# Managing N to Reduce $N_2O$ Emissions in Rainfed Cropping Systems

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# Strategies to reduce $N_2O$ emissions

1) Reduce Inputs (maintain/increase productivity)

*This will require increasing N use efficiency*

-Fertilizer: Amount, Form, Placement, Timing

*N use efficiency is not fertilizer N use efficiency!*

-Unmanageable N: Manure N-Plant N-Soil N

*N use efficiency = f(N available, N uptake, N loss)*

2) Increase Storage: Every kg increase in SOC = 0.4 kg $CO_2$ eq savings as $N_2O$ (C:N=1, 1% of $N_2O$)

3) Decrease Denitrification and/or $N_2O$ : ($N_2$ + $N_2O$) ratio:

Field scale - Fertilizer form, placement, timing

- Bioreactors to reduce in treat $NO_3$

Landscape scale – Wetlands

4) Increase Atmospheric $N_2O$ Consumption

? Doubtful ?

# Cover crops as a strategy to improve N use efficiency and reduce $N_2O$ emissions

*Cover Crops are grown during normally fallow times between the main crop seasons.*

**Potential Benefits of a non-legume cover crop:**

- Decrease $NO_3$ leaching losses
- Compete with microorganisms for residual inorganic N
- Increase N storage in soil organic matter

**Potential detriments of a non-legume cover crop:**

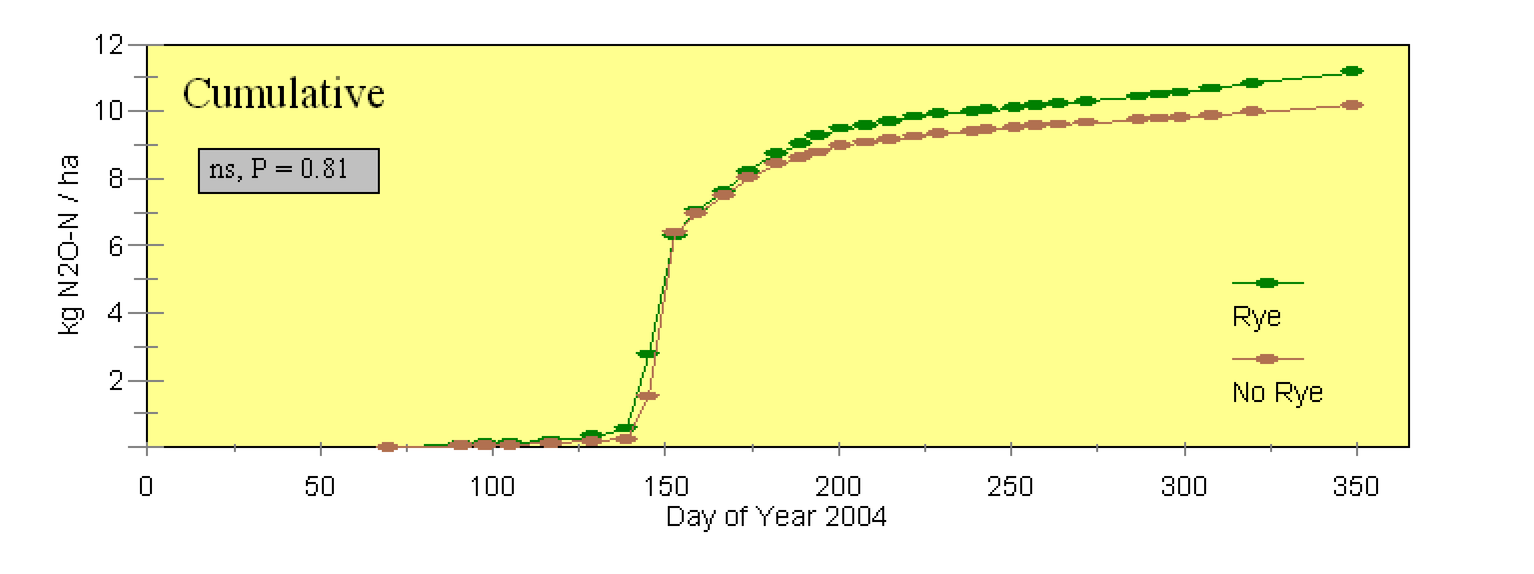
- Increase pool of "unmanageable N"
- Increased C substrate to support denitrification

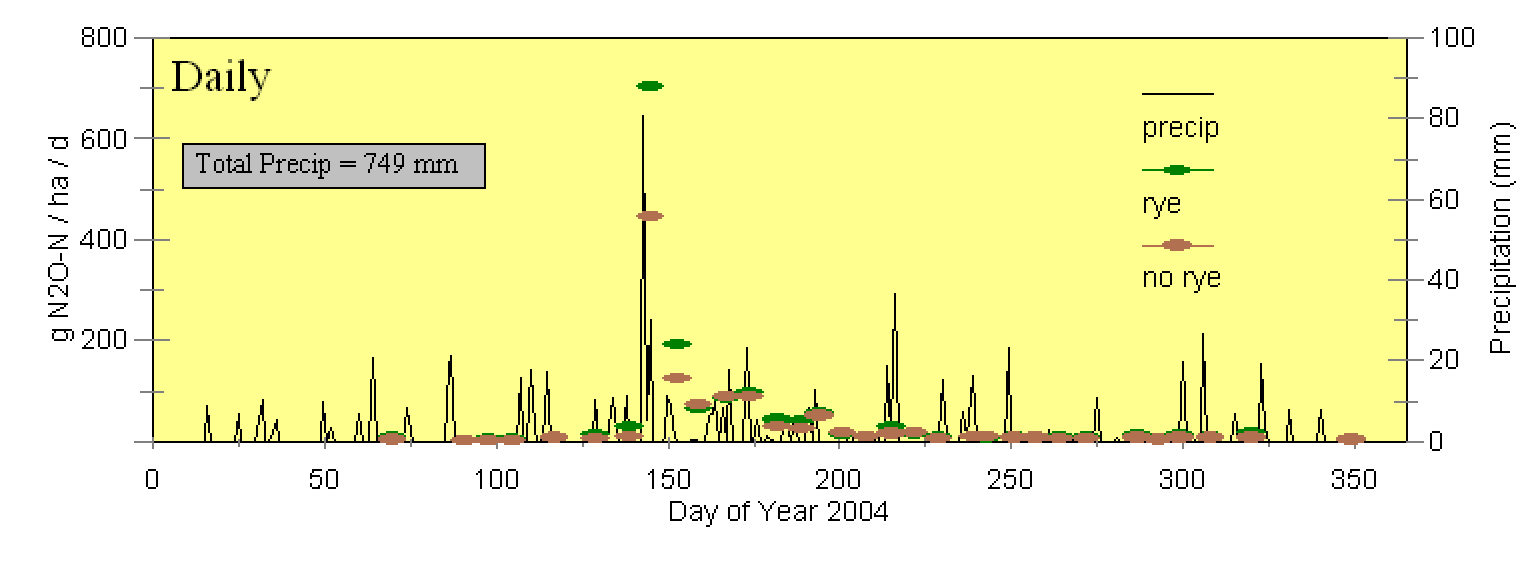
# Cover Crop Effects on $N_2O$ Emissions

-Plots were established in 1999
-Corn / Soybean rotation with and without a rye winter cover crop
-N fertilizer (corn years), spoke injected UAN, 175-230 kg N/ha
-Individual tile lines drain each plot
-Four replicate plots / treatment
-Gas flux since 2004, 2 chambers/plot

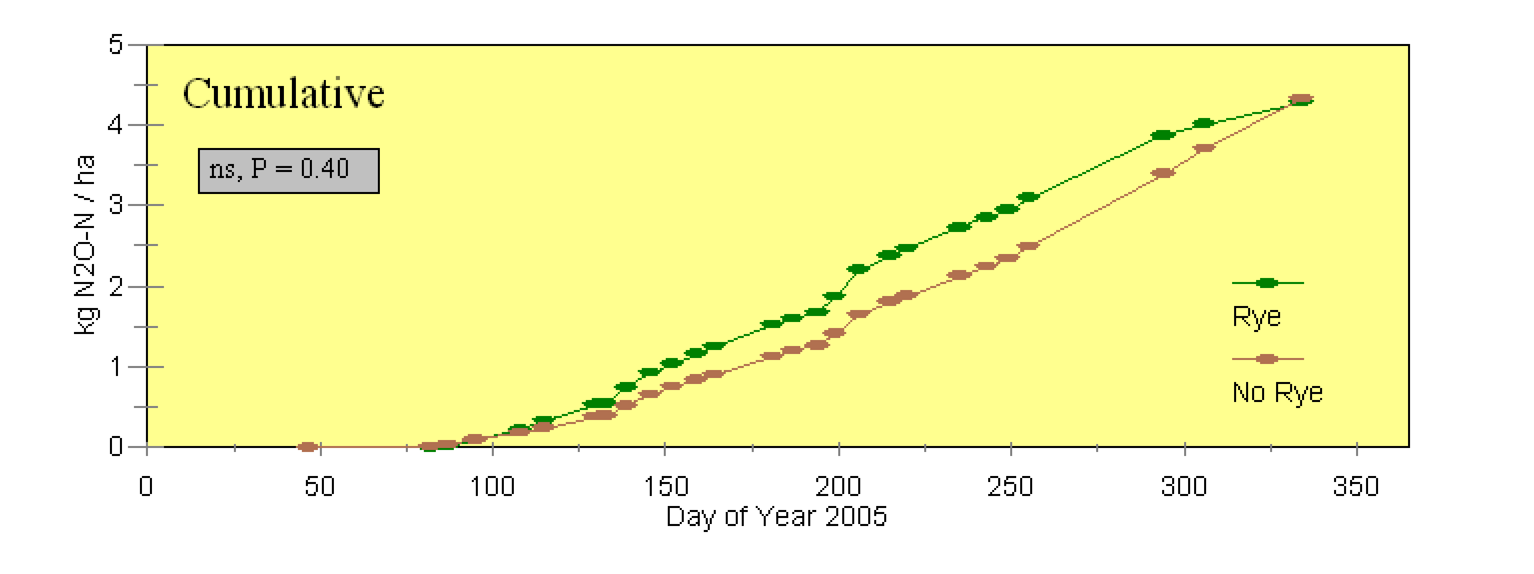


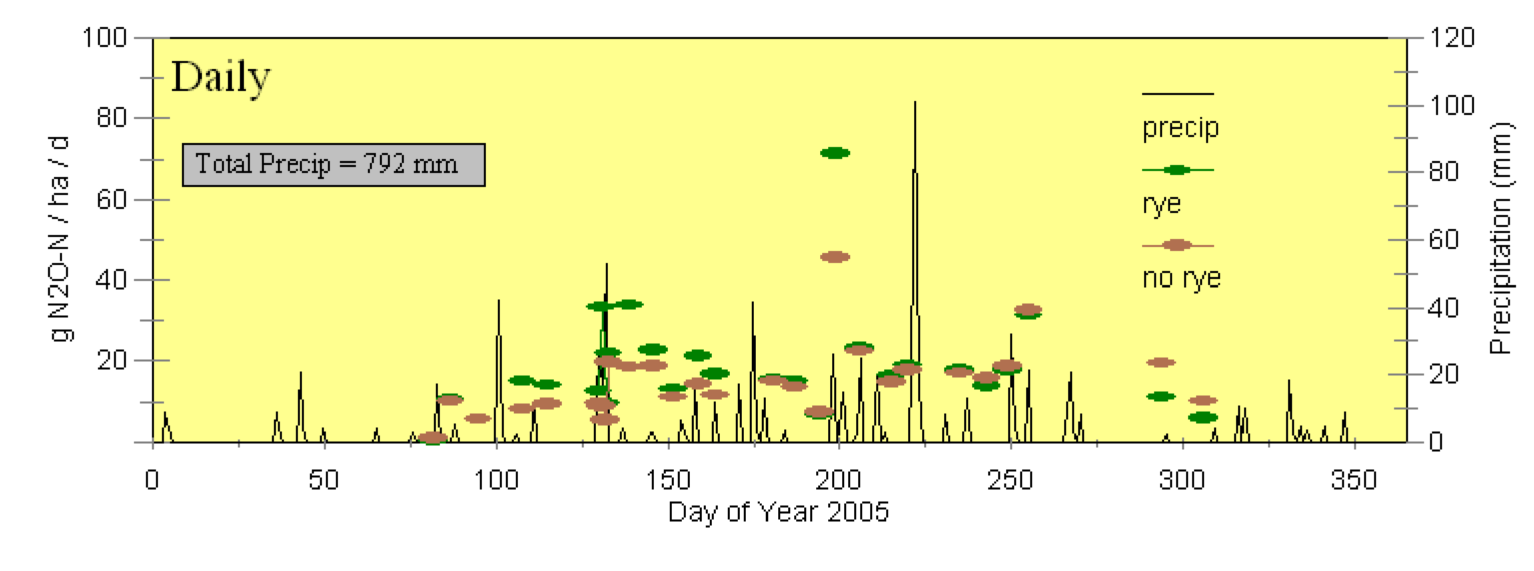
# $N_2O$ Emissions 2004 - Corn



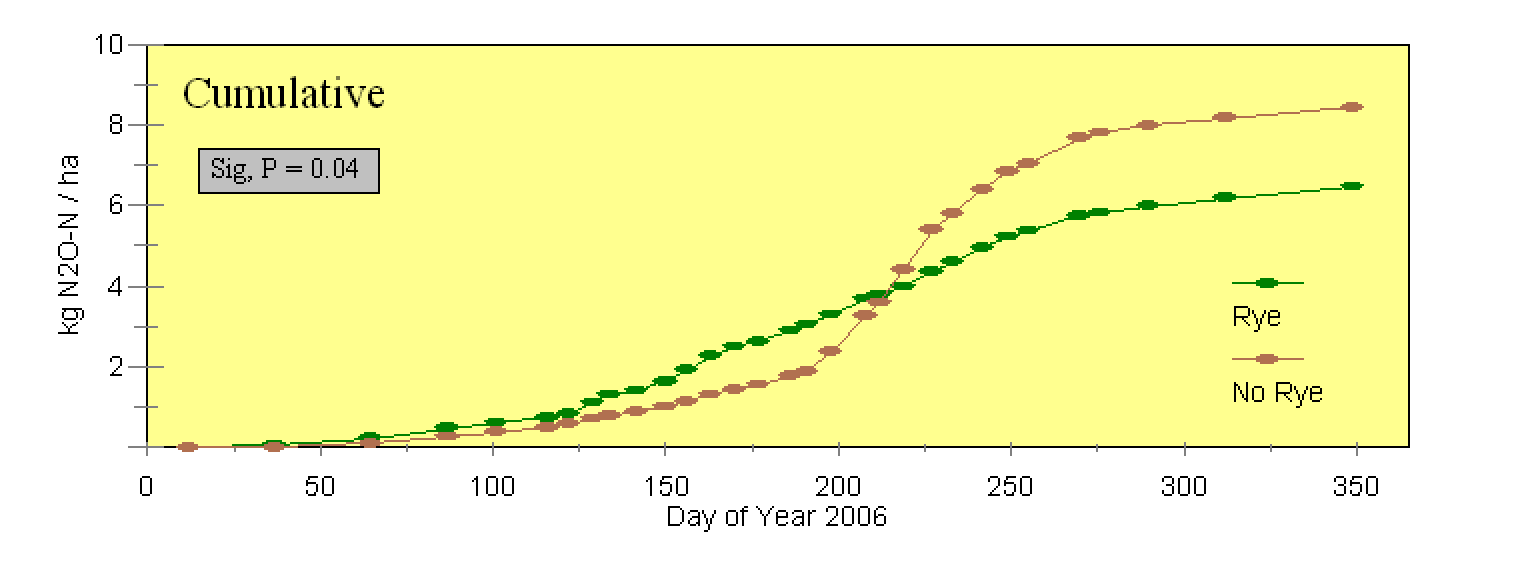



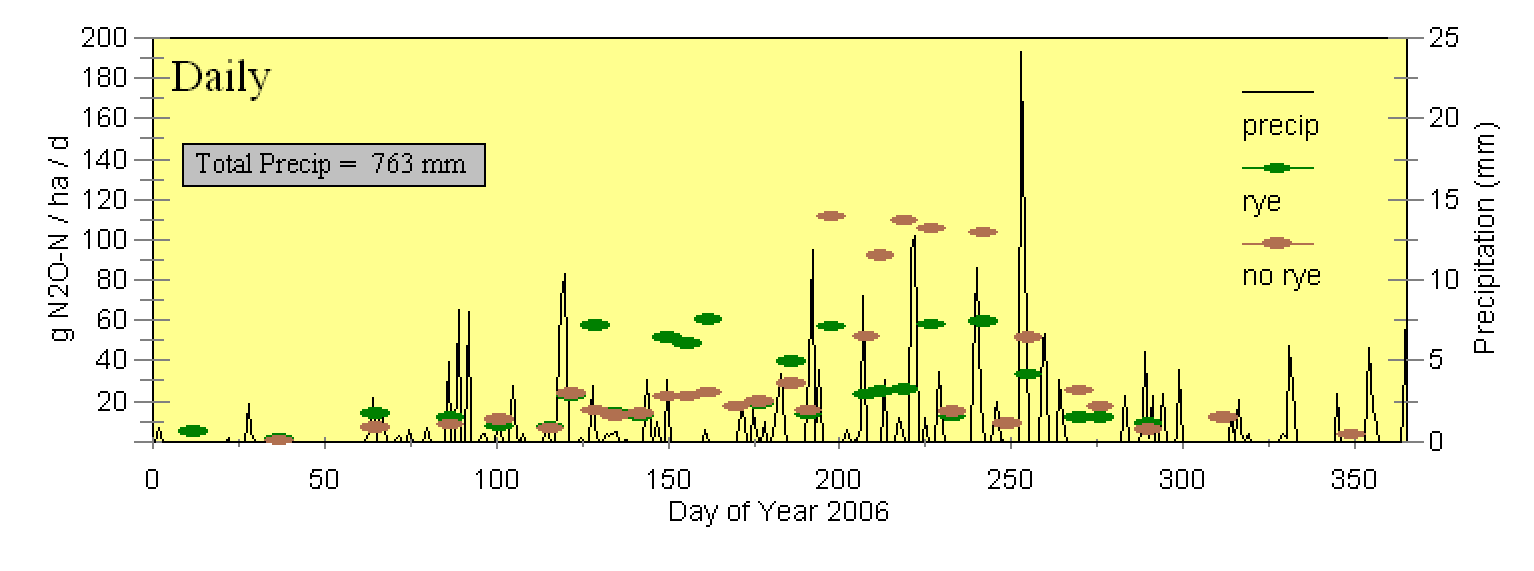
# $N_2O$ Emissions 2005 - Soybean



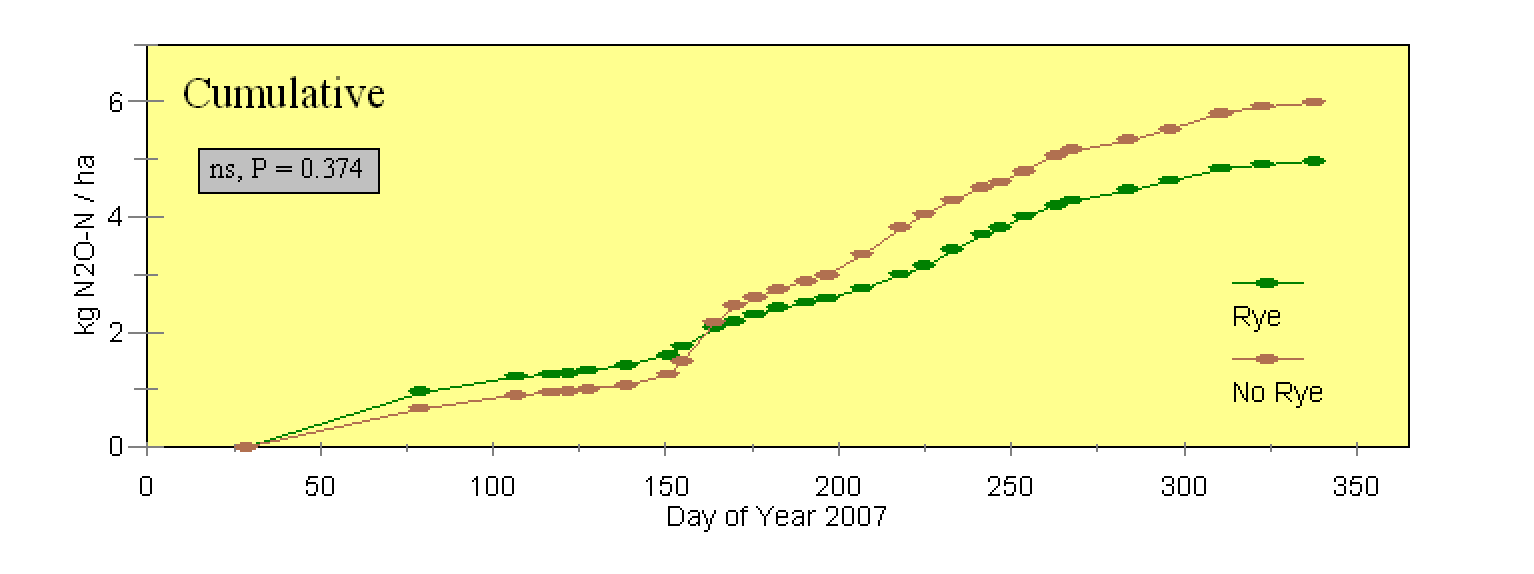



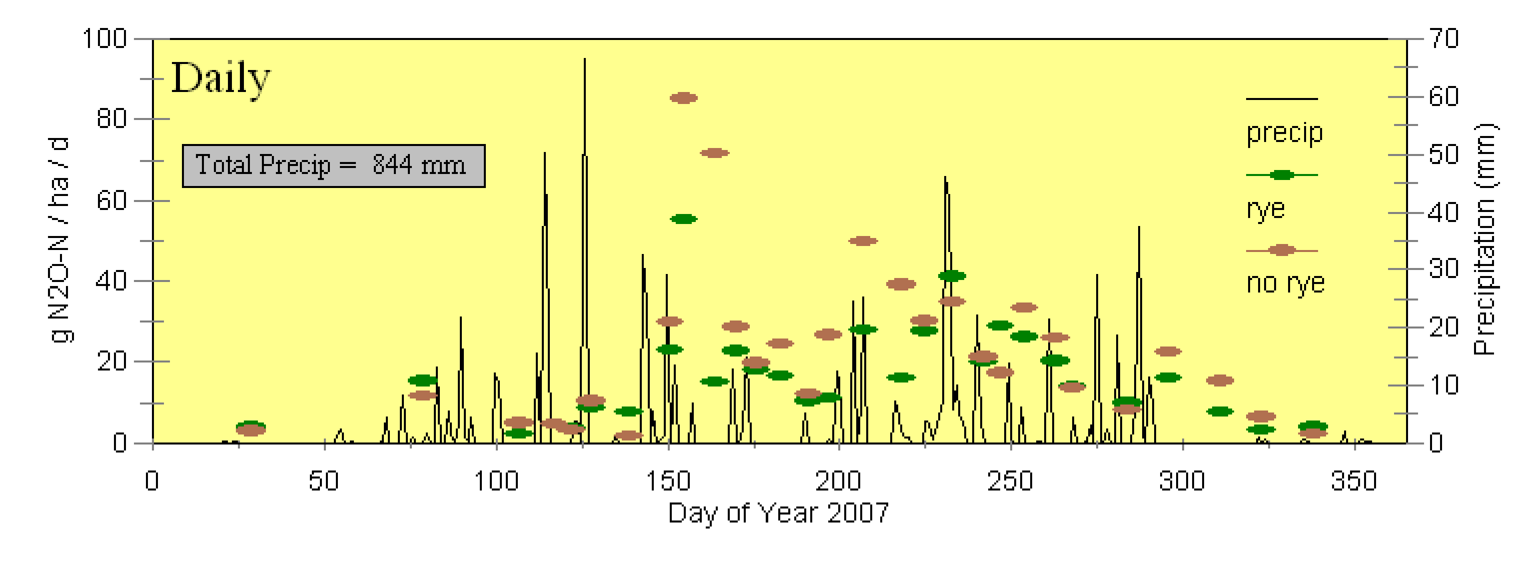
# $N_2O$ Emissions 2006 - Corn



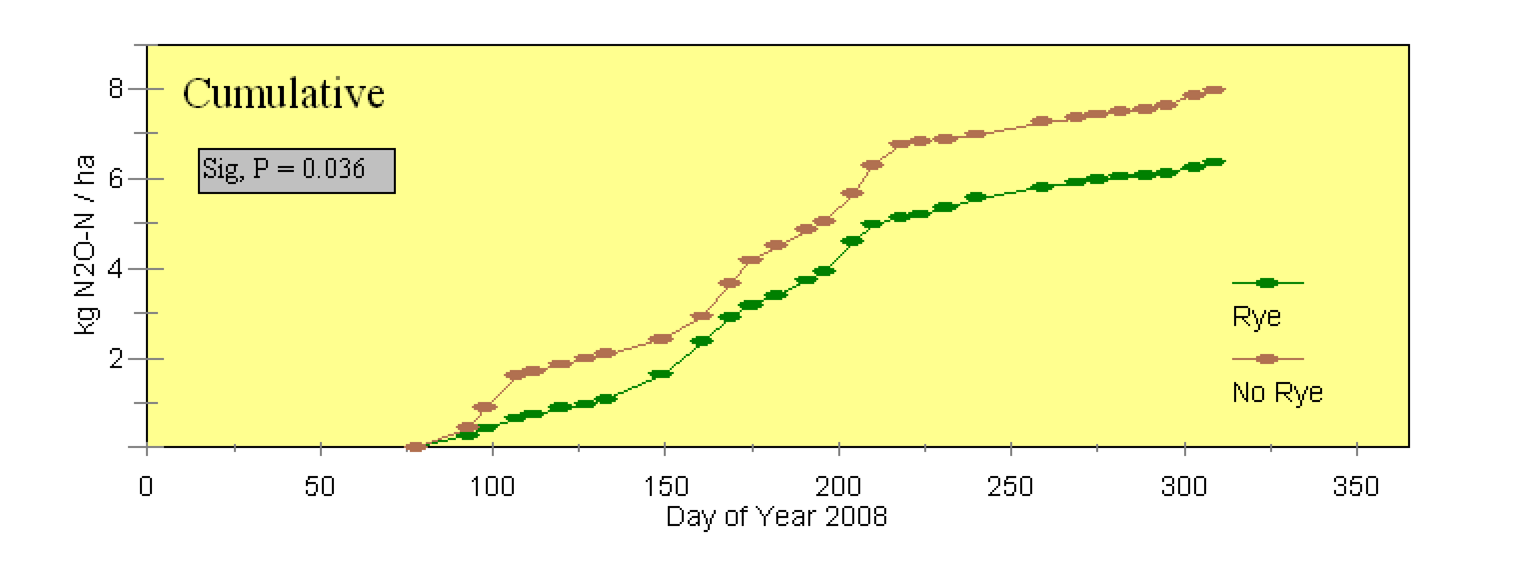



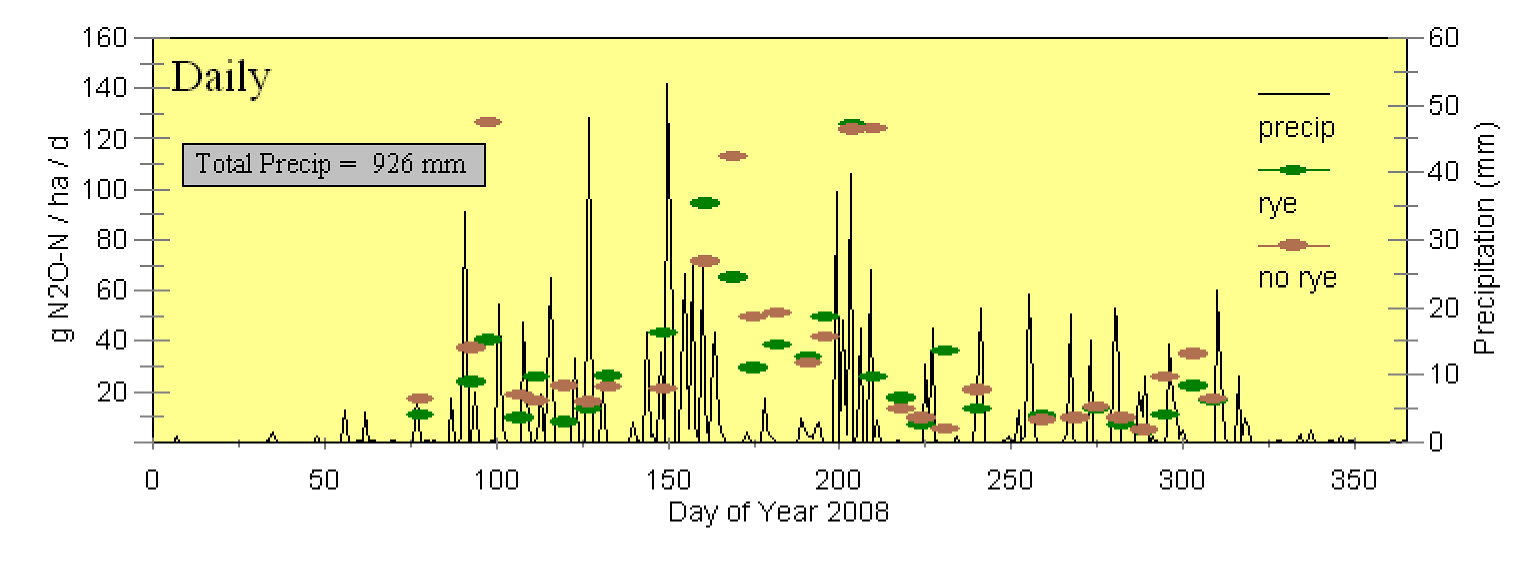
# $N_2O$ Emissions 2007 - Soybean



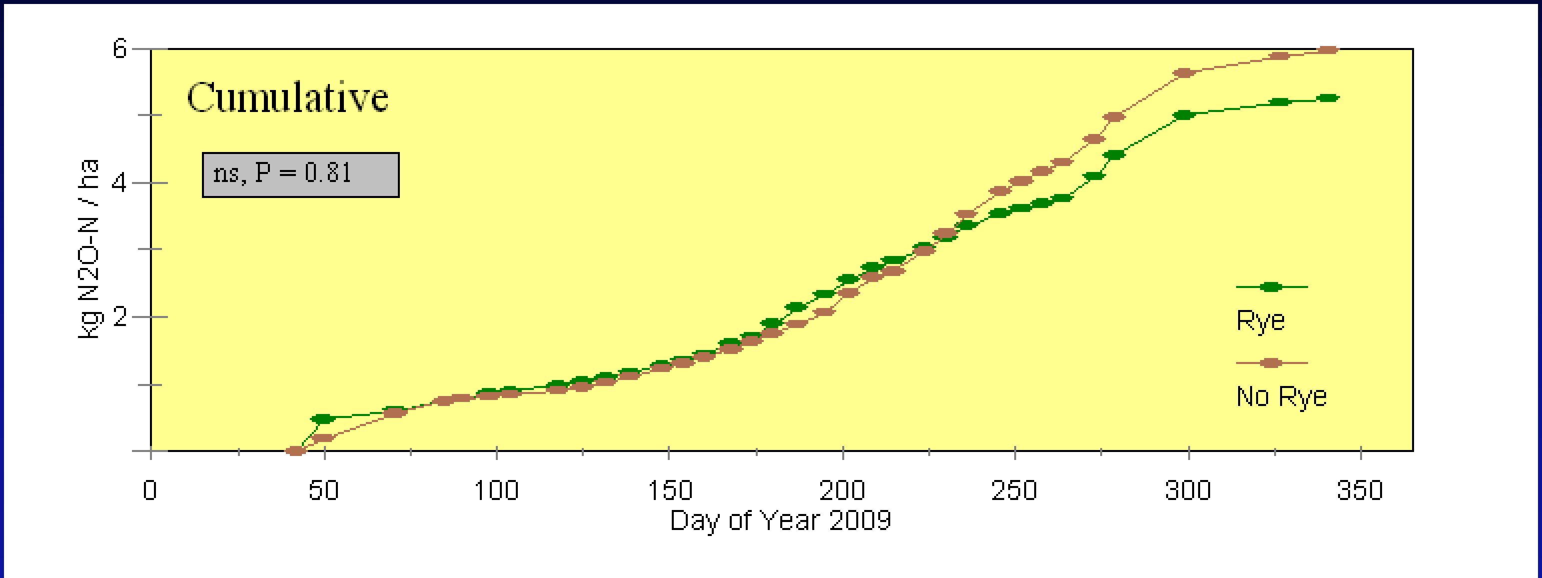



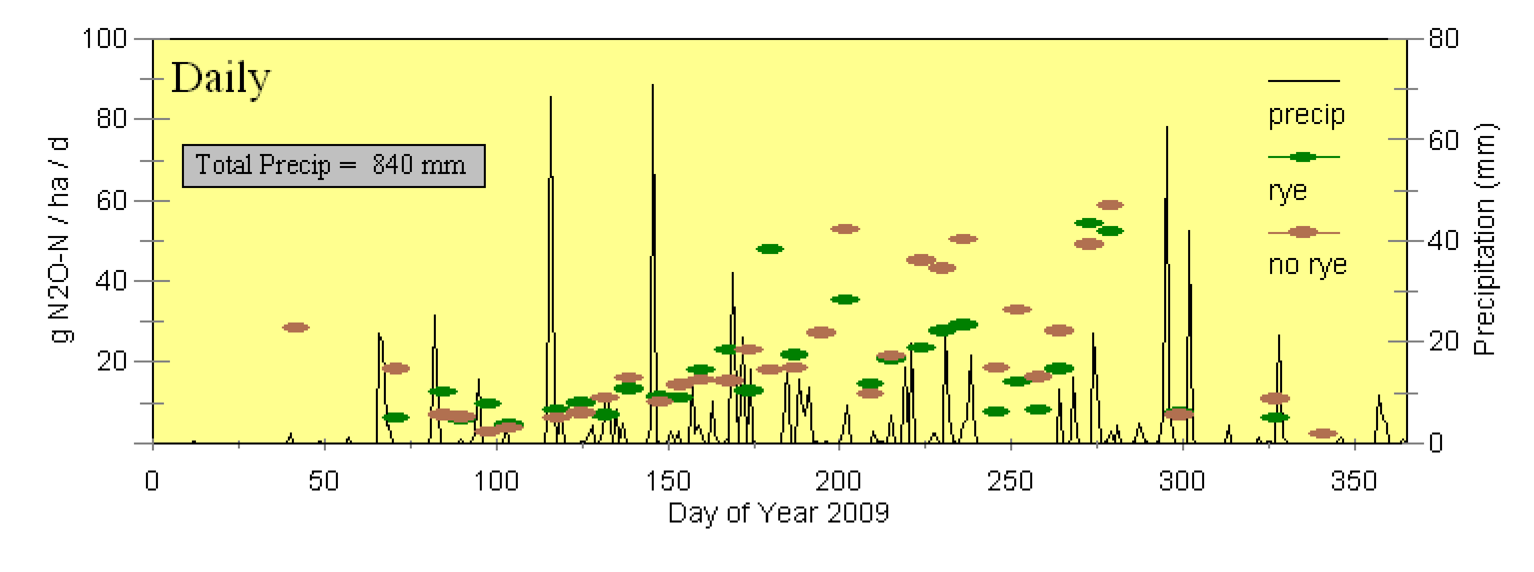
# $N_2O$ Emissions 2008 - Corn



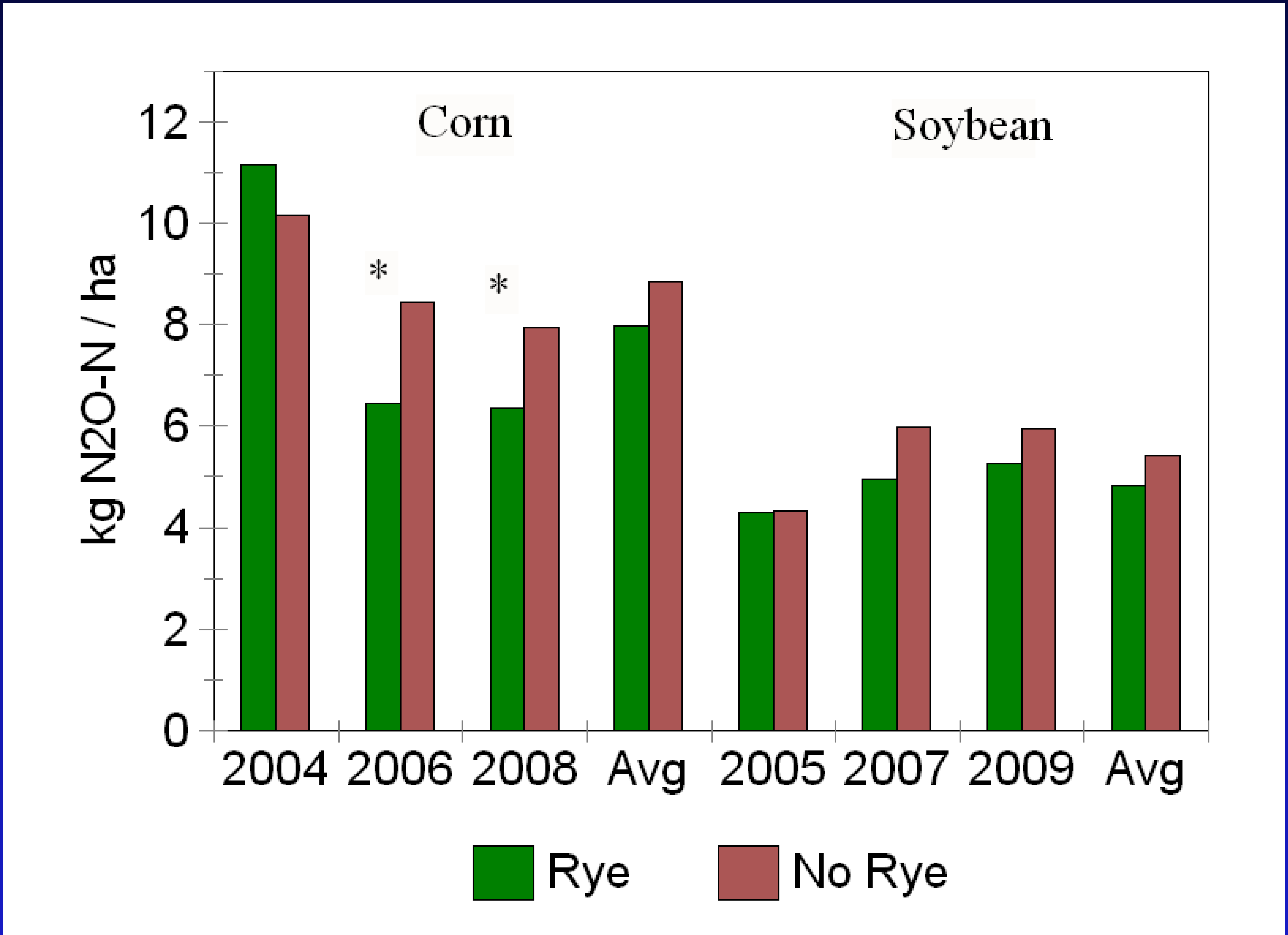



# $N_2O$ Emissions 2009 - Soybean



# Cumulative $N_2O$ Emissions



# Partial N mass balance for a no-tillage corn/ soybean rotation in central Iowa with and without a rye winter cover crop, 2004 – 2009.[1]

| | N Inputs (kg N $ha^{-1}$) | | | | N Outputs (kg N $ha^{-1}$) | | | | 6 Year |
|---|---|---|---|---|---|---|---|---|---|
| Treatment | N Applied[2] | Wet & Dry Deposition | $N_2$ Fixation[3] | | Grain Removal | Drainage $NO_3$ Loss | $N_2O$ | | **N Balance** |
| No Rye | 644 | 72 | 376 | | 887 | 295 | 43 | | **-133** |
| Rye | 656 | 72 | 365 | | 872 | 138 | 39 | | **44** |
| Difference | 12 | 0 | -11 | | -15 | -157 | -4 | | **177** |

[1]Gaseous N losses other than $N_2O$ are not represented, erosion, runoff, and soluble organic N leaching losses assumed to be zero.
[2]N fertilizer applied only in corn years. Seed N inputs are included (38.2 and 51.4 kg N $ha^{-1}$ for NT and NT + Rye Cover, respectively).
[3]Symbiotic $N_2$ fixation measured in 2007 and 2009 was used to estimate 2005 $N_2$ fixation. Non-symbiotic fixation not measured or included in this estimate.

# Rye Cover Crop Effect on GWP Summary

| Component | GWP (No Rye – Rye) 6 year kg $CO_2$ eq ha$^{-1}$ | GWP (No Rye – Rye) Annual kg $CO_2$ eq ha$^{-1}$ y$^{-1}$ |
|---|---|---|
| SOC Storage | -7788 | -1298 |
| $N_2O$ - Direct | -1949 | -325 |
| $N_2O$ - Indirect | -574 | -96 |
| Planting | 18 | 3 |
| Seed Production | 36 | 6 |
| $CH_4$ Emissions | 0 | 0 |
| **Net GWP** | **-10257** | **-1710** |

# N Use Efficiency

- Fertilizer N use efficiency: (grain N / N applied)

  No rye = (442 / 606) * 100 = 72.9%

  Rye = (440 / 606) * 100 = 72.6%

- System N Use Efficiency (Corn & Soybean):

  [(plant N uptake – N loss) / N available]

  No rye = (1599-338)/2058 * 100 = 61.2%

  Rye = (2007-177)/2059 * 100 = 88.8%

# Final Thoughts

- Reduce fertilizer N use, but not at the expense of mining soil organic N.
- Potential for reducing direct $N_2O$ emissions through fertilizer management is controlled by rainfall.
- Cover crops provide a means for managing unmanageable N and reducing net GHG emissions.

# AMBITION

THE JOURNEY OF A THOUSAND MILES SOMETIMES ENDS VERY, VERY BADLY.