# Nitrogen Availability, Retention, and Loss in Annual and Perennial Organic Pastures in PA

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**This presentation focuses on a comparison of nitrogen dynamics in annual and perennial pastures.**

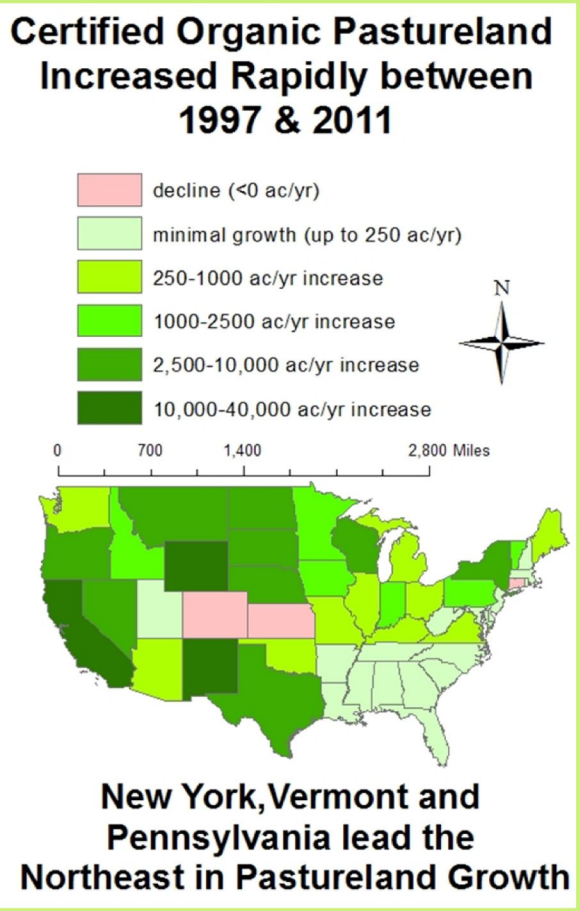
Experimental Overview – what we did

Nitrogen Availability and Uptake


Ammonia and
Nitrous Oxide Losses

# Contextual motivation for this research includes Important Changes in Market, Policy and Climate Factors

## Organic Market Growth +




## Pasture Rule Increases Grazing +

## Increases in Extreme Rainfall Events in Fall

10 top ranked precipitation events in the last 63 years

| Rank | Date | 24 hour rain (in) |
|---|---|---|
| 1 | 9/7/2011 | 5.62 |
| 2 | 9/18/2004 | 4.5 |
| 3 | 6/25/2006 | 3.94 |
| 4 | 7/21/1994 | 3.84 |
| 5 | 9/28/2004 | 3.55 |
| 6 | 7/23/1997 | 3.48 |
| 7 | 10/14/1955 | 3.47 |
| 8 | 4/16/2011 | 3.46 |
| 9 | 10/7/2005 | 3.34 |
| 10 | 9/19/2000 | 3.18 |

# Managing nitrogen in grazed organic systems in a region with increasing extreme rainfall events is challenging.

Not enough nitrogen

Too much nitrogen?

Too much water from heavy rainstorms poses additional nitrogen challenges

# Getting enough nitrogen can be especially challenging in organic systems

Pure grass plots like this Teff plot (right) were particularly N-limited in 2012

# Grazing complicates nitrogen provisioning by creating areas with too little and those with too much

Distribution is highly uneven

Average about

15% coverage/year

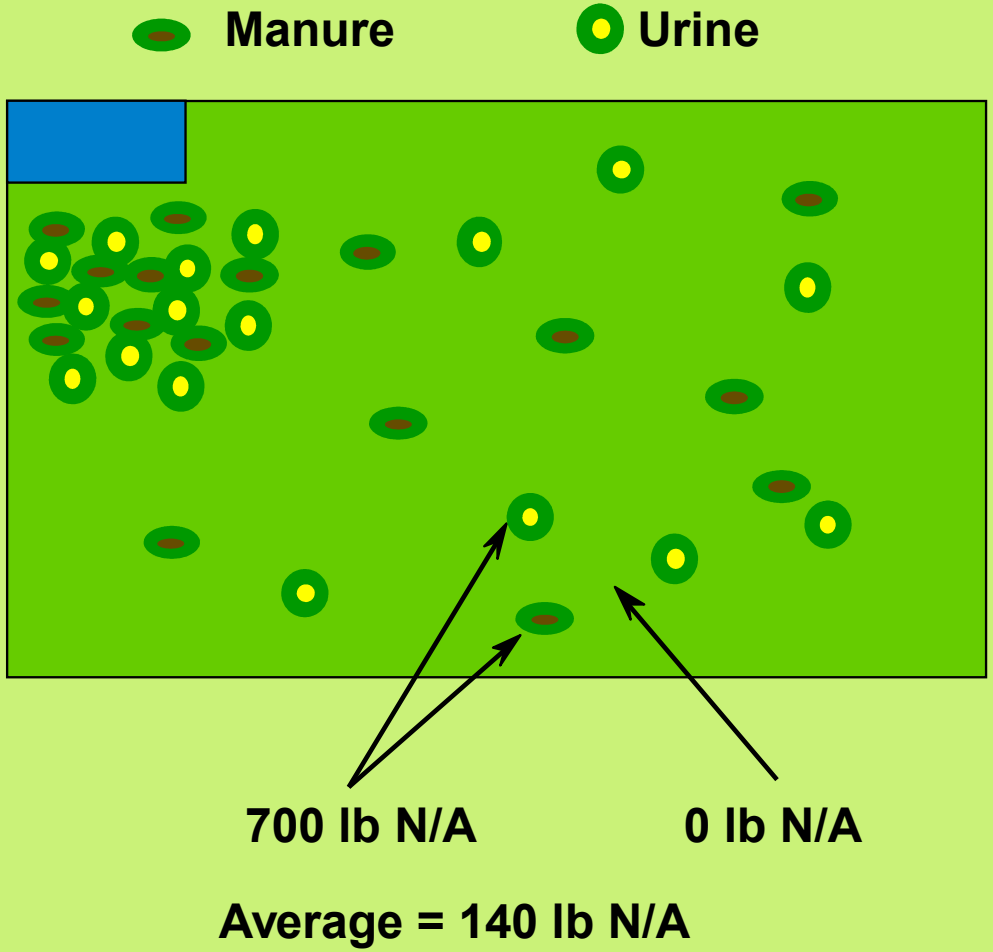





Image courtesy of Dr. Doug Beegle, PSU

# Trends in Hydroclimatic Variability in the Northeast Pose Challenges for Crop Production and N Retention

**Too little**

**2012 Early-Mid Summer Drought limited Crop Productivity and N Uptake in Central PA**

**Too much**

**Increasingly Common Extreme Rainfall Events in Late-summer and Fall Liberate residual N**

**Photo Credit: Jen Dent**

# Experiment focuses on Nitrogen Provisioning, Retention and Loss in 2 Types of Organic Pastures with Simulated Grazing and Rain

*Vegetation Factor*

1) Orchardgrass – red clover pasture
2) Sorghum sudangrass – red clover pasture

***Simulate Grazing (clipping + manure)***

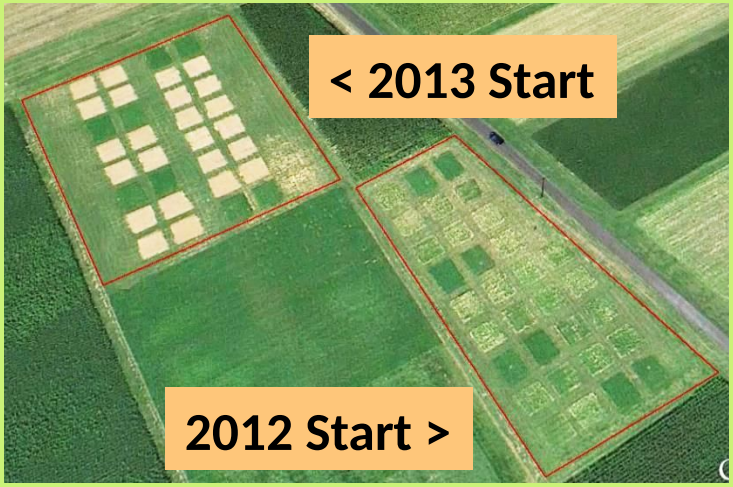
3) With manure
4) Without manure

***Extreme rain (3" in 24 hr)***

5) With and
6) without extreme precipitation

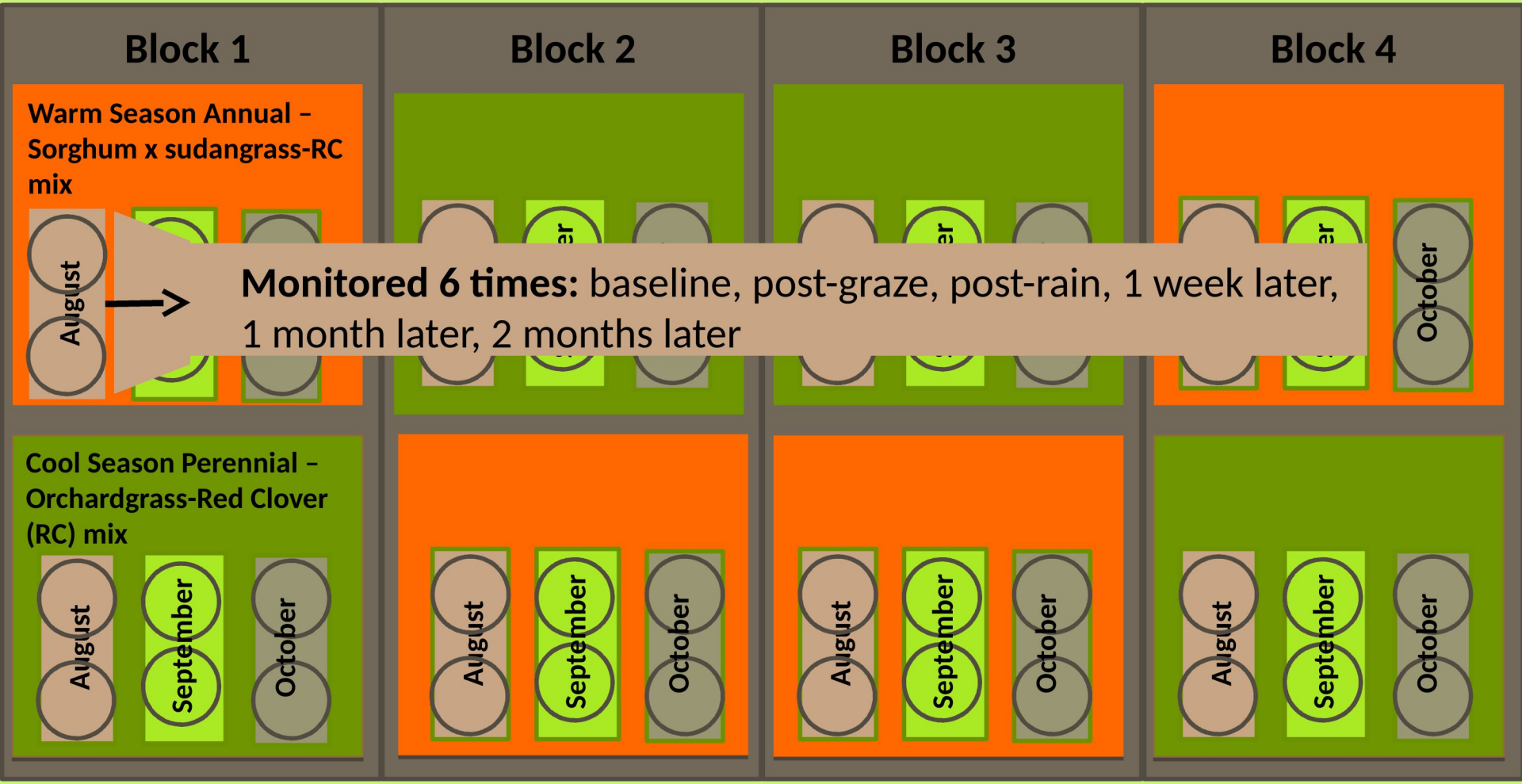
**Simulated Grazing and Extreme Rain 3x/year for 2 years:**

7) August, September and October 2012
8) July, August and September 2013




# Measurements conducted in a split-plot repeated measures design

Russell E. Larson Experimental Research Farm, Rock Springs, PA



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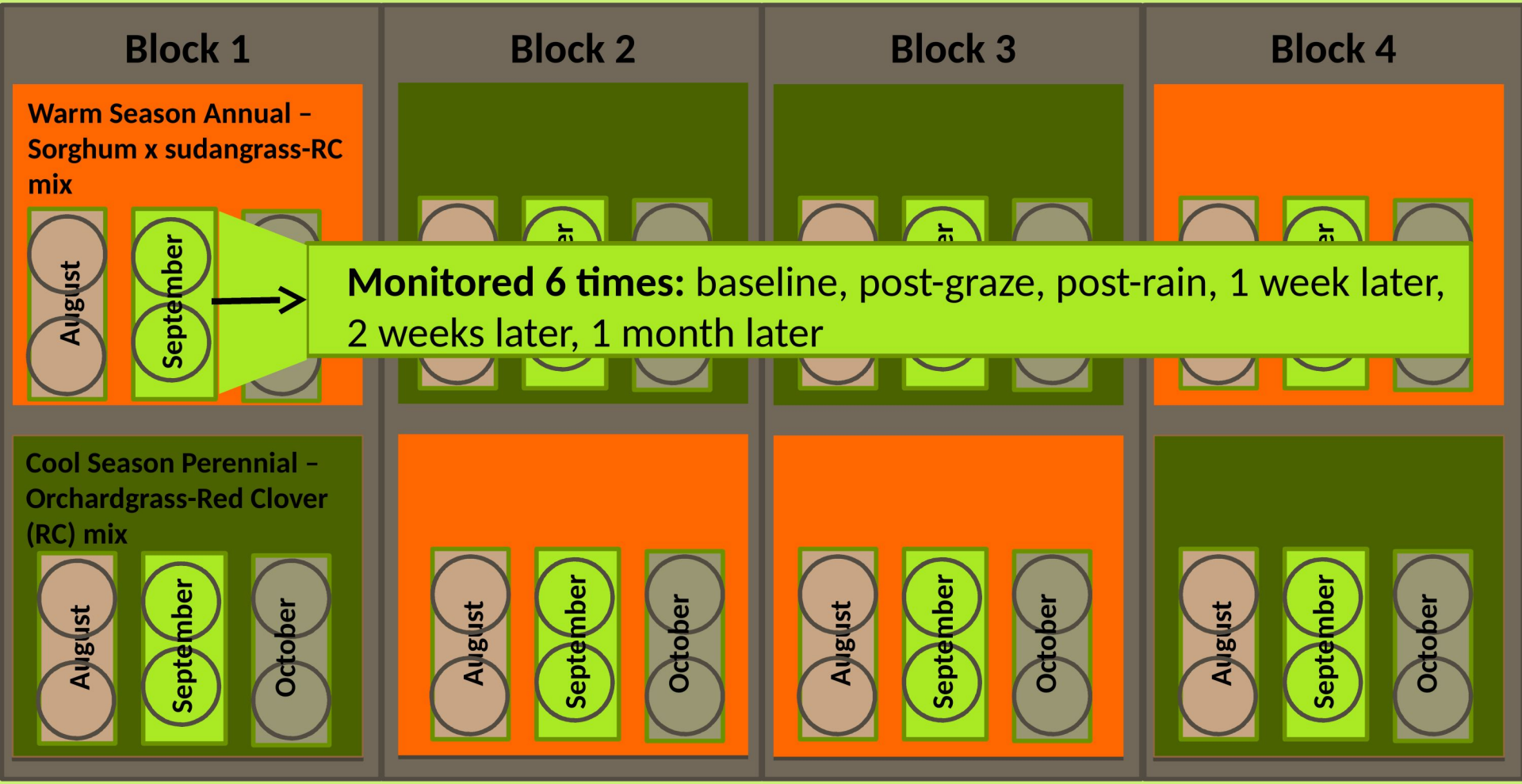
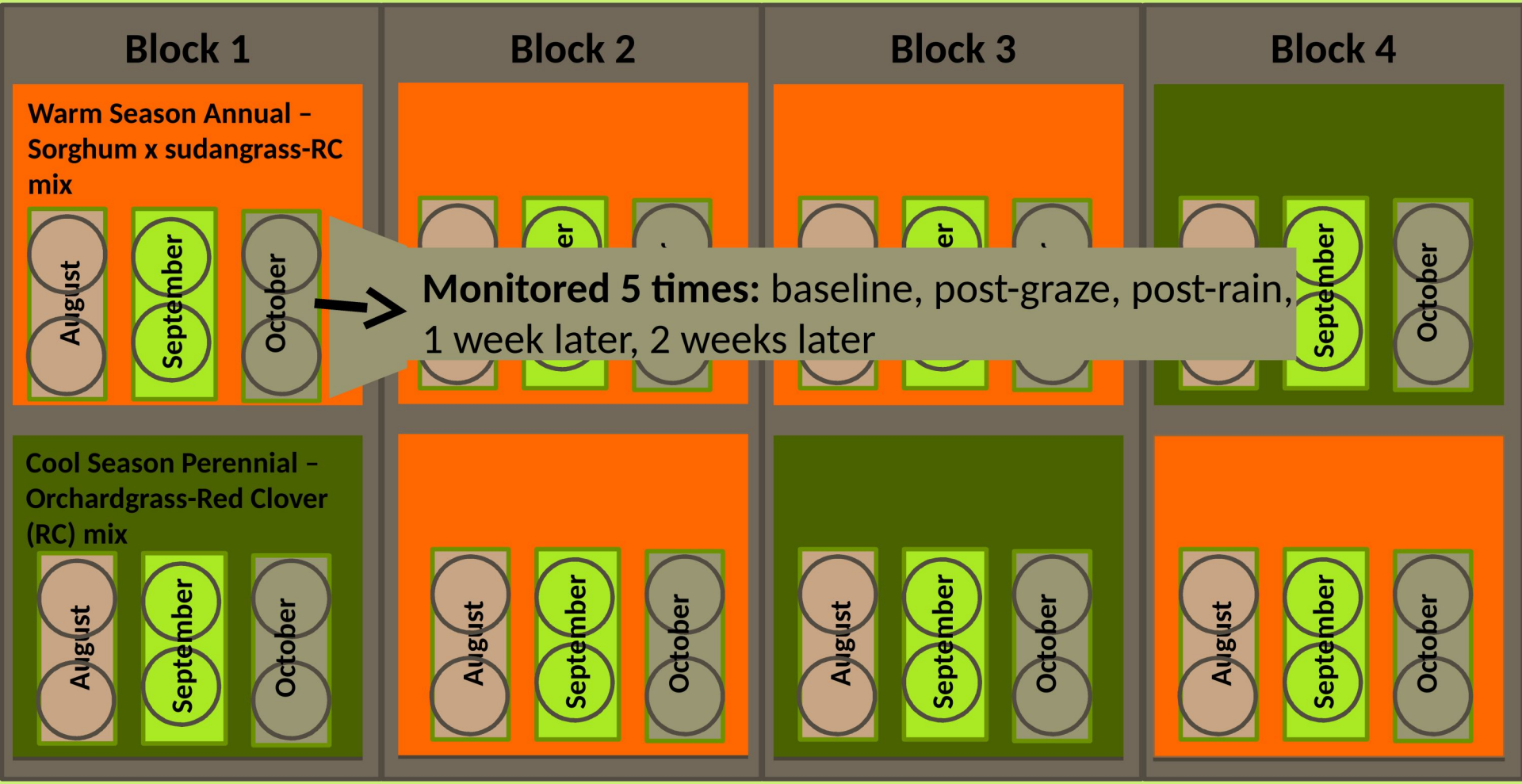


# Event-based sampling designed to capture highly episodic nitrous oxide fluxes

*(and avoid measuring a whole lot of nothing!)*



# We used several measures of N supply and loss

Measuring nitrous oxide and ammonia emissions with a Photoacoustic Analyzer

## Measures of N Supply:

1. **Soil Nitrate ($NO_3^-$)**
2. **Soil Ammonium ($NH_4^+$)**
3. Red clover shoot N
4. **Plant N uptake**

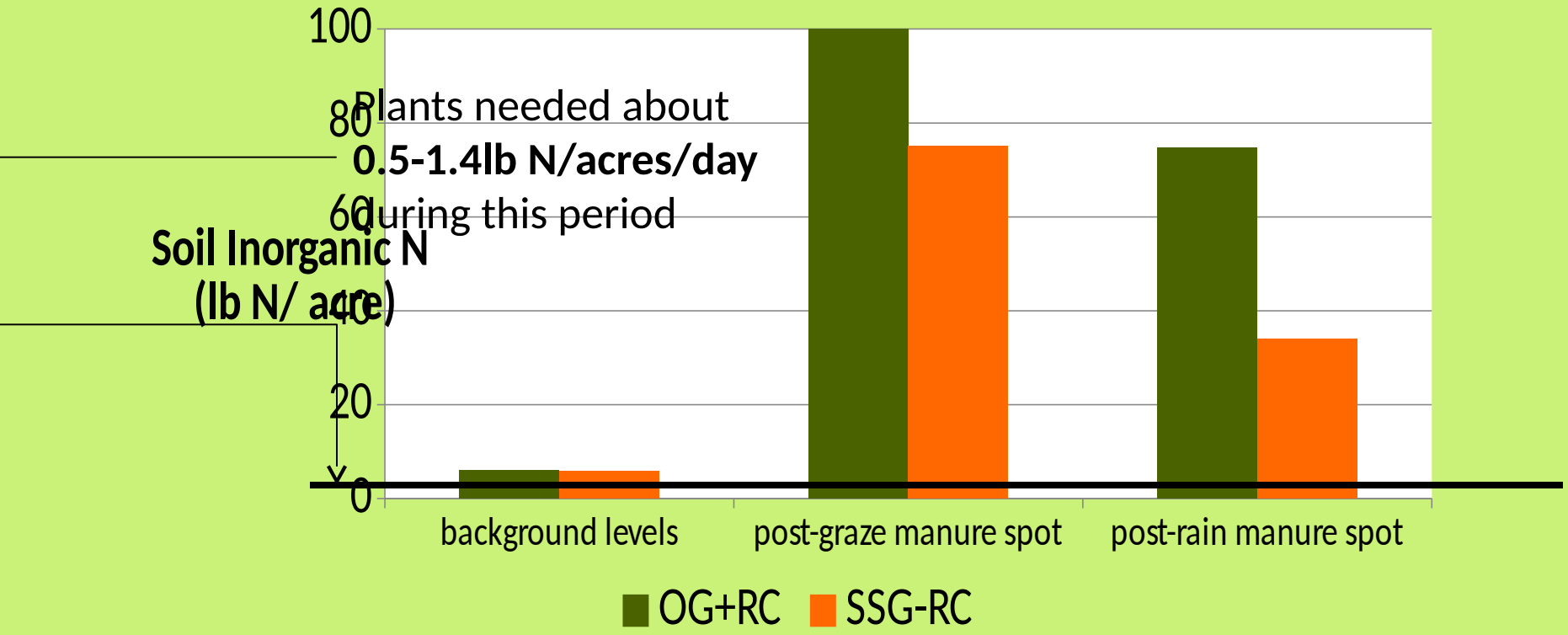
## Measures of N Loss:

5. **Ammonia ($NH_3$ ) volatilization**
6. **Nitrous Oxide ($N_2O$) emissions**
7. Potentially leached soil nitrate ($NO_3^-$ at 30 cm fall to spring)

# There were some mismatches in Nitrogen Supply and Demand

*(August 2012 simulation example)*

*Very high soil inorganic N levels in manure spots create an opportunity for loss*



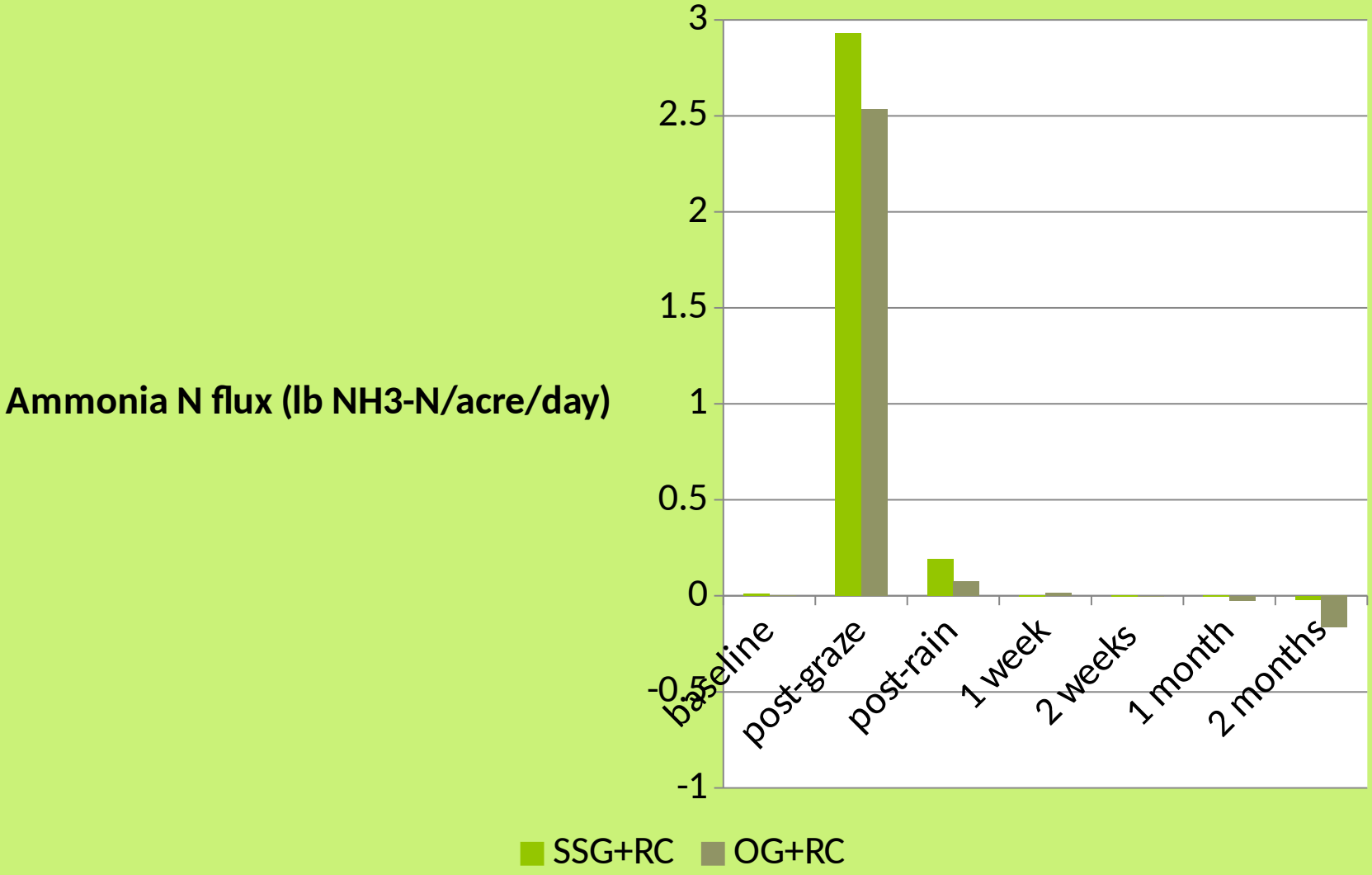
# WHERE DID ALL THIS AVAILABLE N GO?

Air, Soil and Water

**Today:**

Measured N lost as Ammonia and Nitrous Oxide

# Nitrogen lost as ammonia is immediate and Rain stops ammonia loss

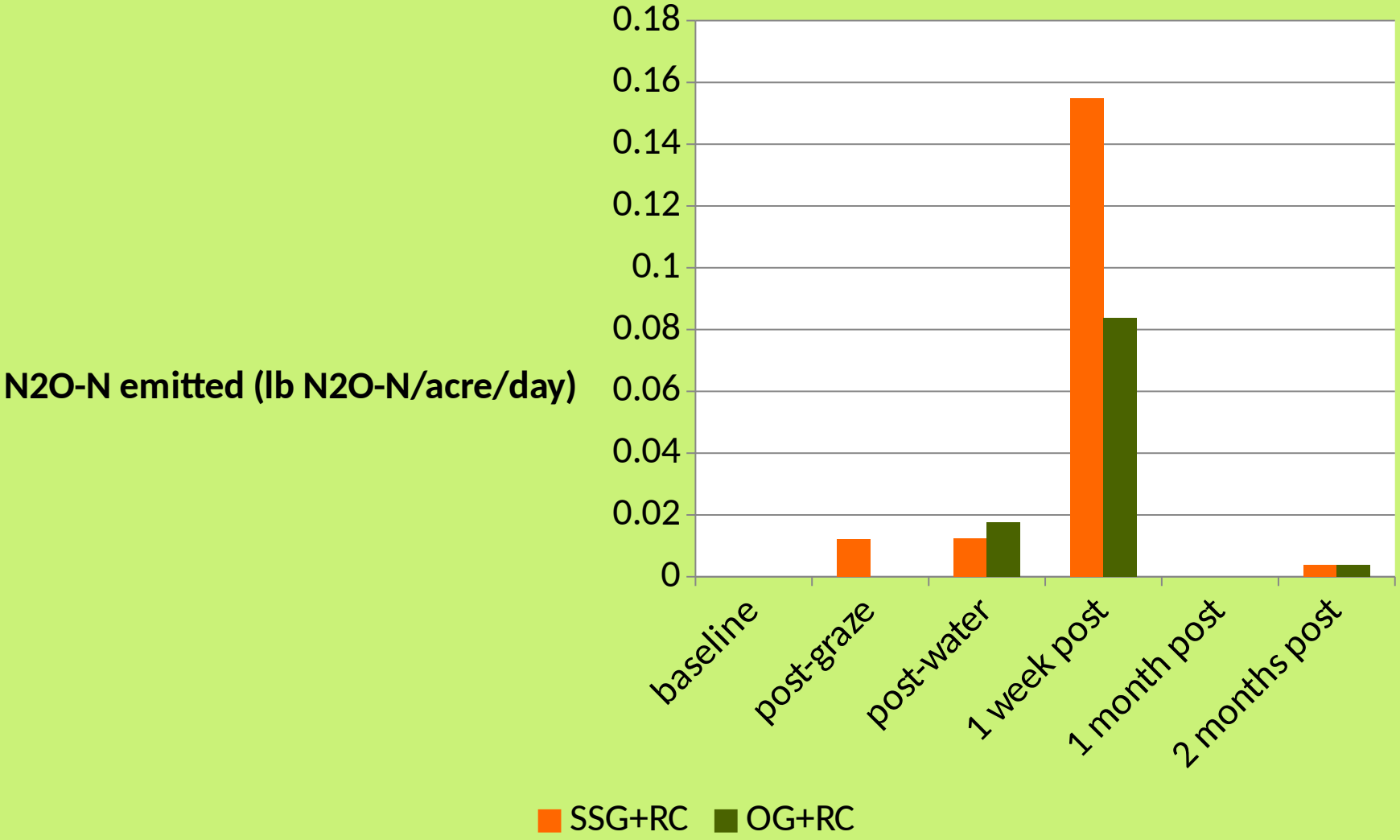


# Manure $NH_4^+$ drives soil $NH_3$ emissions

- High $NH_4^+$ levels &/or
- Rapid ammonification of organic N
- Warm, moist environment

1. From manure, immediately after application
2. Highest in warm summer weather, lower in cooler fall
3. Extreme precipitation will truncate high fluxes
4. Higher SSG+RC $NH_4^+$ uptake in summer may result in lower $NH_3$ from them in summer, BUT higher $NH_3$ later in fall

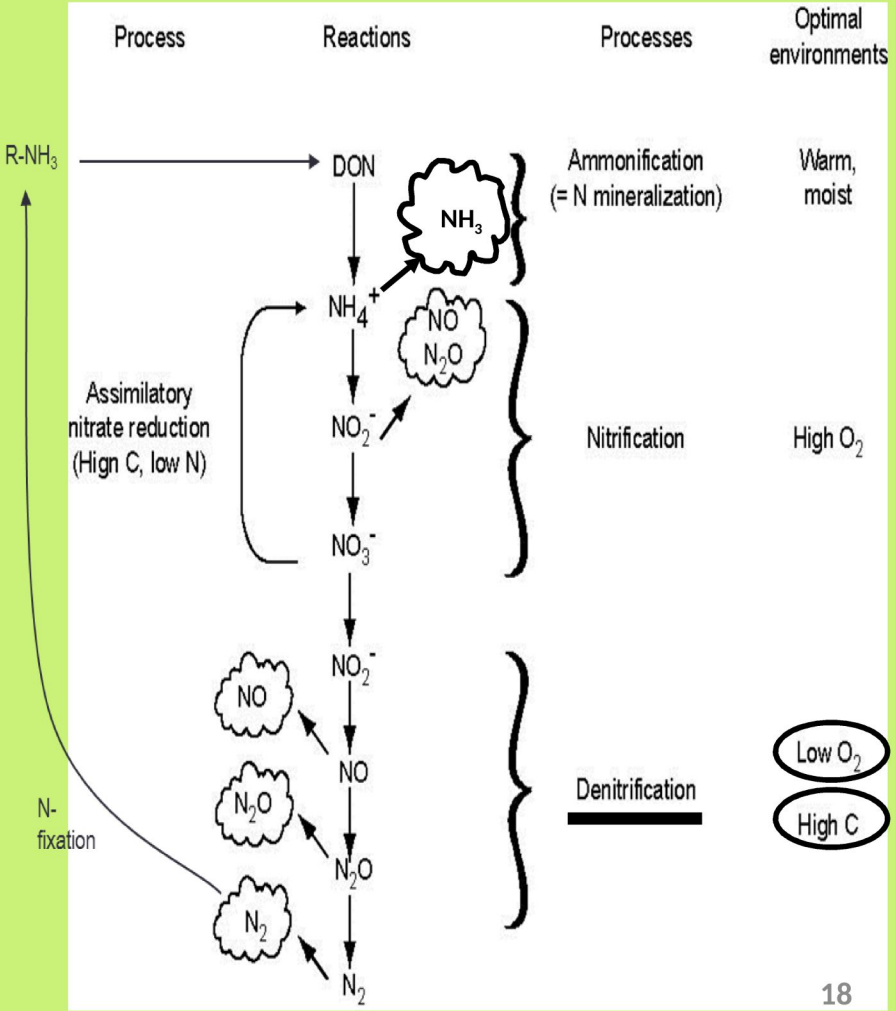
# Less N is lost as nitrous oxide, but even small losses have global importance



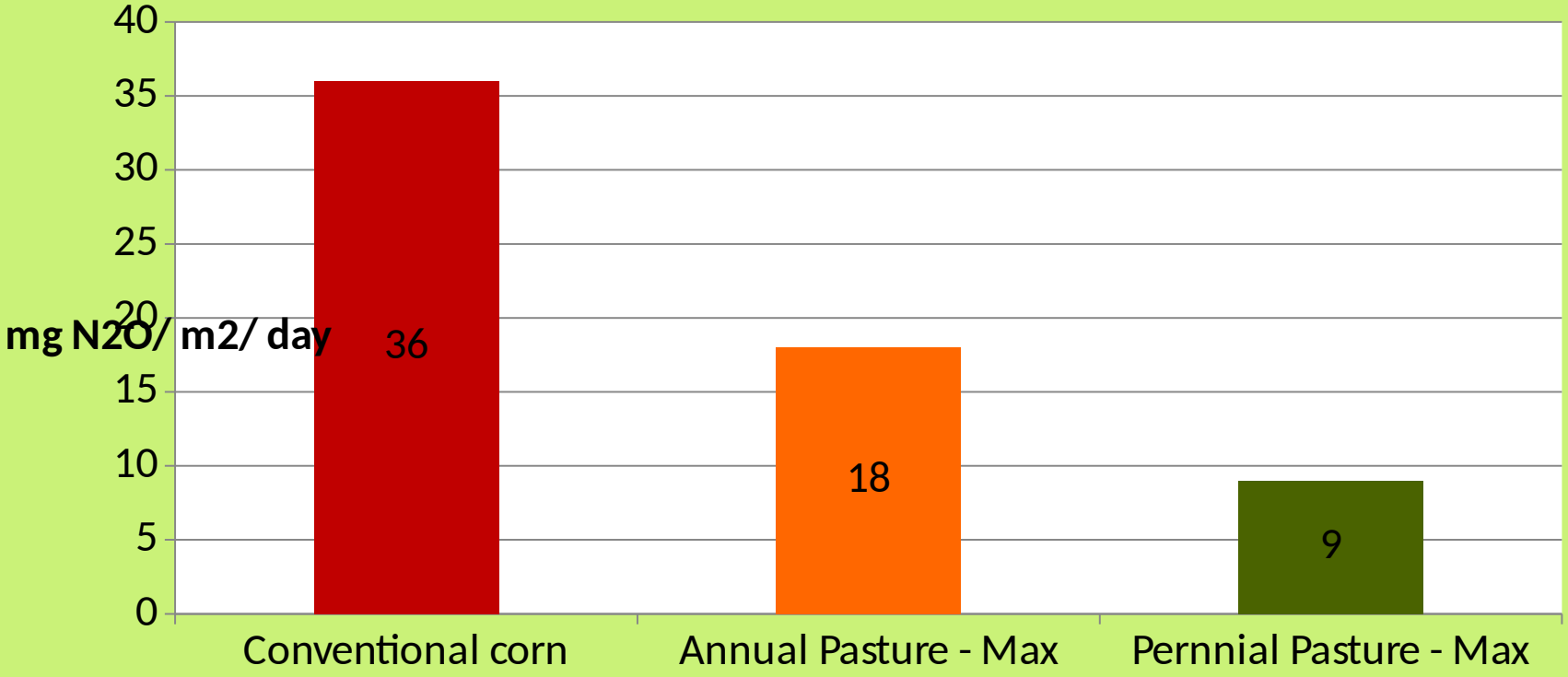
# $N_2O$ emissions peak after rain when there is high soil N

- Primarily from denitrification
- Low $O_2$

1. Takes 1-2 weeks for peak fluxes to occur
2. Highest in warm summer weather, lower in cooler fall
3. Account for <5% of N applied
4. Soil uptake occurs after dung applications



# Preliminary comparisons to row crop feed production are favorable

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# QUESTIONS?