OPTIMIZING ORGANIC FERTILIZER APPLICATIONS

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N availability

- Organic N
  - Not plant available
  - Protein and genetic material

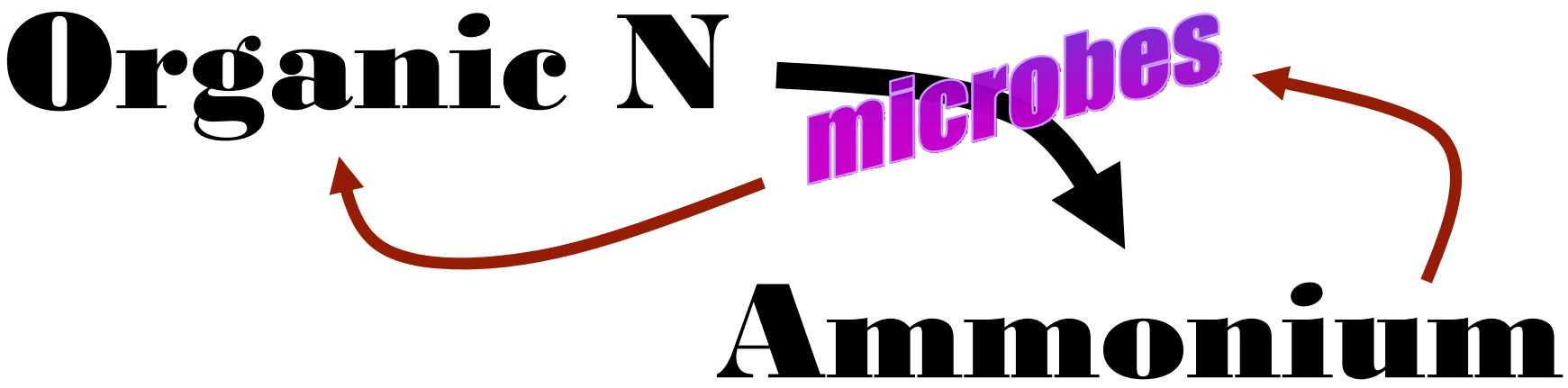
- Inorganic N
  - Plant available
    - Ammonia
    - Nitrate

Objective

- Schedule organic fertilizer applications to
  - Meet crop needs
  - Minimize leaching losses

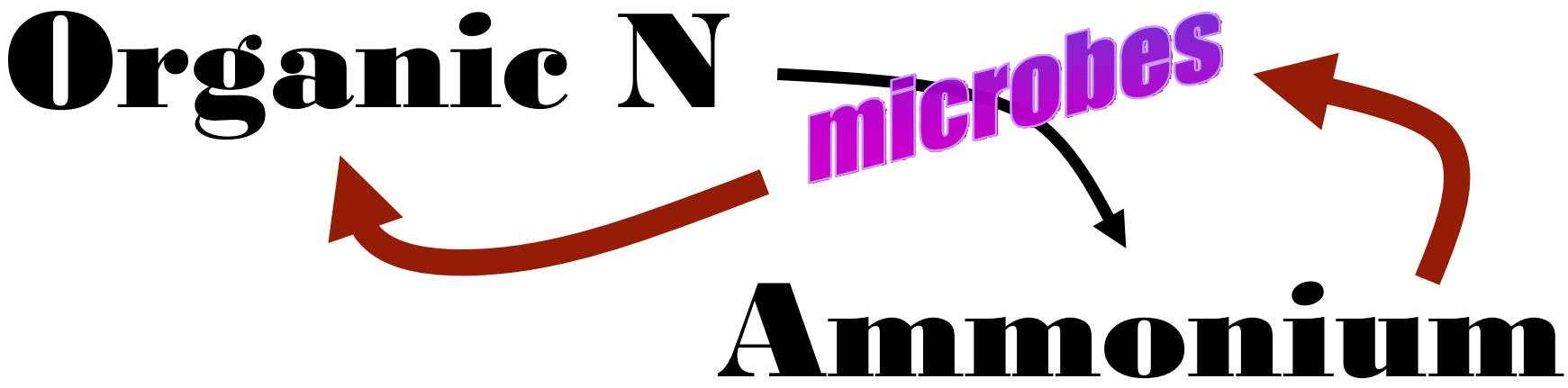
N mineralization

- Process by which microbes convert N from organic to plant available inorganic forms
- Microbes use C for energy and expel excess N as ammonium (NH_4^+)



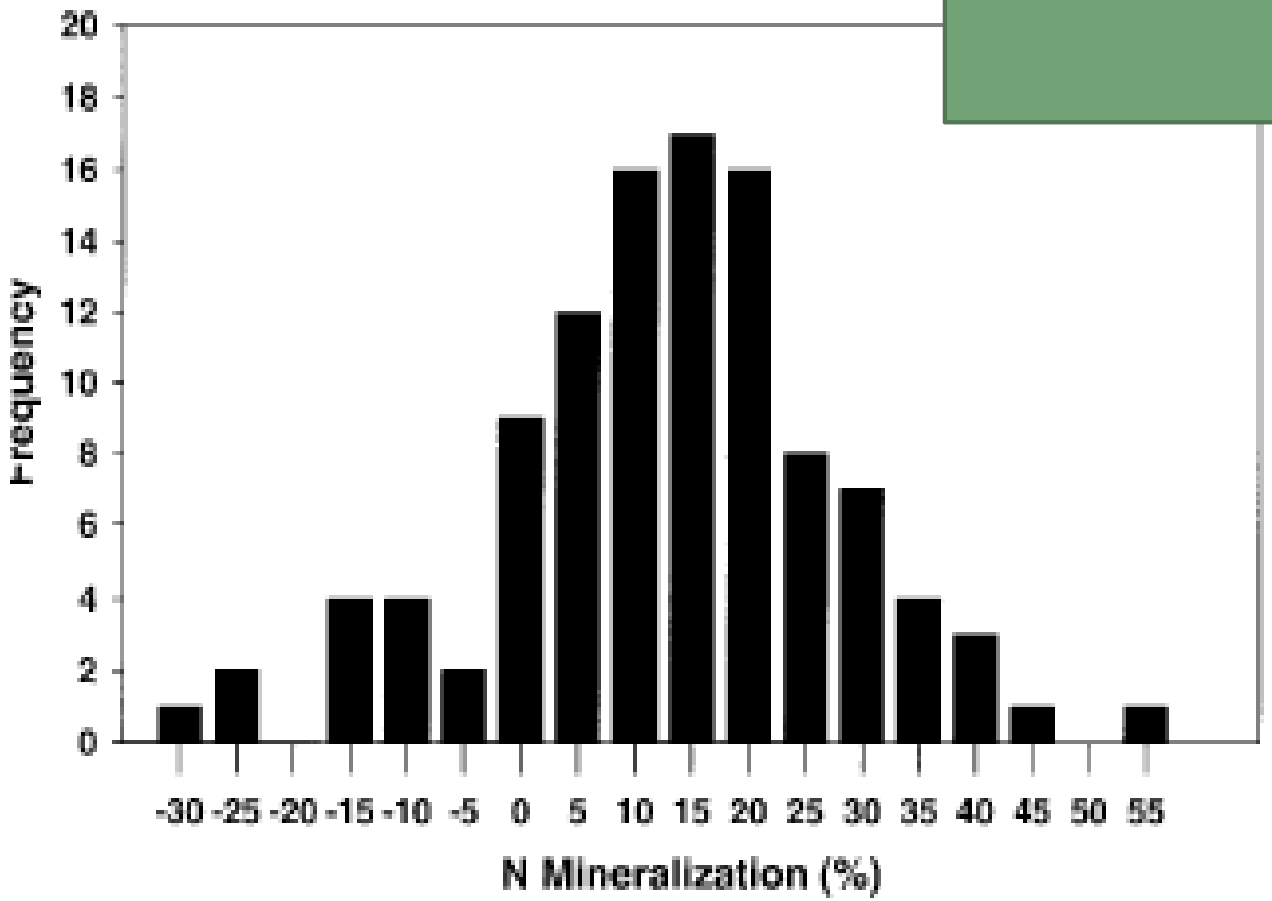
N immobilization

- Net immobilization occurs when microbes use more N than they release
- Immobilization is temporary
- Hard to measure
- No accepted method for predicting



No accepted way to predict mineralization

N release from 107 dairy manures after 56 days at 77°F

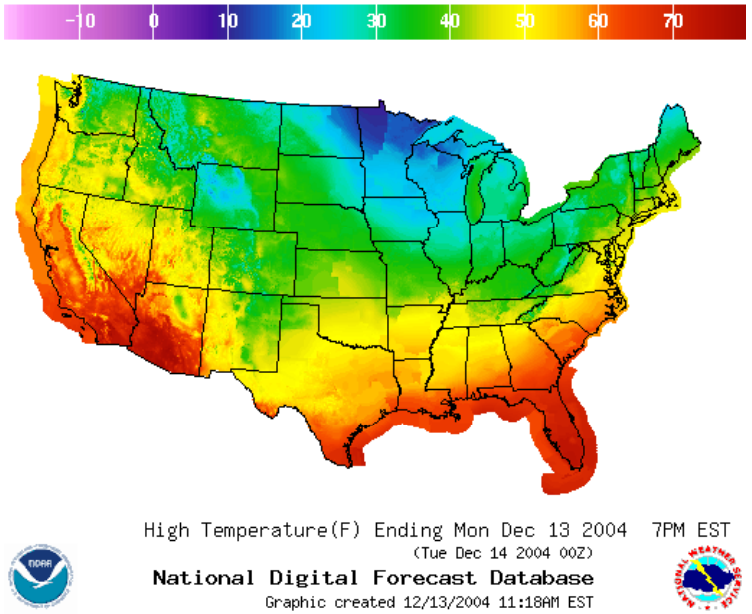


No correlation with C:N ratios!

Van Kessel and Reeves 2002

In the field, the mineralization rate is determined by

- Organic matter
  - structure
  - chemistry
- Soil
  - Temperature
  - Aeration
    - Texture
    - Structure
  - Moisture

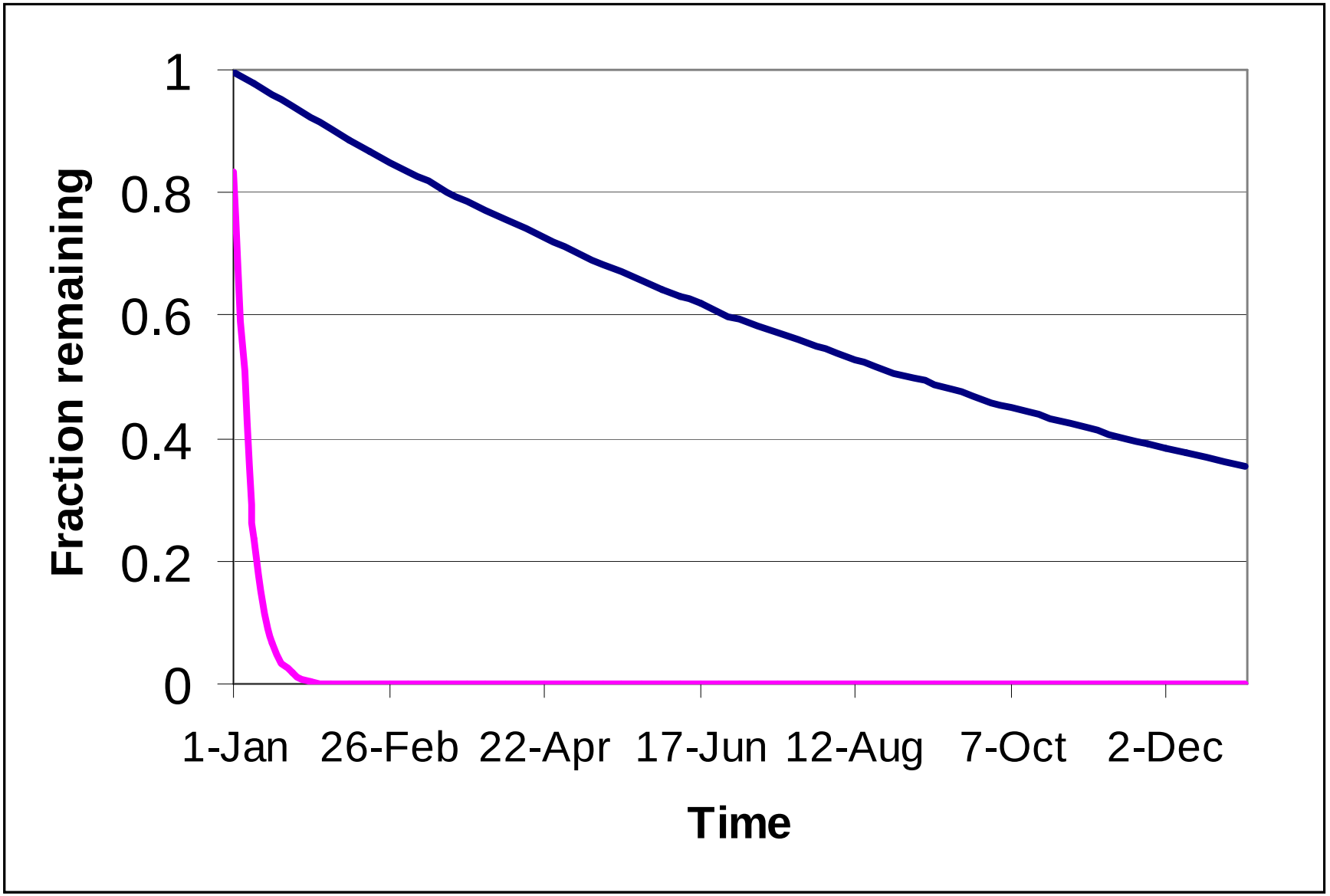


*But.... Temperature is most important**

***At least under irrigated conditions...**

La

- Labile = readily available = fast decay
- Recalcitrant = slow decay



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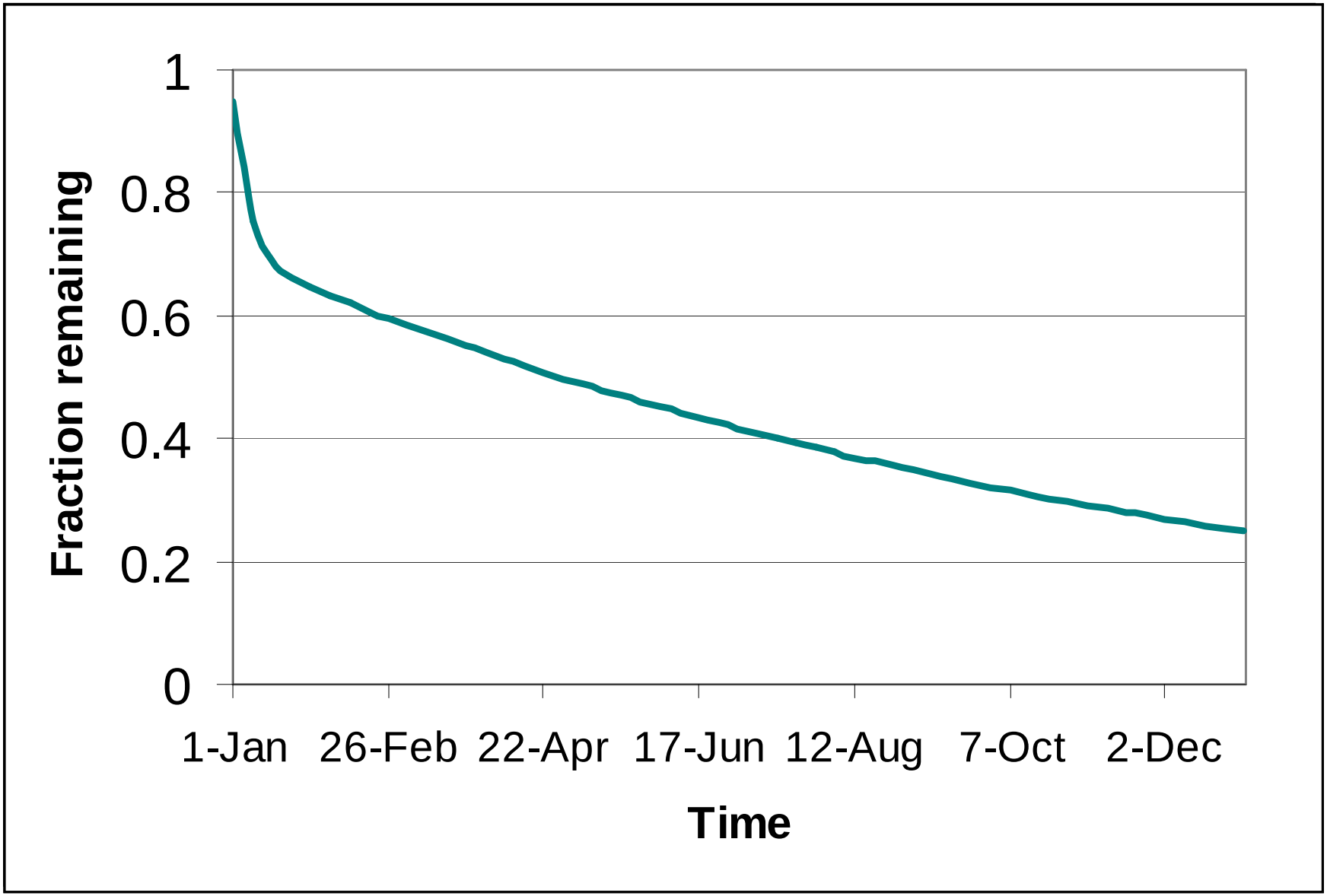


Yard trimmings

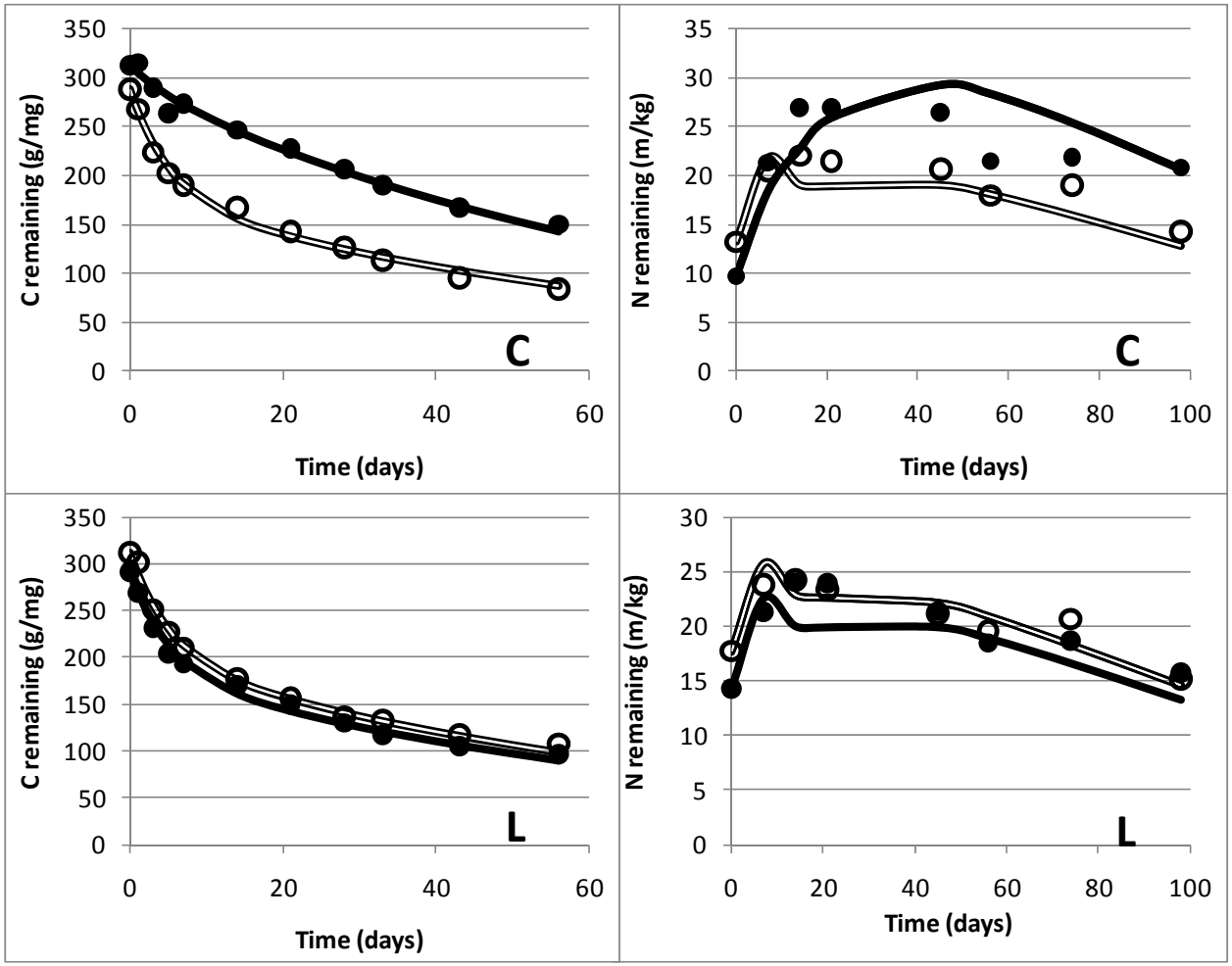


Fig. 6. Organic C and N remaining in incubated yard trimmings collected from two sources collected in April 1999 (observed:●, modeled: ▬) and May 1999 (observed:O, modeled: 〓) (Crohn 2011).

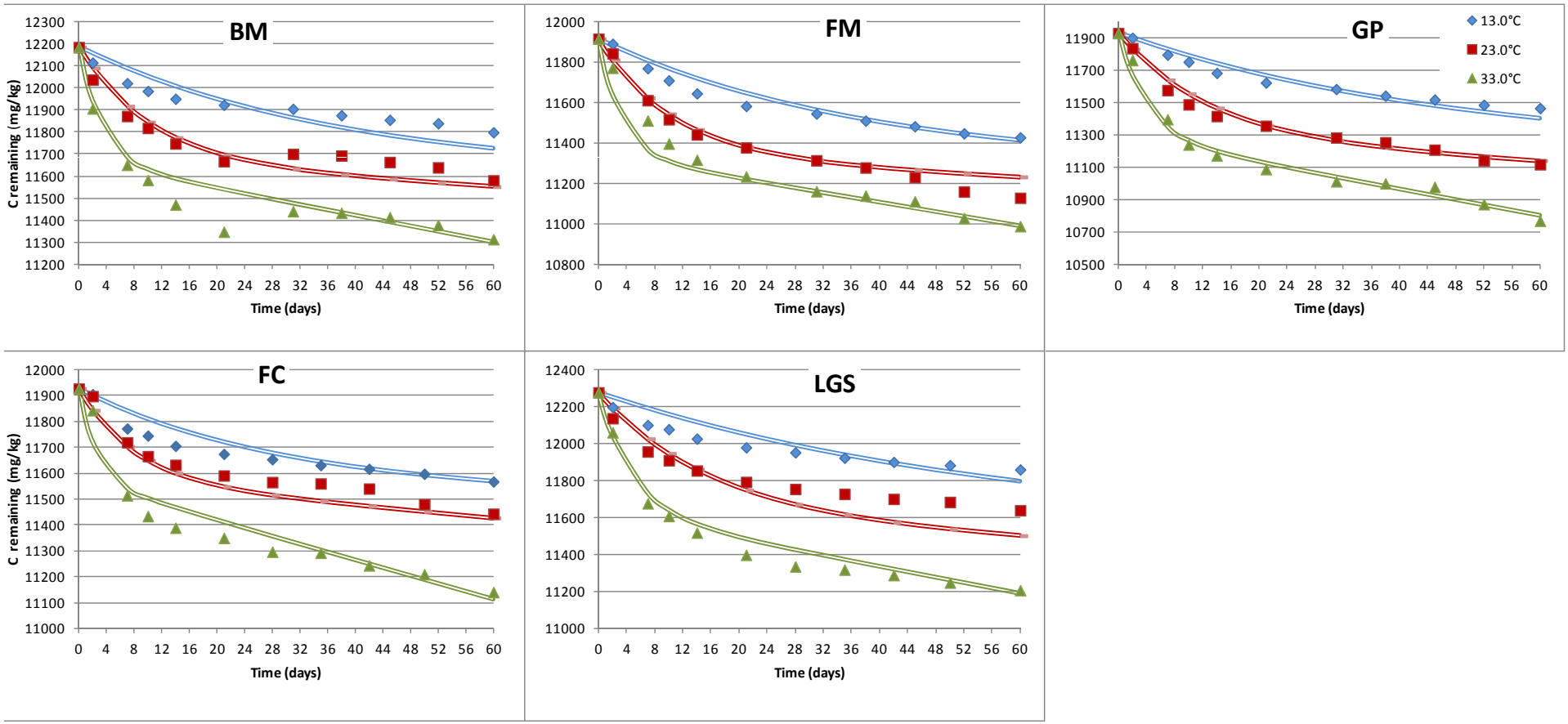
Characteristics of study fertilizer materials

Treatment	Total C (%)	Total N (%)	NH_4^+-N (ppm)	NO_3^--N (ppm)	N_o (ppm)	C: Organic N
BM	28.5	5.5	430	24.0	5.5	5.2
FM	49.3	12.7	780	13.4	12.6	3.9
GP	46.4	11.8	1799	34.4	11.6	4.0
FC	16.4	4.0	5430	12.4	3.5	4.8
LGS	42.9	7.8	358	10.6	7.8	5.5
A	18.6	1.6	277	95.2	1.6	11.9
B	13.2	1.1	157	15.0	1.0	12.6
C	43.9	1.5	381	3.9	1.4	30.6
D	24.5	2.0	429	25.1	2.0	12.5
E	21.4	4.3	2980	16.4	4.0	5.3
F	18.6	1.4	825	4.3	1.3	14.4

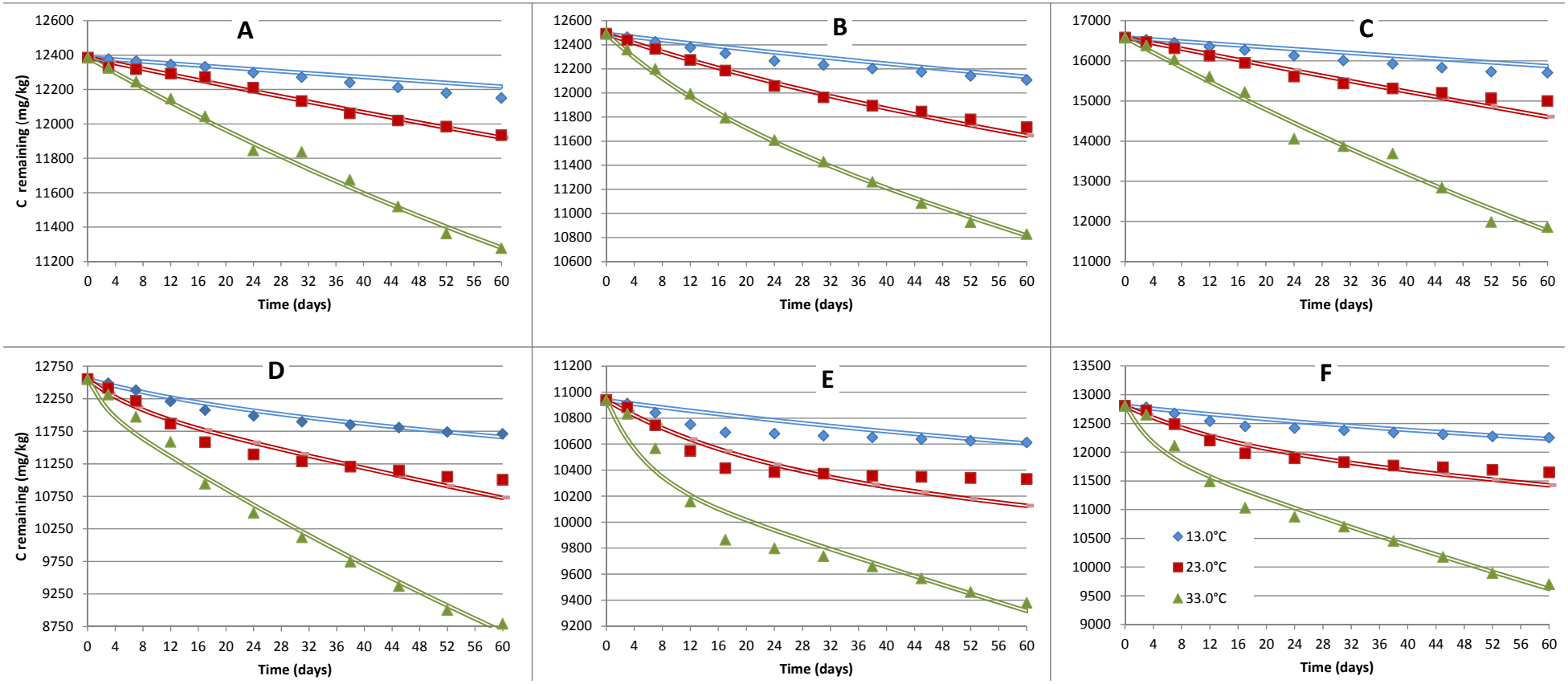
Materials

Identifier	Material	Initial C:N	Final C:N
BM	Bone Meal	5.2	3.5
FM	Feather Meal	3.9	3.5
GP	Guano Plus	4.0	3.5
FC	Fish Concentrate	4.8	3.5
LG	Leafy Green Special	5.5	3.5
A	Aerobic manures	12	3.5
B		13	3.5
C		31	3.5
D		12	3.5
E	2 Anaerobic manures	11	3.5
F		14	3.5

Fitting the C decomposition of COF at 3 temperatures



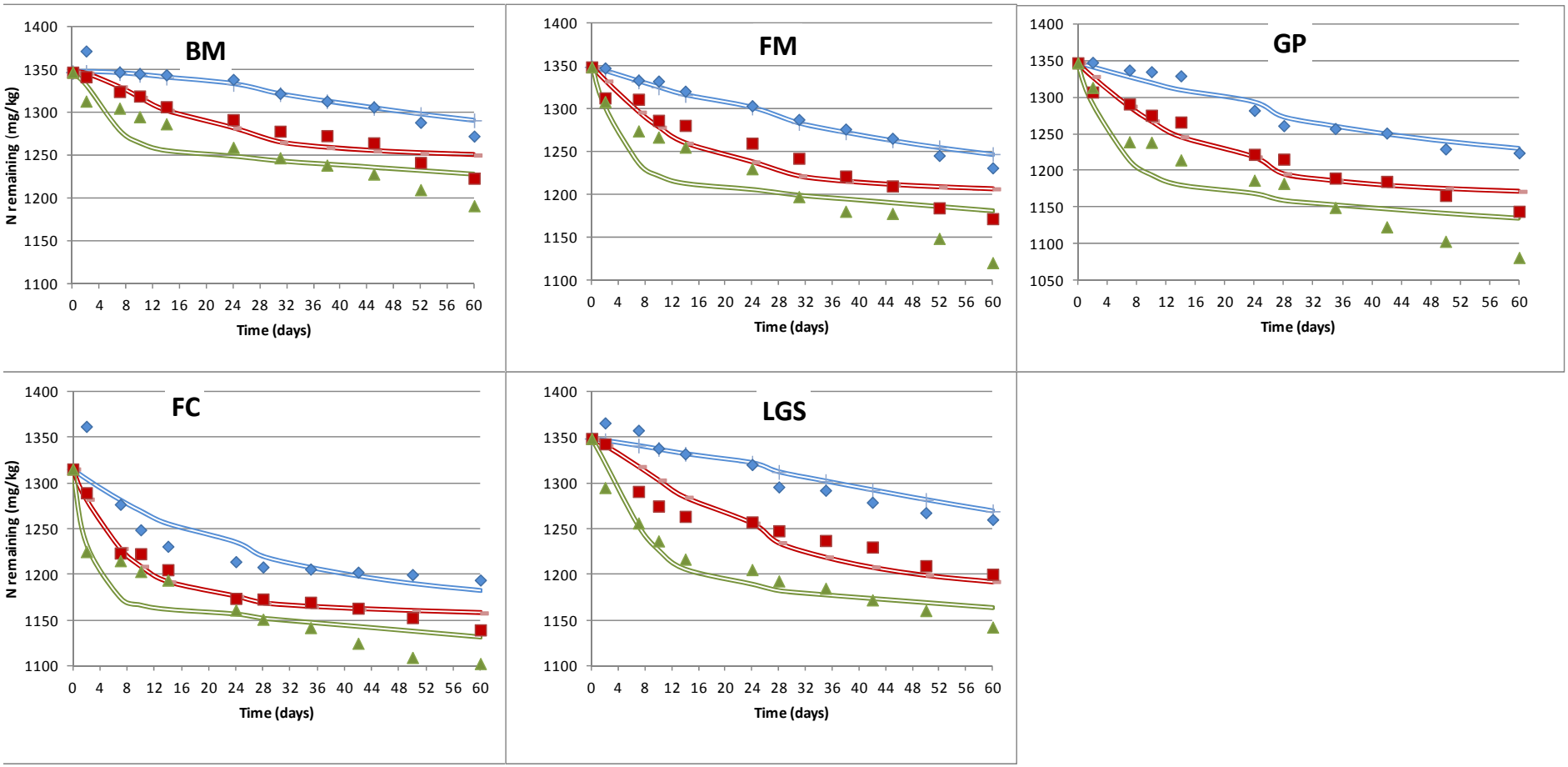
Fitting the C decomposition of UR at three temperatures



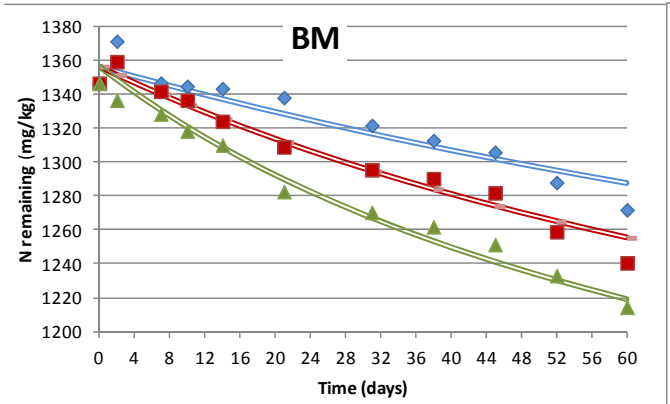
Q_{10}

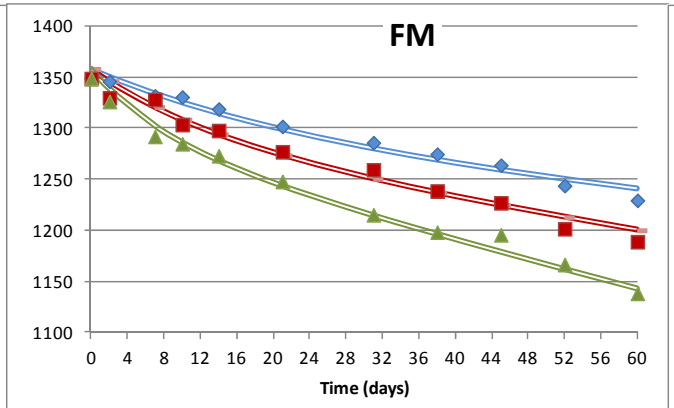
- Certified Organic Fertilizers
  - Carbon: 3.1
  - Nitrogen alone: 1.6
- Manures
  - Aerobic: 2.7
  - Anaerobic: 3.9

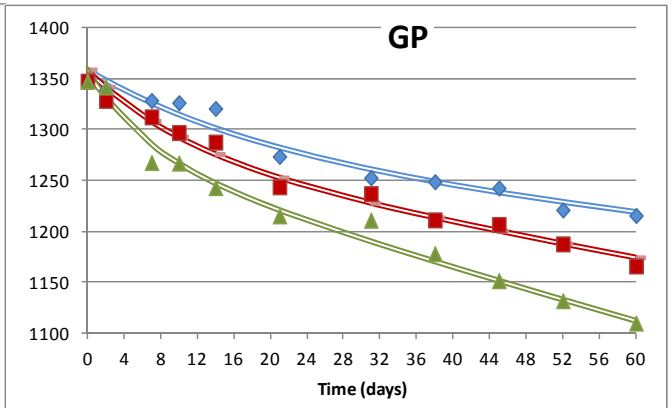
N mineralization of COF at three temperatures based on C decay

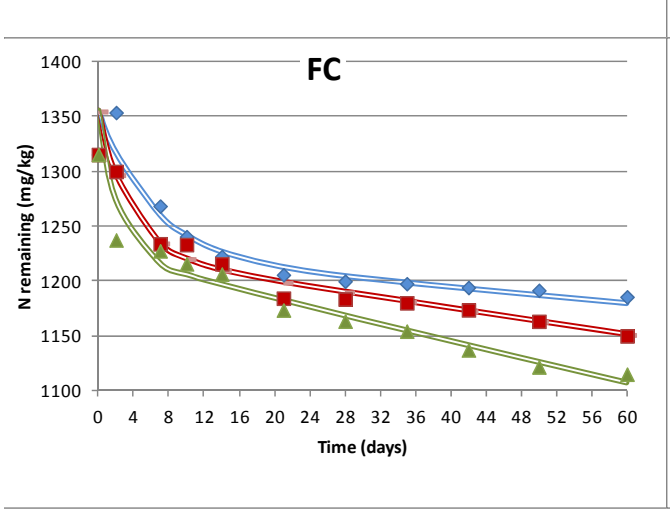


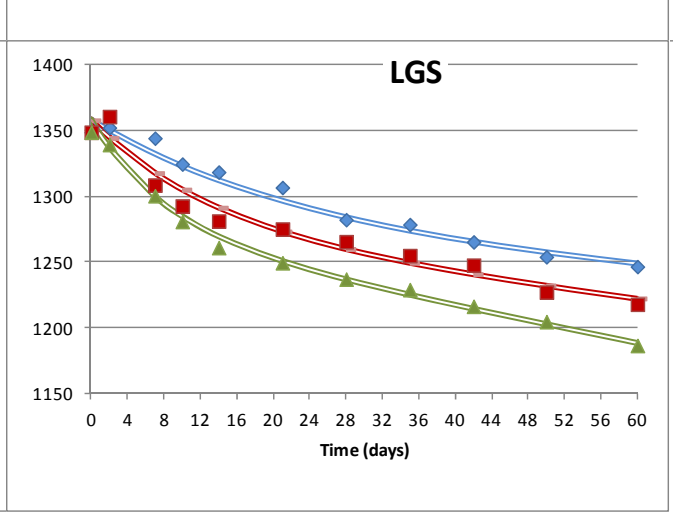
N mineralization of COF at three temperatures based on N measures



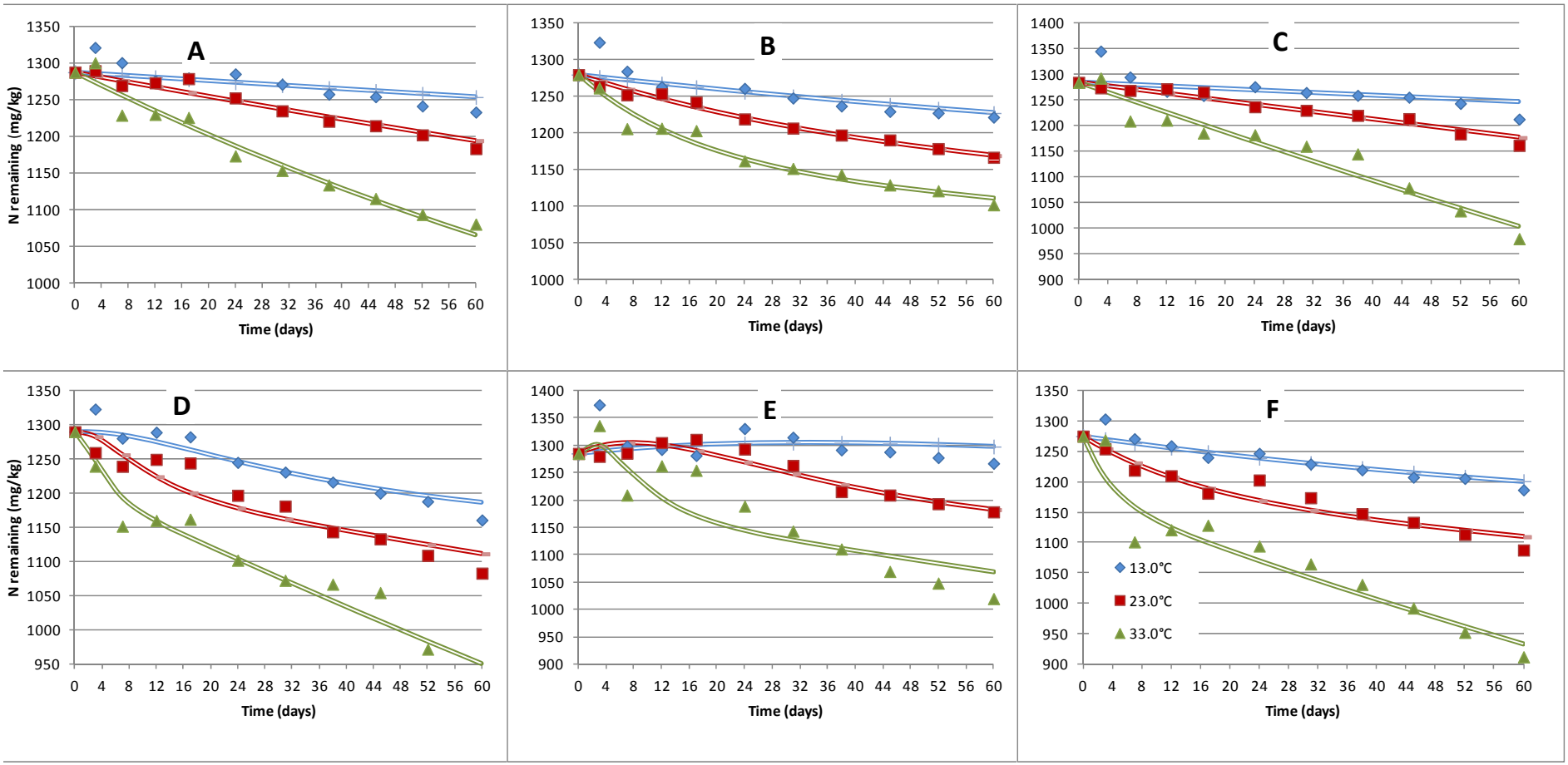








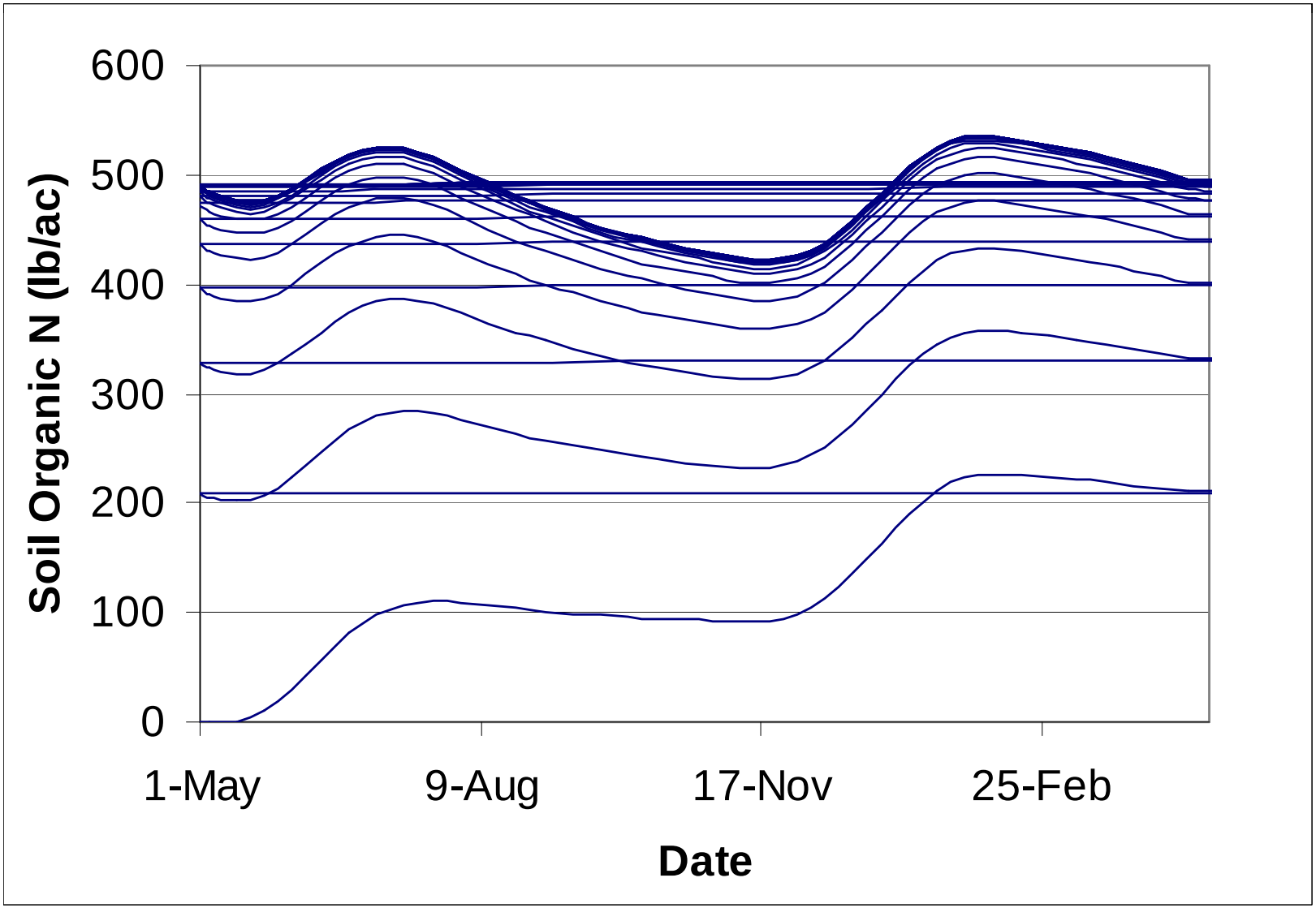
N mineralization of UR at three temperatures based on C decay



Steps

- Estimate decay rates (Incubations for now)
  - Labile
  - Recalcitrant
  - Compartment sizes
- Measure initial C:N ratio
- Estimate C:N ratio of labile compartment from its decay rate
- Currently working on validation with two new composts

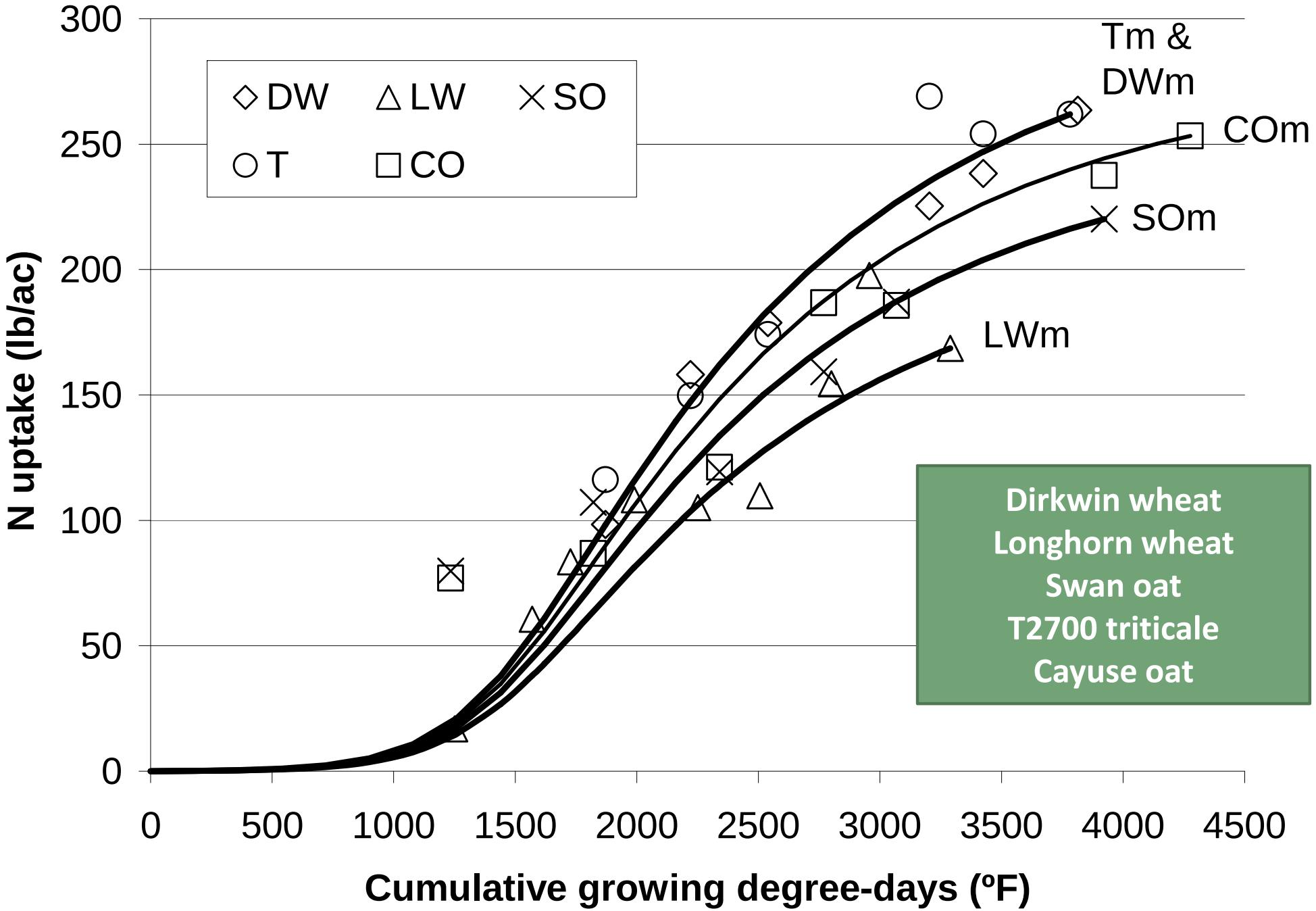
Soil Organic N Accumulation

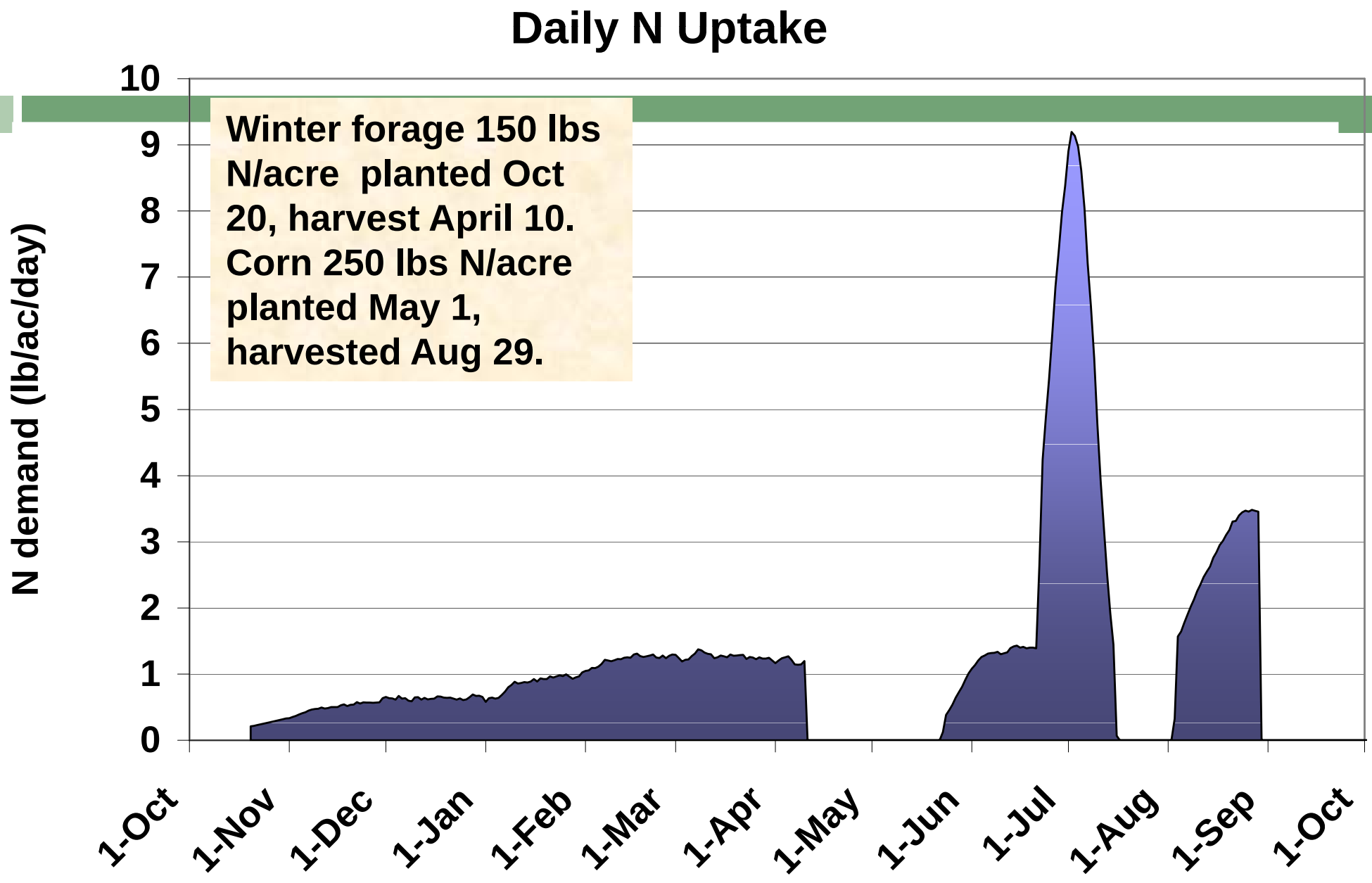


Timing and sizing applications

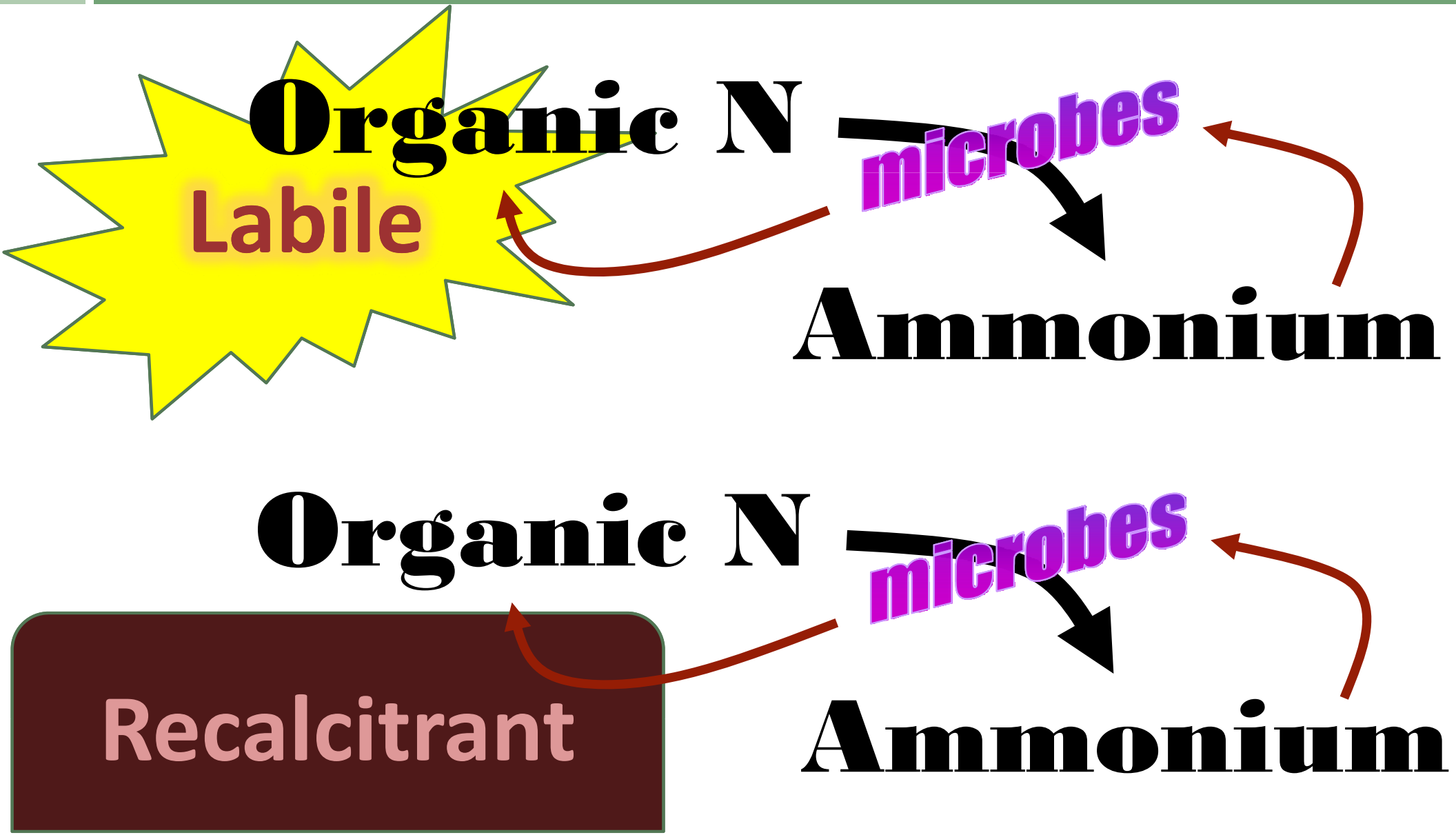
- Mineralization must be sufficient for crop
- Too much time encourages leaching leading to nitrate contamination of groundwater

Representing Crop N Uptake

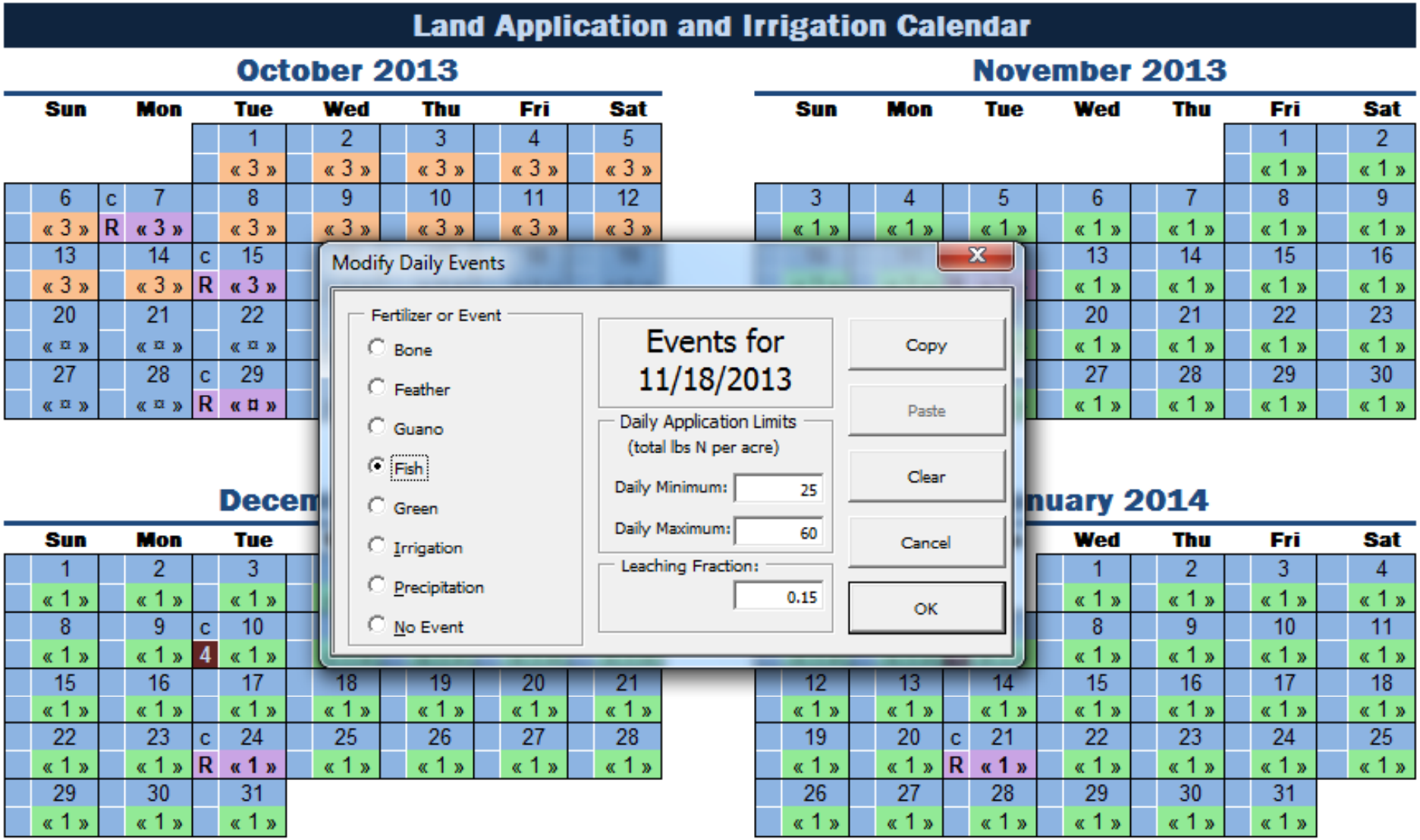



Daily N Uptake
Winter forage 150 lbs N/acre planted Oct 20, harvest April 10. Corn 250 lbs N/acre planted May 1, harvested Aug 29.
N demand (lb/ac/day)
10
9
8
7
6
5
4
3
2
1
0
1-Oct
1-Nov
1-Dec
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct

Concept: 2 C compartments, each immobilizing and mineralizing N



Two input alternatives



Two input alternatives

Date	Event	Leaching Fraction	Minimum Daily Application Rate	Maximum Daily Application Rate
9/26	Irrigation only	0.05		
11/4	Guano	0.11	20	300
12/2	Guano	0.11	20	300
12/30	Guano	0.11	20	300
1/1	Meal		25	200
1/2	Feather		25	1000
1/3	Guano		20	300
1/4	Irrigation only	0.2		
1/5	Precipitation only	0.05		
1/27	Guano	0.11	20	300
2/24	Guano	0.11	20	300
3/11	Meal		25	200
3/24	Guano	0.11	20	300
5/18	Fish	0.2	25	200
5/20	Fish	0.1	25	300
5/25	Fish	0.15	25	150
5/27	Fish	0.1	25	300
6/3	Fish	0.1	25	300
6/10	Fish	0.1	25	300
6/17	Fish	0.1	25	300
6/24	Fish	0.1	25	300
7/1	Fish	0.1	25	300
7/8	Fish	0.1	25	300
7/15	Fish	0.1	25	300
7/22	Fish	0.1	25	300
7/29	Fish	0.1	25	300
8/5	Fish	0.1	25	300
8/12	Fish	0.1	25	300

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1/1	Meal		25	200
1/2	Feather		25	1000
1/3	Guano		20	300
1/4	Irrigation only	0.2		
1/	Precipitation only	0.05		
	Guano	0	20	300
2/	Guano	.11		300
3/11	Meal		2	20
3/24	Guano	.1	2	30
5/18	Fish	0.2	2	
5/20	Fish	0.1	25	
5/25	Fish	0.15	25	150
5/27	Fish	0.1	25	300
6/3	Fish	0.1	25	300
6/10	Fish	0.1	25	300
6/17	Fish	0.1	25	300
6/24	Fish	0.1	25	300
7/1	Fish	0.1	25	300
7/8	Fish	0.1	25	300
7/15	Fish	0.1	25	300
7/22	Fish	0.1	25	300
7/29	Fish	0.1	25	300
8/5	Fish	0.1	25	300
8/12	Fish	0.1	25	300

A THIRD IS COMING!

Result

Nitrogen Application Schedule

Date	Material	Method	N (lb/ac)
Aug. 5, 2013	Fish	Spray irrigation	25 lb
Aug. 12, 2013	Fish	Spray irrigation	39 lb
Nov. 4, 2013	Guano	Spread no-till	28 lb
Jan. 2, 2014	Feather	Spread no-till	26 lb
Jan. 27, 2014	Guano	Spread no-till	28 lb
Feb. 24, 2014	Guano	Spread no-till	41 lb
Mar. 24, 2014	Guano	Spread no-till	37 lb
Jun. 3, 2014	Fish	Spray irrigation	25 lb
Jun. 17, 2014	Fish	Spray irrigation	27 lb
Jun. 24, 2014	Fish	Spray irrigation	74 lb
Jul. 1, 2014	Fish	Spray irrigation	60 lb
Jul. 29, 2014	Fish	Spray irrigation	25 lb

Nitrogen Schedule Result Summary

N Application Summary (lb/ac)	
Meal total:	0
Feather total:	26
Guano total:	133
Fish total:	275
Fish 2 total:	0
All applied N:	434

N Fate Summary (lb/ac)	
Total crop N removal:	382
Leaching losses:	11
Denitrification losses:	2
Volatilization losses:	40
Regulatory N supply ratio:	1.14

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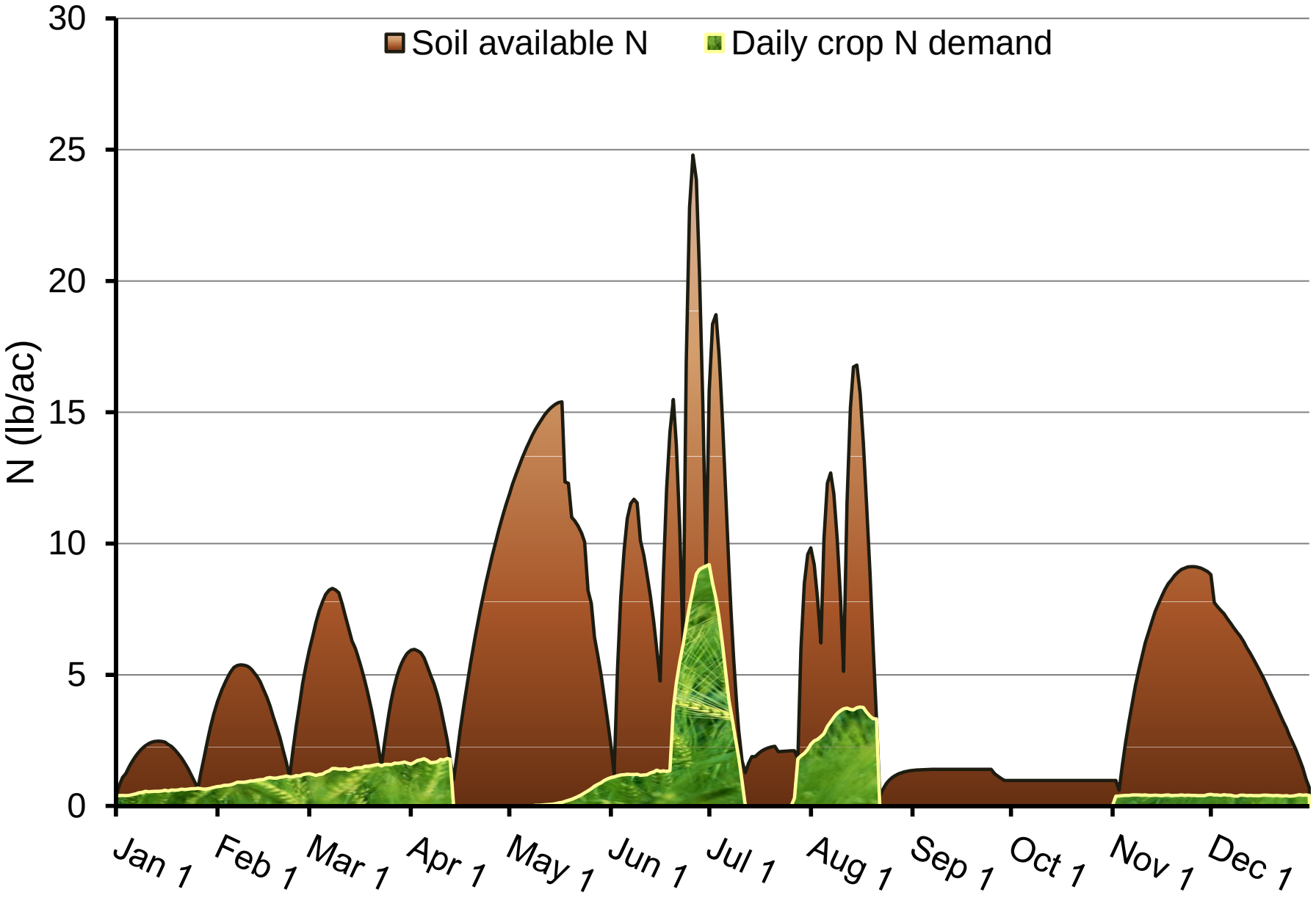
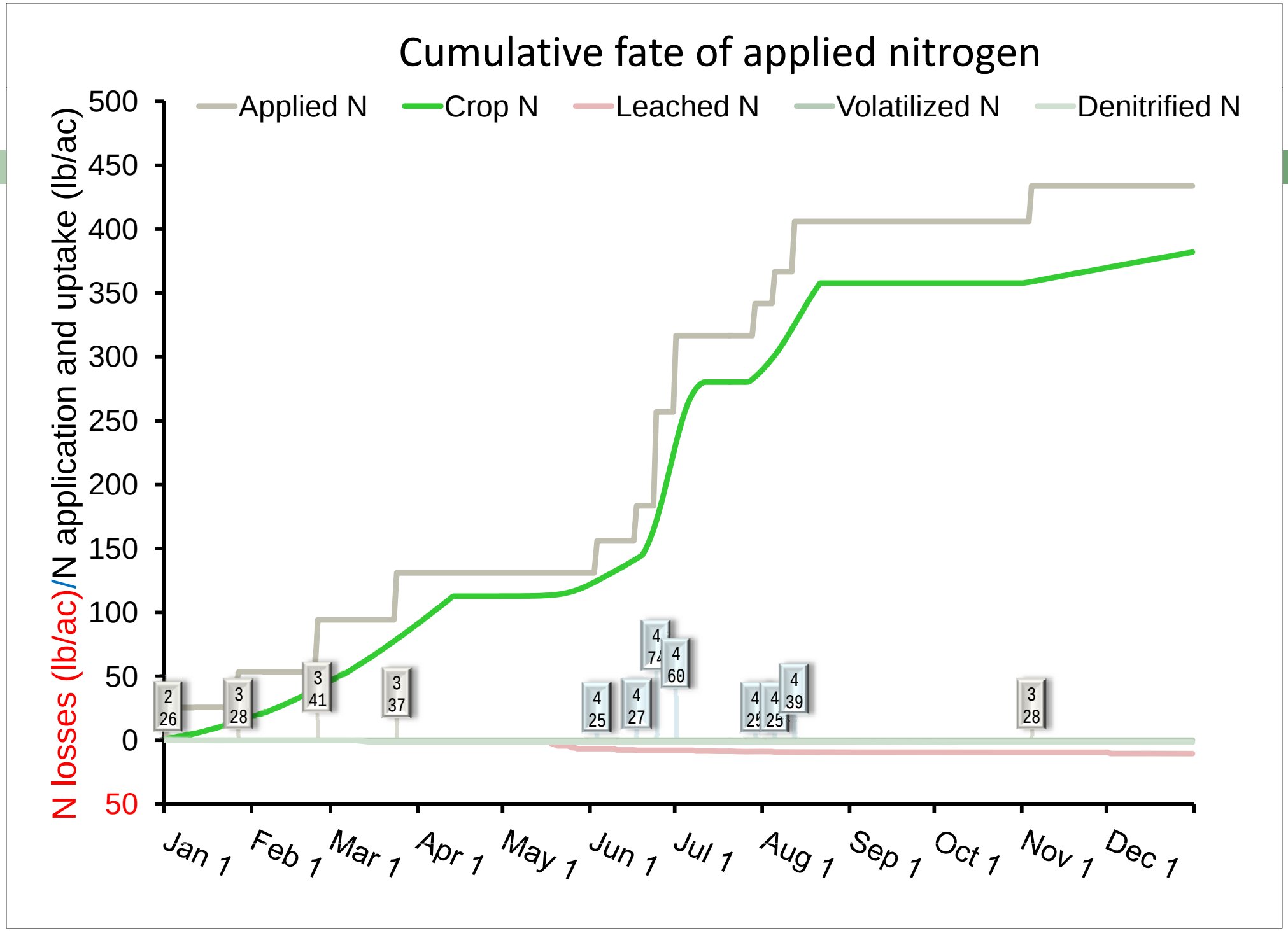
Soil available N and daily crop demand




Cumulative fate of applied nitrogen
Applied N
Crop N
Leached N
Volatilized N
Denitrified N
N losses (lb/ac)/N application and uptake (lb/ac)
500
450
400
350
300
250
200
150
100
50
0
50
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Nov 1
Dec 1
2 26
3 28
3 41
3 37
4 25
4 27
4 74
4 60
4 25
4 25
4 39
3 28

Current and future work

- Improved hydrology component (underway)
- Weather data
- Crop data
- More fertilizer-specific data
- Complete farm interface (underway)