Estimating second- and third-year N availability from dairy manure.

P.R. Cusick, G.R. Muñoz, K.A. Kelling, and J.M. Powell

Soil Science Department

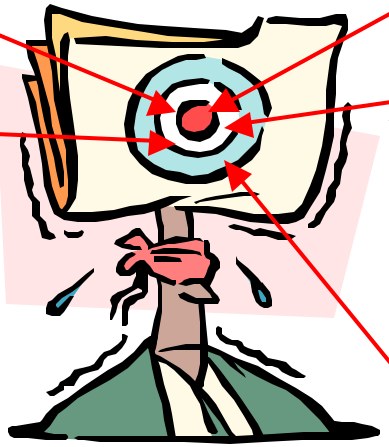
University of Wisconsin-Madison

Increased knowledge is needed

Hypoxia

Production

NITROGEN



Regulations

Energy Prices

Waste Management

Current Outlook:

- Residual Nitrogen Estimates For Dairy Manure
  - 10% for second year
  - 5% for third year
    - University of Wisconsin (Kelling et al., 1998)
- Other research
  - 9 and 3% Klausner et al. (1994)
  - 8.8 and 2.3% Paul and Beauchamp (1993)

Objectives:

- Estimate residual nitrogen
  - Single Applications
  - Multiple Applications
- Evaluate Various Methodologies
  - Difference Method
  - Fertilizer Equivalence Method
  - ^{15}N Isotope Method

Study Design

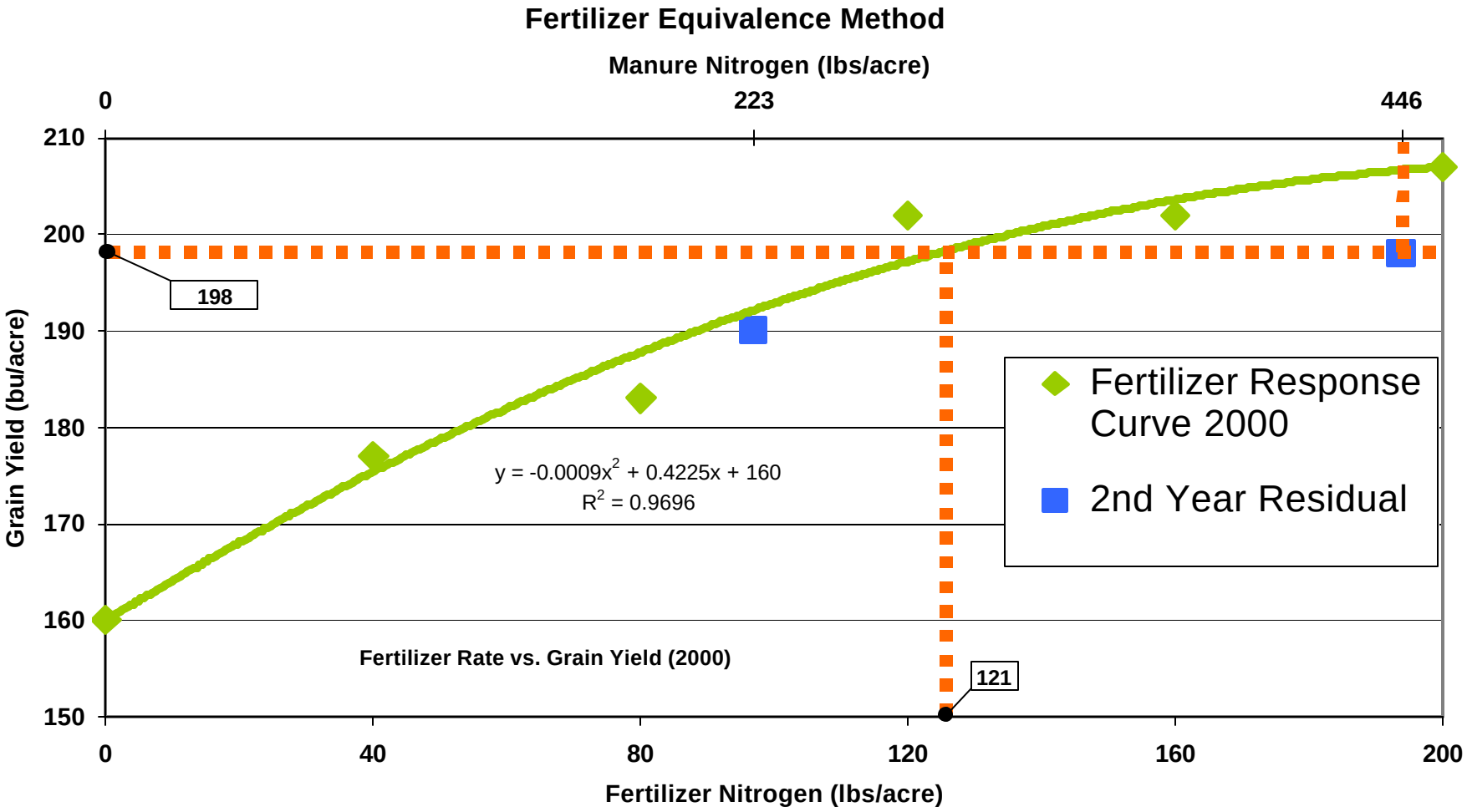
- West Madison Agricultural Research Station, Madison, WI
- Plano silt loam
- Established 1998, has cont. to 2001
- Corn (*Zea mays L.* c v Lemke 6063)
- Treatments replicated 4X

Study Design (cont)

- Treatments
  - Fertilizer (NH_4NO_3)
    - 0,40,80,120,160 and 200 lbs N $acre^{-1}$
  - Manure
    - 80,160 lb N $acre^{-1}$ available in first year
- Intervals
  - Fertilizer
    - Every year
  - Manure
    - Various intervals
      - Every 1, 2, or 3 years

Methodologies:

- ^{15}N Method
  - Enrichment of natural isotope levels.
- Difference Method
  - Compares treatment uptake of nitrogen to the control plots.
- Fertilizer Equivalence Method
  - Compares manurial N yield or uptake responses from where a similar response is obtained from a fertilizer N treatment.


Fertilizer Equivalence Method
Manure Nitrogen (lbs/acre)
0
223
446
210
200
190
180
170
160
150
Grain Yield (bu/acre)
198
121
y = -0.0009x2 + 0.4225x + 160
R2 = 0.9696
Fertilizer Rate vs. Grain Yield (2000)
Fertilizer Response Curve 2000
2nd Year Residual
0
40
80
120
160
200
Fertilizer Nitrogen (lbs/acre)

Second year residual grain yields from a single manure application.

Treatment	N rate	1999 Grain	2000 Grain	2001 Grain
	lb/a	bu/a	bu/a	bu/a
Control	0	179	135	156
Fertilizer	40	181	149	155
	80	199	154	183
	120	204	170	177
	160	211	170	178
	200	217	175	166
2nd year	191†	184	161	151
Residual	388†	201	167	167
p-value		0.011	0.052	0.011
LSD		20	28	24

† Rate is three-year average of total N applied.

Third year grain yields from a single manure application.

Treatment	N rate	2000 Grain	2001 Grain
	lb/a	bu/a	bu/a
Control	0	135	156
Fertilizer	40	149	155
	80	154	183
	120	170	177
	160	170	178
	200	175	166
3rd year	201£	146	150
Residual	409£	154	165
p-value		0.052	0.011
LSD		28	24

£Rate is two-year average of total N applied.
*Not significant

Grain yields from multiple manure applications.

Treatment	N rate	1999 Grain	2000 Grain	2001 Grain
	lb/a	bu/a	bu/a	bu/a
Control	0	179	135	156
Fertilizer	40	181	149	155
	80	199	154	183
	120	204	170	177
	160	211	170	178
	200	217	175	166
2 consec	198†	185		
Applic	395†	201		
3 consec	201†		173	
Applic	409†		192	
4 consec	185†			187
Applic	400†			178
p-value		0.005	0.01	0.011
LSD		20	30	24

† Average manure N rate of years applied.

Apparent N availability of single manure applications using the fertilizer equivalence method.

Residual Year	Manure application Year	Crop Year	Manure N rate	WPNU§	GY§	WPY§
				----------%	----------	
second	1998	1999	173	2	18	5
			345	7	31	23
second	1999	2000	223	2	40	11
			446	18	27	-9
second	2000	2001	223	-----£	-10	-3
			446	-----	5	21
third	1998	2000	173	0.5	20	-16
			345	-4	18	9
third	1999	2001	223	-----	-18	25
			446	-----	5	8

§ **WPNU**: Whole Plant Nitrogen Uptake; **GY**: Grain Yield; **WPY**: Whole Plant Yield;

£ WPNU data for crop year 2001 is not yet available.

Apparent N availability of single manure applications using the difference method.

Residual Year	Manure application Year	Crop Year	Manure N rate	Apparent recovery	Relative Effectiveness
				---%---	---%---
second	1998	1999	173	-3	-5
			345	10	25
second	1999	2000	223	-8	-28
			446	3	15
third	1998	2000	173	-10	-36
			345	-7	-38

Apparent N availability of multiple manure applications using the difference method.

Treatment	Crop Year	Manure N	Apparent Recovery	Relative Effectiveness
			------%-----	------%-----
Single Application	1999	250	18	28
		501	10	27
Single Application	2000	223	17	61
		489	4	22
2nd Year Residual	1999†	444	12	20
		889	6	14
3rd Year Residual	2000†	677	13	46
		1378	8	47

† Average manure N rate of years applied.

Apparent N availability from a single manure application using the ^{15}N method

Residual Year	Manure Appl. Year	Crop Year	Manure N lb acre-1	^{15}N recovery
				---%---
second	1998	1999	173	**4**
second	1999	2000	223	**5**
third	1998	2000	173	**2**

Conclusions

- Methods?
  - Single vs. Multiple manure applications?
  - High variability
  - Variability is reduced with ^{15}N
- Current crediting estimates rarely overestimate actual results
- Apparent residual availability.
  - 2nd year –10 to 40% mean= 12%
  - 3rd year –18 to 25% mean= 5%