43	11.4	54.3
Digest liquid	4.7	20.0	9.8	49	7.6	45.3
Digested separated liquid	3.1	18.4	9.9	54	5.4	21.1
Digested separated stored liq.	3.3	18.4	9.9	54	5.7	26.2
Digested separated solid	32.6	10.2	0.3	3	29.9	80.5
Digested separated cured solid	32.3	14.0	1.1	8	20.5	79.0
Farm 2						
Raw liquid	4.9	16.2	8.4	52	9.7	45.1
Digested liquid	2.6	17.2	11.4	66	4.6	20.1
Digested separated liquid	7.5	24.0	12.7	53	8.3	47.5
Digested separated solid	26.2	11.4	2.8	25	19.9	72.2

Manures

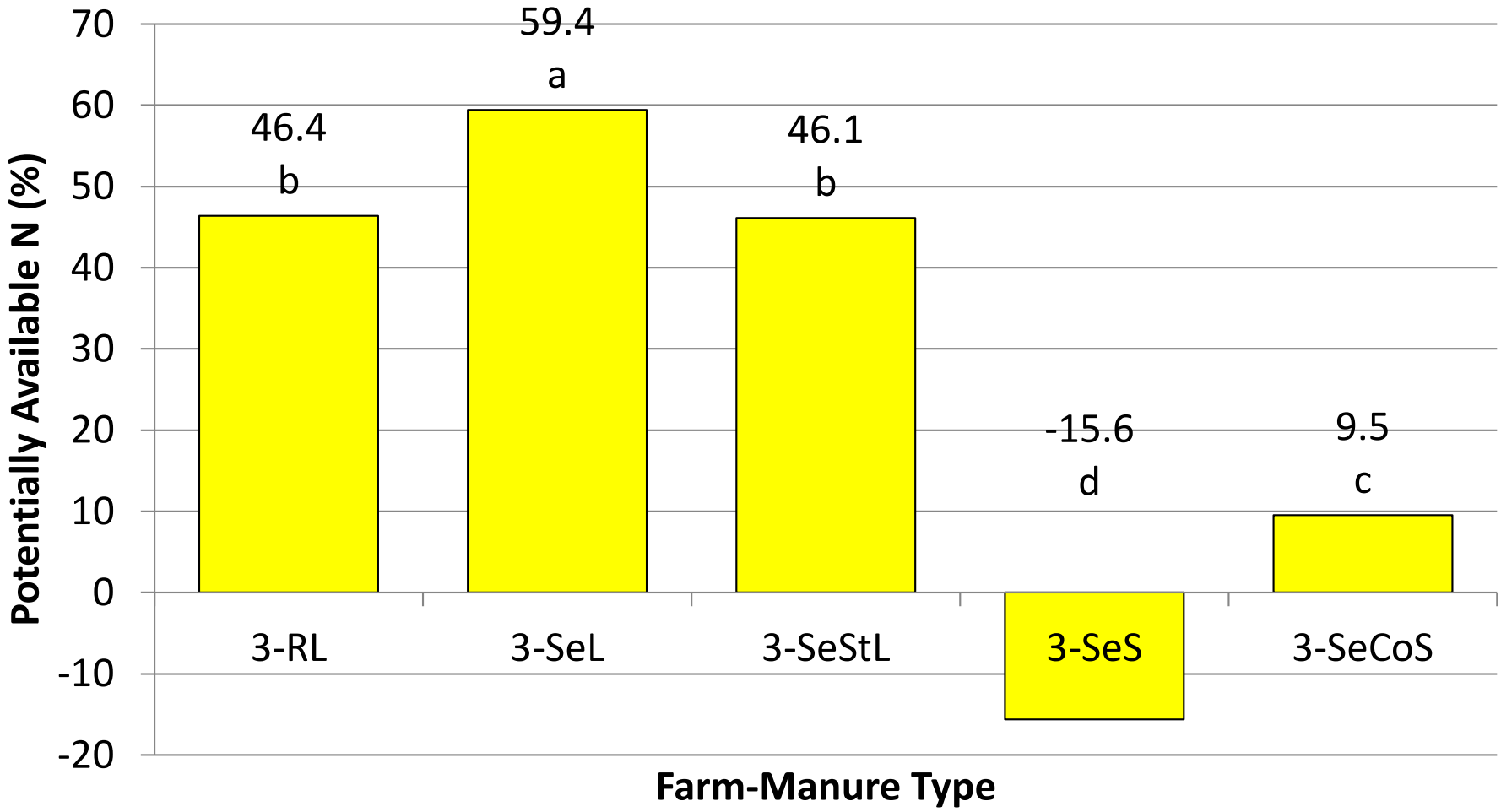
Manure type	DM	TN	NH_4	NH_4/TN	Total C: Total N	NDF
	%	lb/T or 1000 gal		%		%
Farm 3						
Separated liquid	1	9.5	7.3	76	3	15.5
Separated stored liquid	2.8	26.1	7.5	29	5.2	51.8
Separated solid	16.7	5.2	0.9	18	30.3	84.8
Separated composted solid	24.7	14.0	0.6	4	14.9	73.5
Farm 4						
Compost bedded pack 0-1'	39.7	15.7	0.5	3	23.4	81.4
Compost bedded pack 0-2'	37.7	17.4	4.1	23	18.7	81.4
Compost bedded pack 0-3'	38.3	16.3	3.5	22	18	72.5
Farm 5						
Raw solid-Scrape alley	13.8	8.5	4.1	49	2.2	78.1
Raw solid-Approachment	24.3	7.8	2.4	31	7.4	60.2

Results

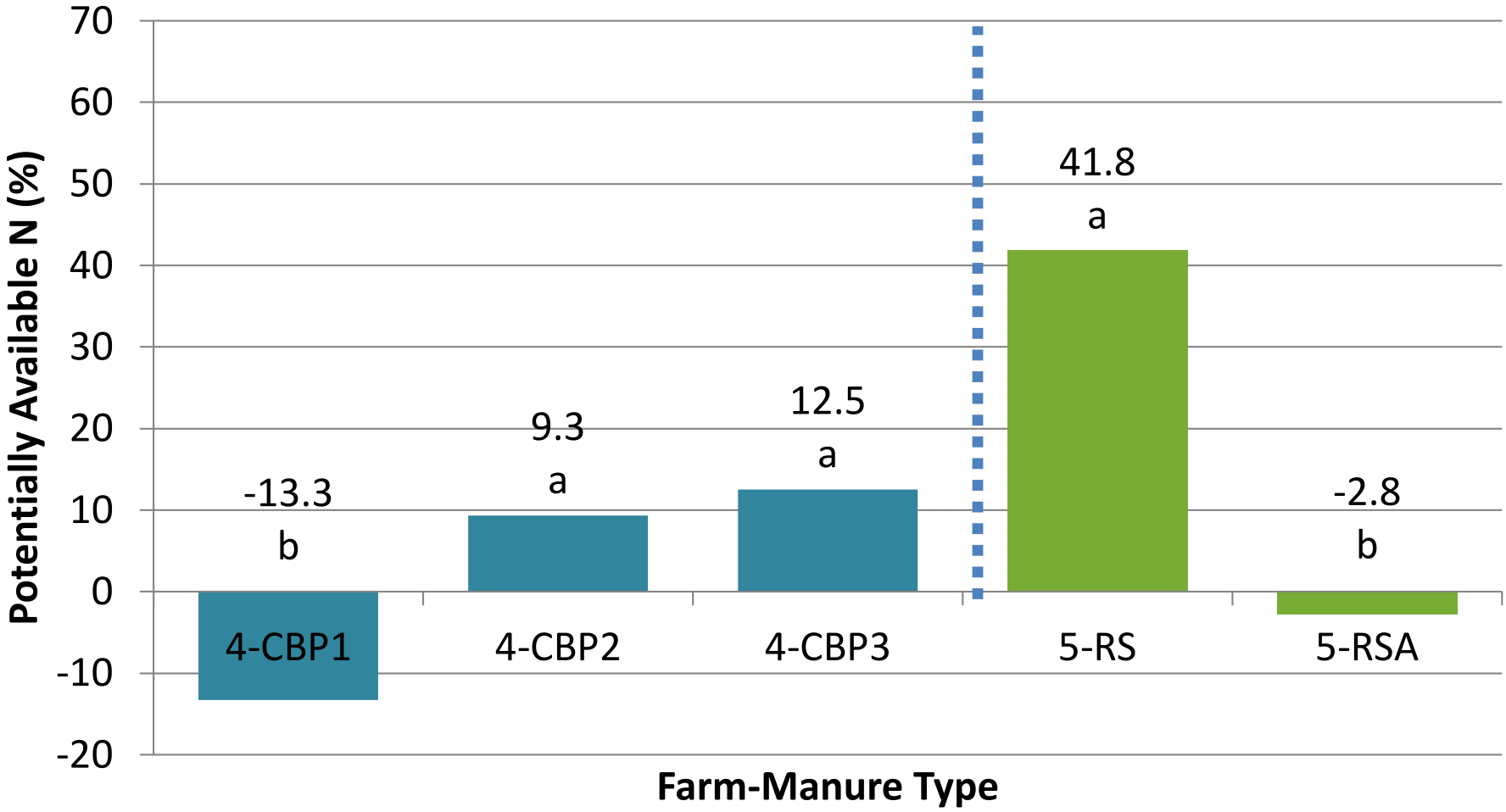
Percent of total N applied that is potentially available N, averaged over all soils – Farms with digesters



Percent of total N applied that is potentially available N, averaged over all soils – Farm with liquid/solid separator



Percent of total N applied that is potentially available N, averaged over all soils – Compost bedded pack and traditional raw solids



Results

- PAN is well correlated with several manure parameters, for example:
  - ADF, ADF:TN
  - NDF, NDF:TN
  - NH_4, NH_4:TN
  - ON, ON:TN

- A predictive equation was developed
  - Best practical equation used TN, NH_4 and DM
  - Needs field validating

Conclusions of N Laboratory Study

- Manure treatments have significant impacts on short-term potentially available N (PAN)
  - Separated and digested liquid manures have more PAN than raw manures
  - Separated and composted solid manures have less PAN than raw manures
  - Some solid manures can lead to N immobilization in the soil
    - Composting/Curing of separated solid manures increases availability
- Field studies needed to determine if effects translate to differences in 1st and 2nd year N availability.

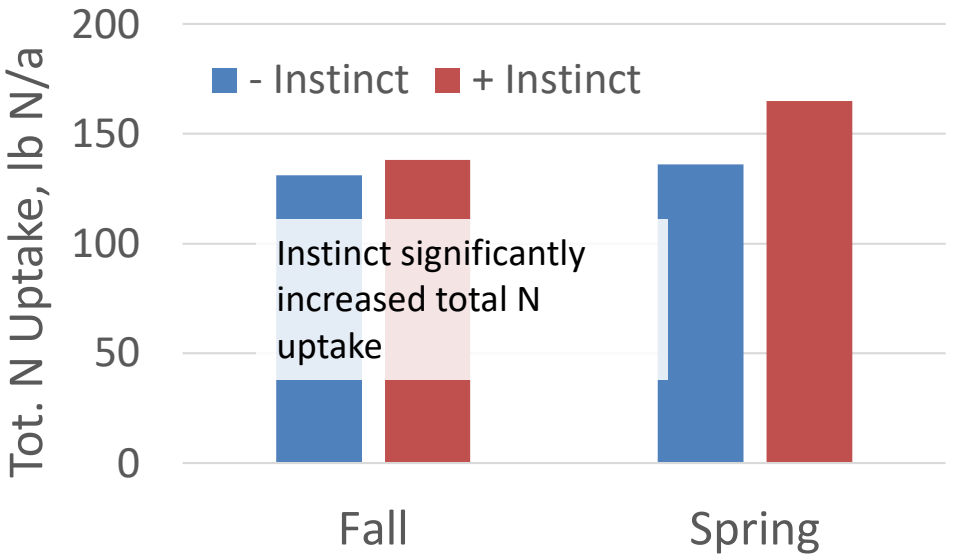
Use of Nitrification Inhibitor with Manure

Research funded by Dow AgroSciences
WI Fertilizer Research Program
WI DNR
UW-Madison CALS Hatch

Effect of Instinct and time of broadcast/incorporated dairy slurry application on corn yield and total N uptake at Arlington, WI, 2011

Timing	Instinct		Mean Timing	Instinct		Mean Timing
	No	Yes		No	Yes	
	Grain Yield, bu/a			Silage Yield, T DM/a		
Fall 10/21; 52 lb avail. N/a	135	141	138	7.25	7.54	7.40
Spring 5/3; 67 lb avail. N/a	135	156	146	7.15	8.40	7.78
Mean Instinct	135	149		7.20 b	7.97 a	

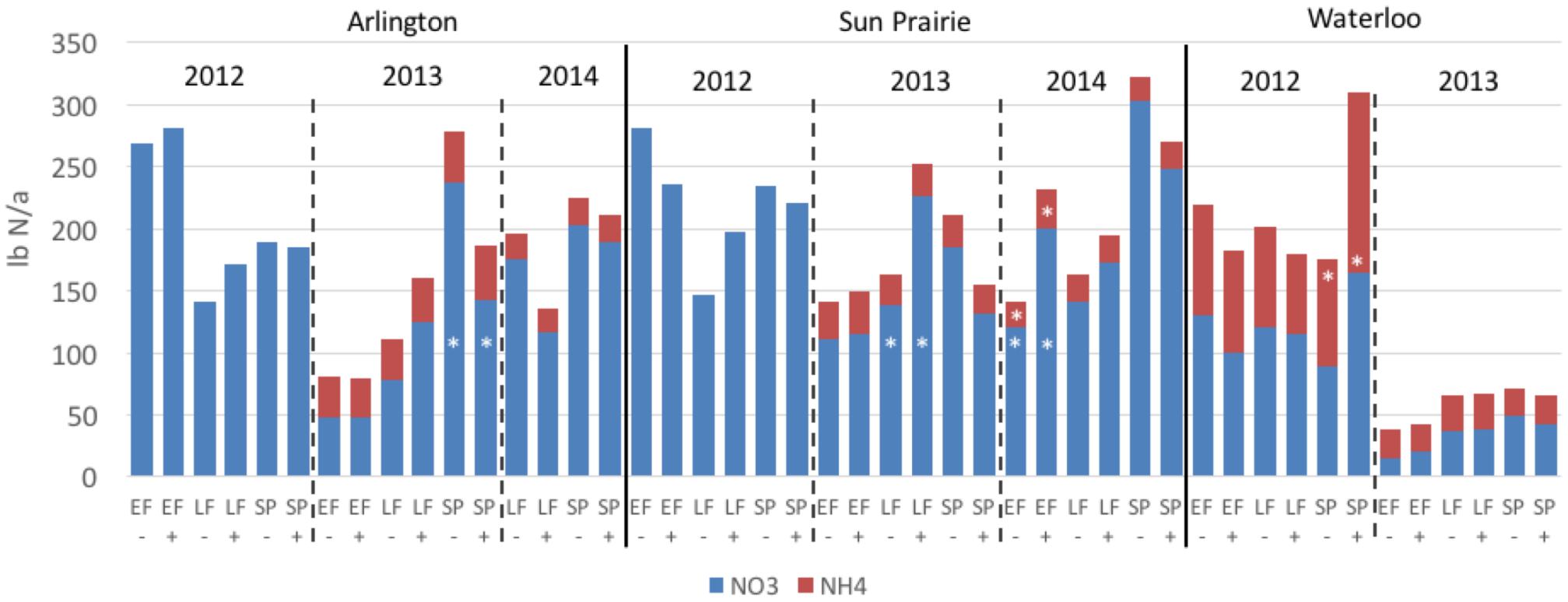
Instinct
- Did not effect soil NO_3 or NH_4 concentrations in late fall, spring, or PSNT
- Significantly increased V8 & VT SPAD meter readings for both application timings



N availability from digested, separated dairy liquid manure as affected by application timing and use of Instinct

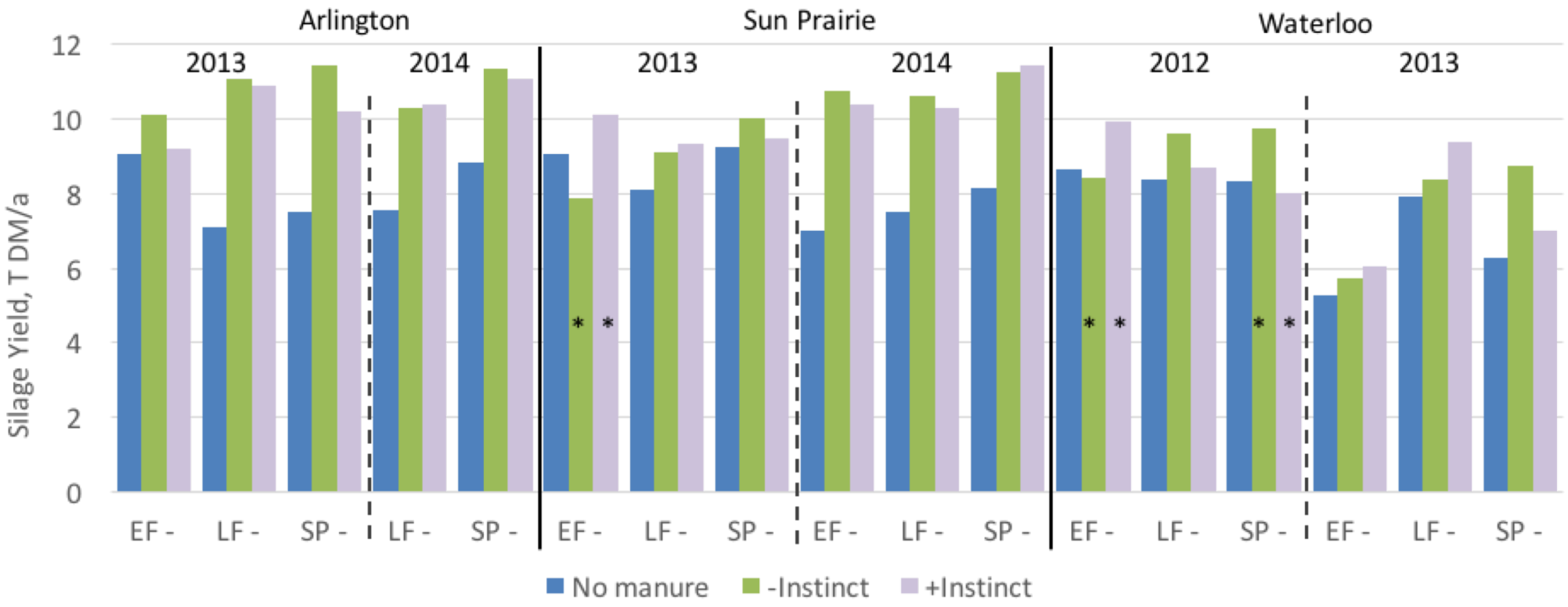
- 8 site-years
  - All sites well drained, except Waterloo 2012 (poorly drained)
- Timing
  - Early fall – early/mid-Oct.
  - Late fall – early/mid- Nov.
  - Spring
- 8,700 gal/a; ~55-60% NH_4-N
- With and without Instinct
  - Label rates (35 vs 70 oz/a)
  - Added to tanker & agitated
- Injected application

Effect of Instinct & manure timing on 0-2’ soil N at ~V6



* Indicate significant differences with Instinct application for a given location/year/timing

Effect of Instinct & manure timing on silage yield



* Indicate significant differences with & without Instinct application for a given location/year/timing

Manure N availability as influenced by timing of application and use of Instinct

		Arlington		Sun Prairie		Waterloo	
Year	Timing	- Instinct	+ Instinct	- Instinct	+ Instinct	- Instinct	+ Instinct
		---------- % of total N available ----------					
2013	Early Fall	39	20	*	*	23	78 ↑
	Late Fall	45	55 ↑	*	*	40	55 ↑
	Spring	70	63	*	*	*	61
2014	Early Fall	-	-	*	*		
	Late Fall	44	63 ↑	*	*		
	Spring	*	*	*	*		

Availability calculated using N fertilizer equivalence value method

* Availability could not be calculated with this method.
- Indicates treatment did not exist.

4 of 6 comparisons Instinct increased N availability

Summary

- Nitrification inhibitors applied with manure will likely have a better ROI when used:
  - On more poorly drained soils
  - Manures with higher percentage of total N as NH_4^+
    - As DM decreases, % of NH_4^+ increases

Thank You!

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