Nitrogen Availability From Dairy Manure

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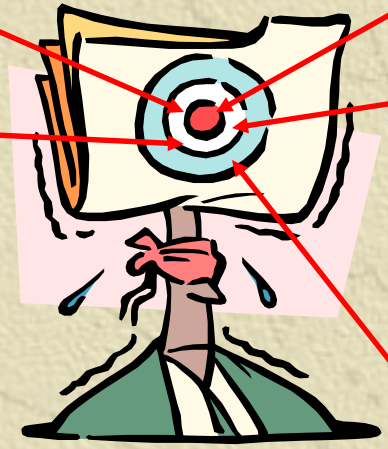
Increased knowledge is needed

Hypoxia

Production

NITROGEN



Regulations

Energy Prices

Waste Management

Objectives

- Better understanding of manure N cycling
- Create accurate manure N availability estimates (first year and residual)
- Reduce N losses into the environment

3 Experiments

- Field trial
  - Availability of dairy manure N
- Litterbag
  - N mineralization of dairy manure in field environment
- Incubation trial
  - Nitrogen mineralization of urine, feces and bedding in controlled environment

Field Trial

- West Madison ARS, Madison, WI
- Plano silt loam
- Established 1998 and concluded 2003
- Corn (*Zea mays L.* C v Lemke 6063)
- Random complete strip block design
- Treatments replicated 4x

Field Trial: Treatments

- Fertilizer (NH_4NO_3)
  - 0,40,80,120,160, and 200 lb N $acre^{-1}$
  - Applied every year
- Manure
  - ≈ 80,160 lb N $acre^{-1}$ available in first year
  - Applied every 1, 2, or 3 years

Methodologies:

- ^{15}N Method
  - Recovery of enriched isotope levels
- Apparent Recovery
  - Compares treatment uptake of N to the control uptake
- Fertilizer Equivalence Method
  - Compares manurial N uptake responses from where a similar response is obtained from a fertilizer N treatment

Estimates of first-, second-, and third-year manure N availability using various methods.

Manure N availability	n†	^{15}N Recovery	Apparent Recovery	Fertilizer Equivalence
		----------%----------		
1st year	6	17 (3.1) ‡	14 (4.7)	25 (10.5) §
2nd year	5	6 (1.1)	8 (6.6)	12 (7.9) §
3rd year	4	2 (0.4)	1 (5.8)	3 (9.4) §

† no. of measurement years in parentheses; 4 reps/year

‡ Average (standard error)

§ Data from 2002 excluded.

Litterbags

- *In situ* method to determine manure N mineralization
- Determine when manure N is becoming available for the crop
- In conjunction with field trial

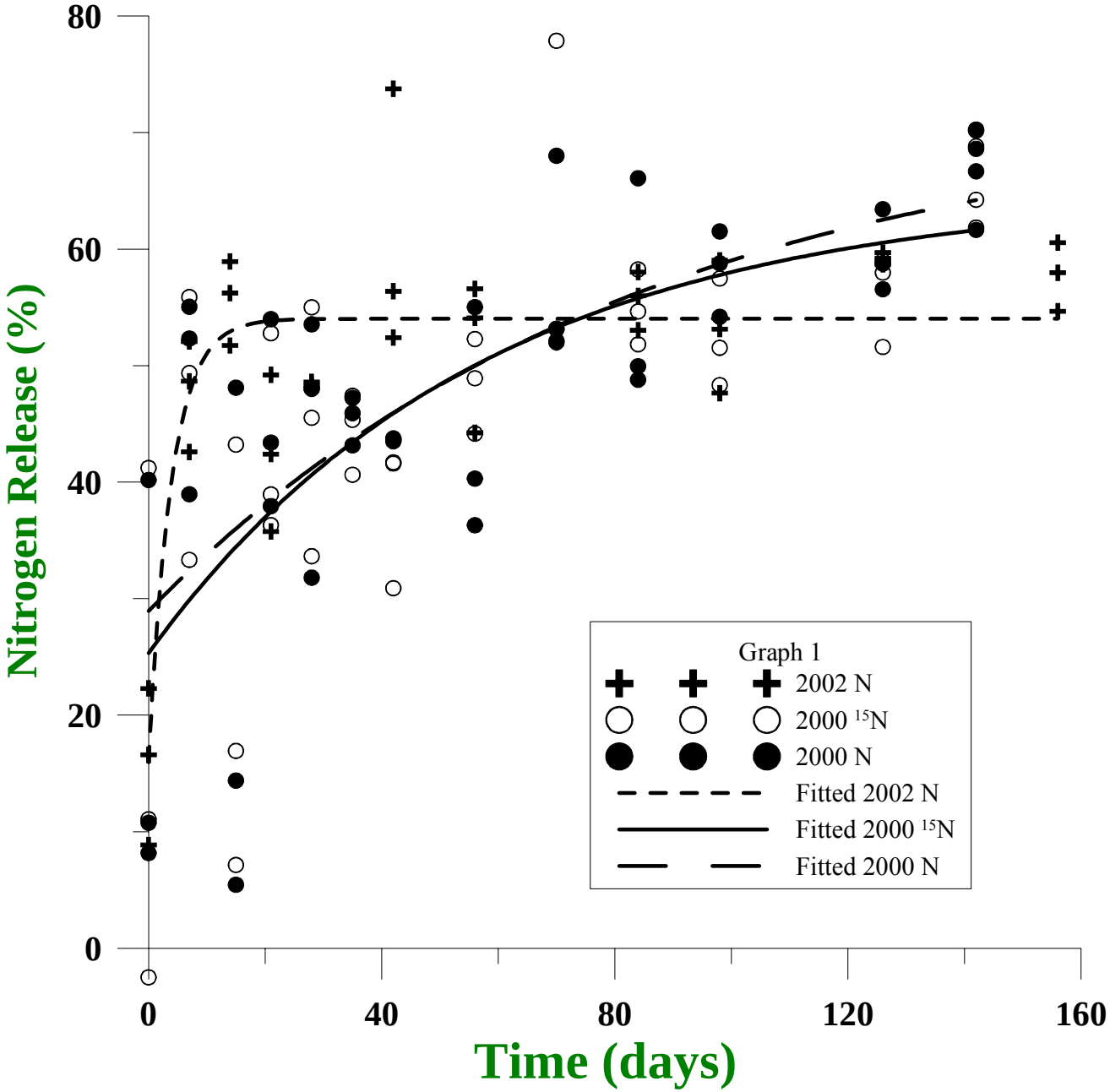
Litterbags

- Mesh bags (3.7 x 7.1 cm, 38μm)
- Filled with urine (42%), feces (36%) and bedding (22%) based on total N
- Components ^{15}N labeled in 2000

Litterbags

- Bags buried to a depth of 3 inches, 6 inches to the side of a corn row, spaced 9.8 inches apart
- Sampled: 0, 7, 14, 21, 28, 42, 56, 84, 98, 126 days and at whole plant harvest
- Control bag frozen, not buried
- Analyzed for total N (total ^{15}N in 2000)

Measured and fitted data for N release from litterbags, 2000 and 2002.



Incubation Trial

- N mineralization of individual dairy manure components using ^{15}N
  - Feces, urine, bedding labeled individually
- Soil type and temperature effect on N mineralization
  - 3 temps (52, 64, and 77 °F)
- 5 treatments utilizing ^{15}N labeling

Incubation Trial

- 2 qt canning jars
- 250 g soil dry wt.
- 60% Water filled pore space
- Aerated jars 1 hour each day
- Incubated for 168 days

Treatment	Feces	Urine	Bedding
1	**^{15}N**	^{14}N	^{14}N
2	^{14}N	**^{15}N**	^{14}N
3	^{14}N	^{14}N	**^{15}N**
4	**^{15}N**	**^{15}N**	**^{15}N**
5	Control (no manure applied)		

Rate: 312 lb N acre^{-1} in which 36% came from feces, 42% from urine and 22% from bedding

Analysis

- Samples were taken at 14, 21, 42, 84, and 168 days
- Analyzed for unlabeled NH_4^+ and NO_3^-
- Samples from day 168 were analyzed for Total and Mineralized ^{15}N

Mineralized ^{15}N recovered from various labeled manure components over all temperatures at day 168.

Temp (ºF)	Urine	Feces	Bedding	All components
	----------% of applied ^{15}N----------			
52	**44**	**13**	**15**	**24**
64	**60**	**18**	**24**	**30**
77	**63**	**26**	**25**	**36**

Overall Conclusion

- ^{15}N greatly reduced variability of estimates for residual availability
- Estimates for first year and residual dairy N availability generally match UW-Extension recommendations.
- Conservation of urine N is the key to greatest manurial benefit