University of Saskatchewan

Nitrogen dynamics and nitrous oxide evolution in two Saskatchewan fields under irrigated and non-irrigated management

By: Aaron Mackay

Soil Nitrogen

- Nitrogen is an important and mobile macronutrient for plant growth
- Keeping nitrogen in the soil and available for plant uptake can be a challenge
- One common means for the escape of Nitrogen from the soil system is by evolution into nitrous oxide (N_2O)

Soil N_2O

- There are three common pathways for nitrous oxide (N_2O) production

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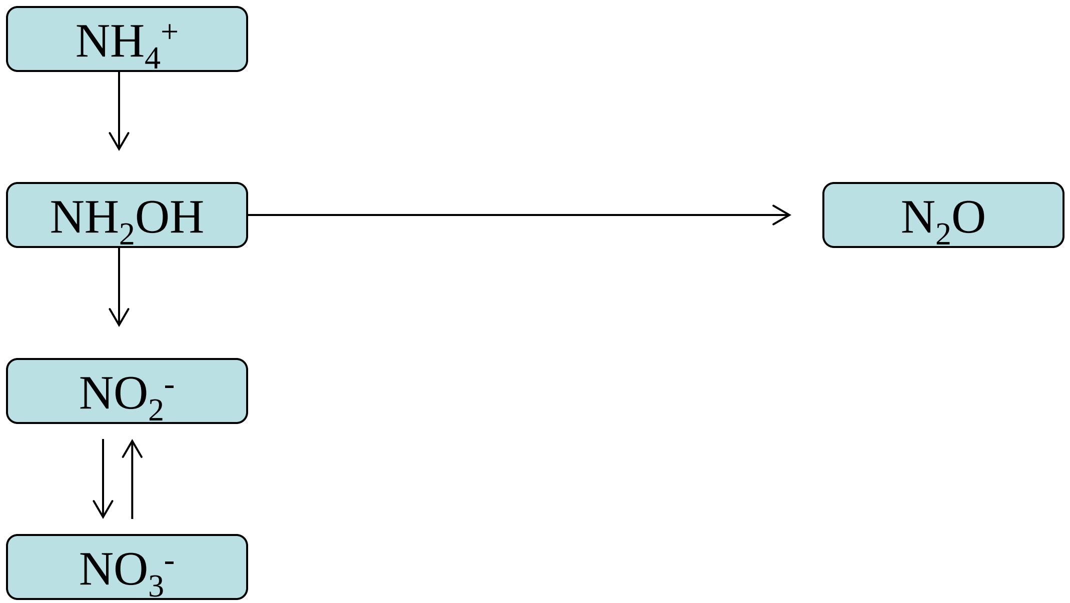

Soil N_2O

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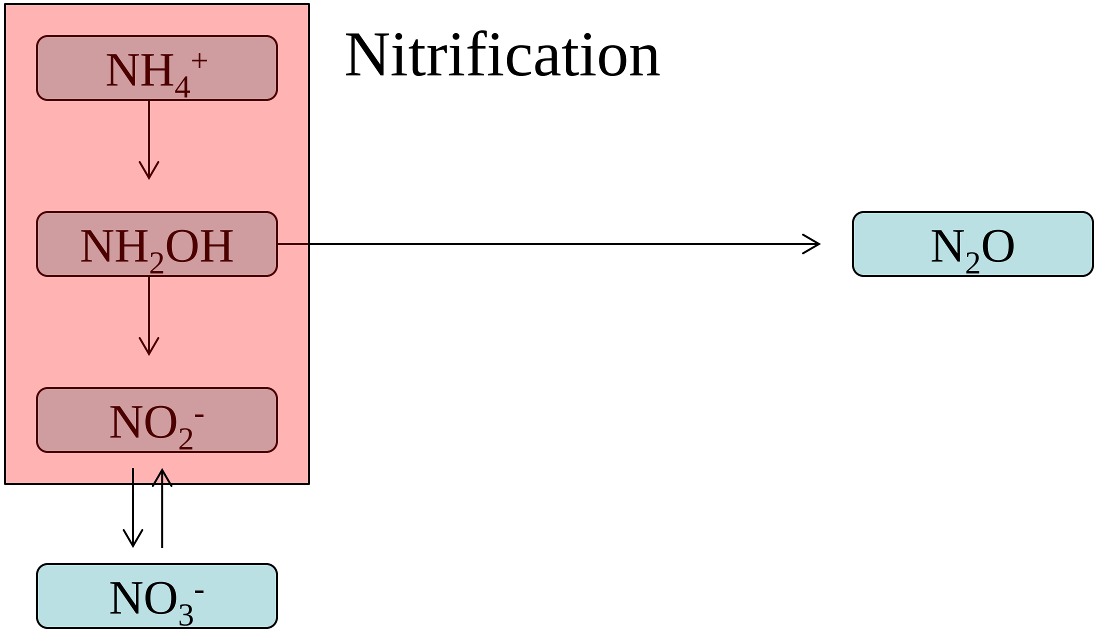

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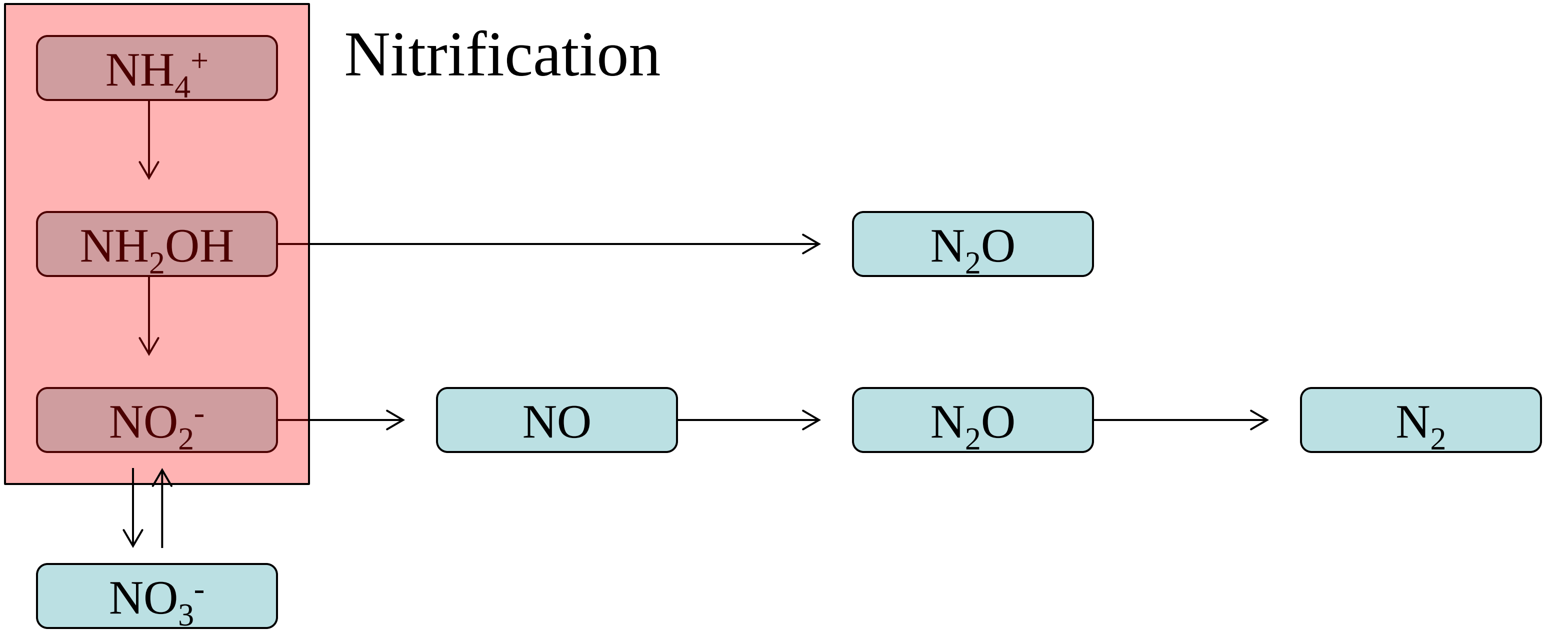

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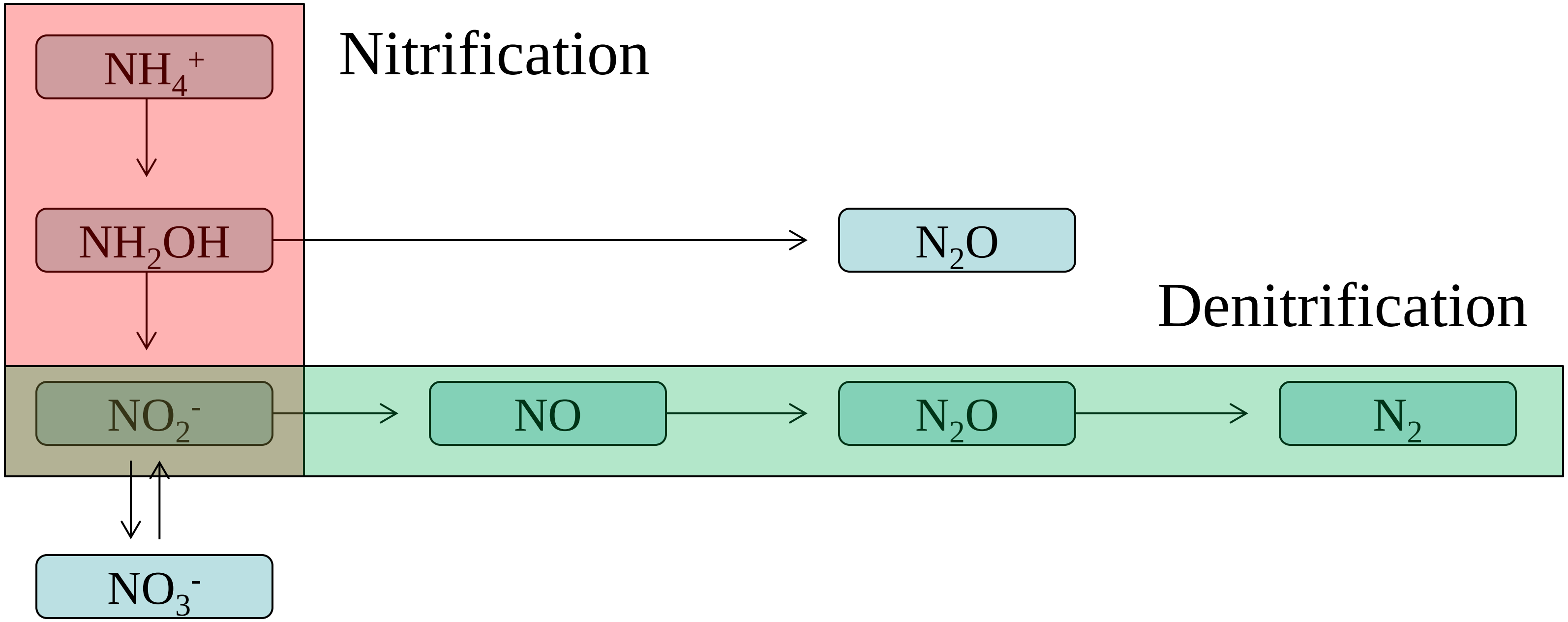

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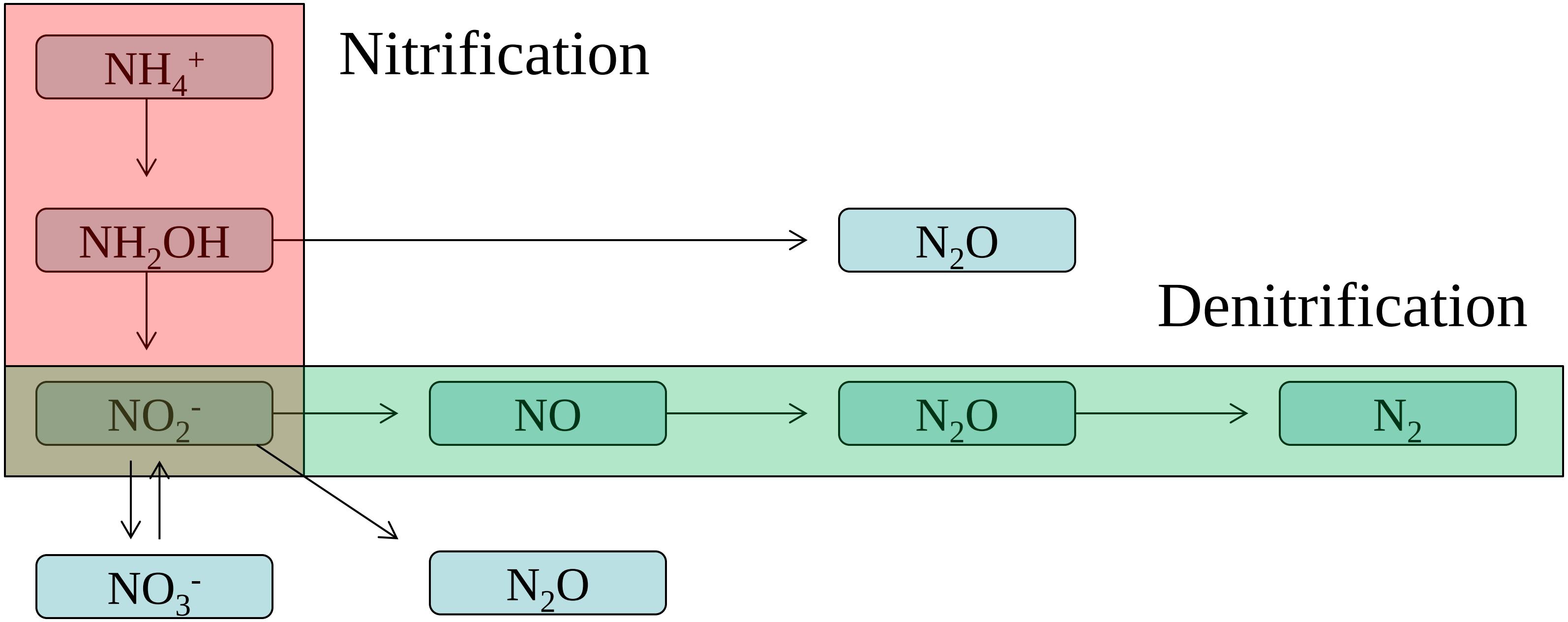

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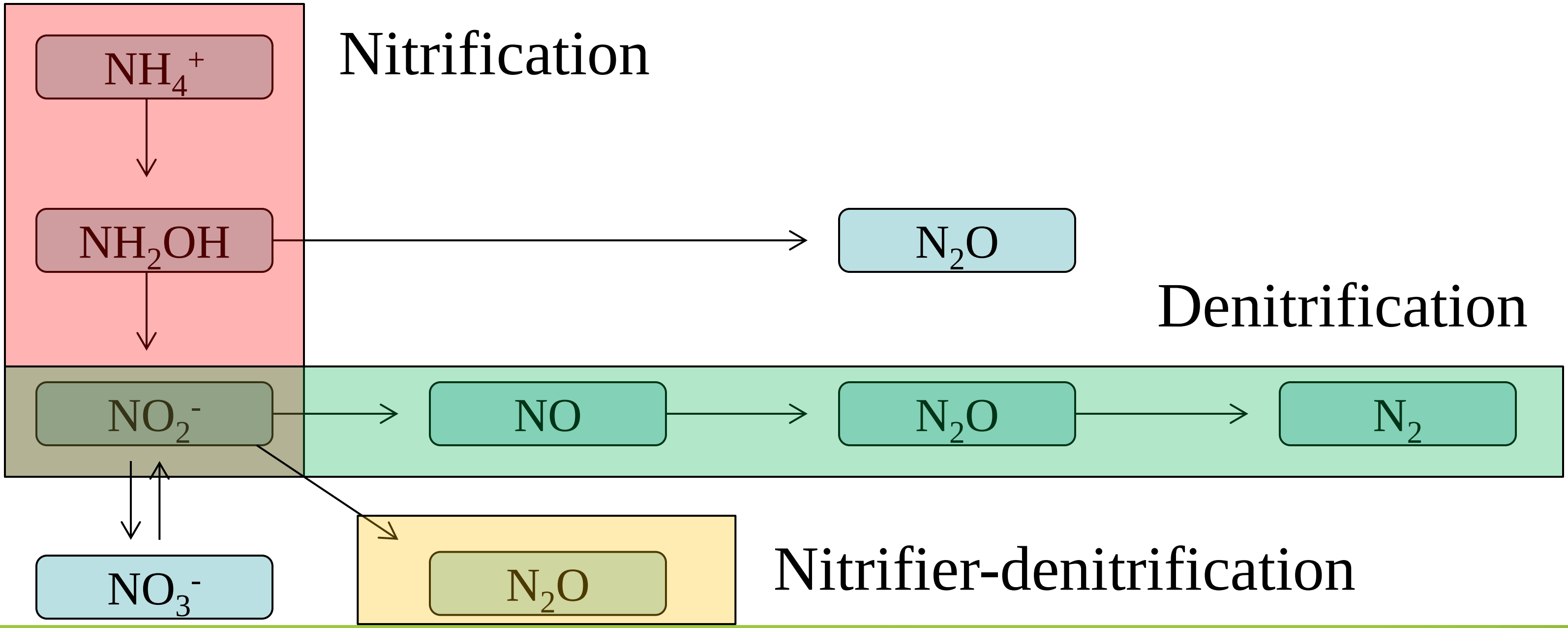


Irrigation

- Since moisture is important in determining which pathway the N_2O evolves from irrigation has great potential to affect N_2O emissions

Photo by: Cody David (2012)

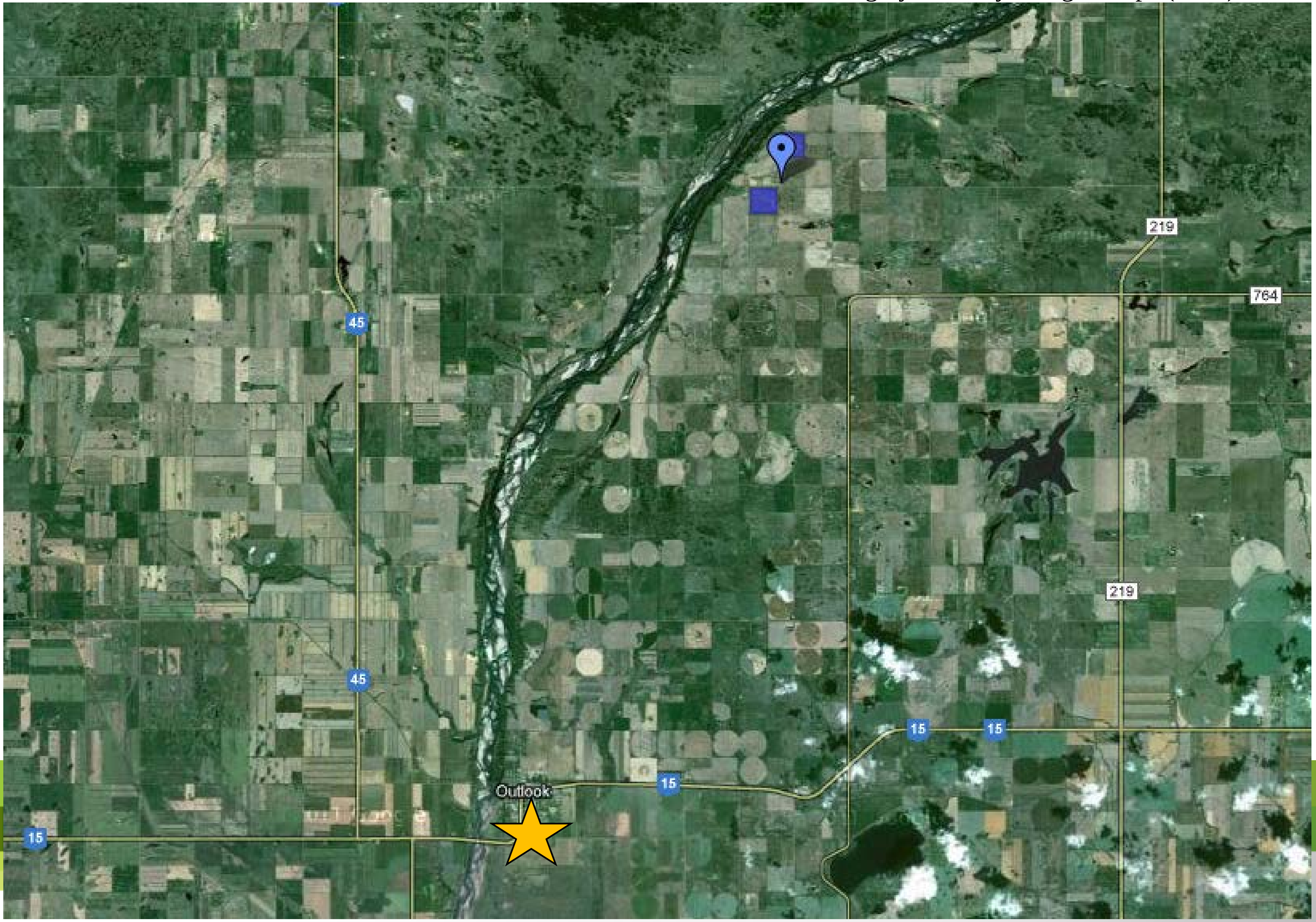
Research

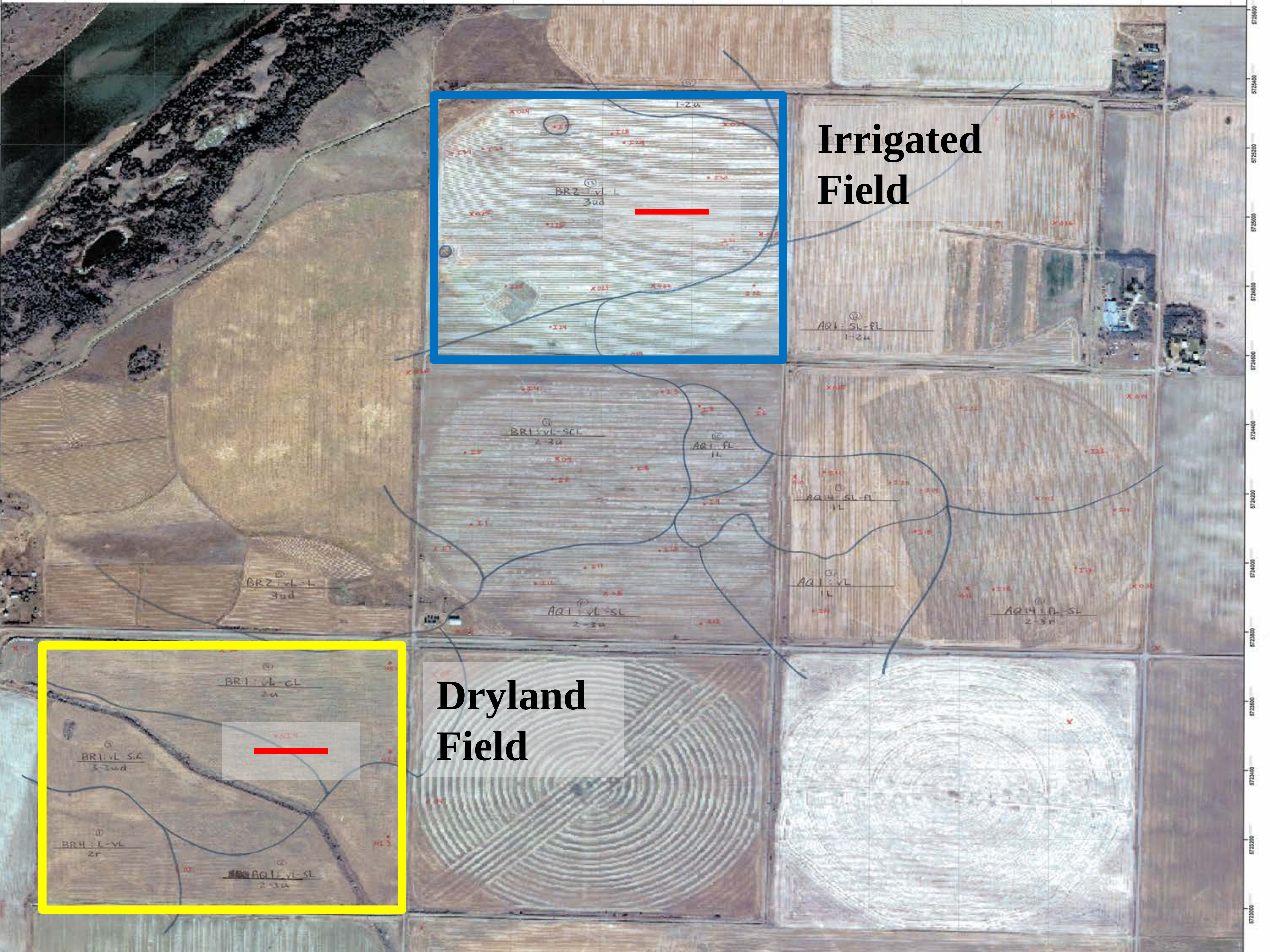
- N_2O emissions are an environmental and economic liability
- Irrigated production has the potential to lead to higher yields but also has the potential to increase N_2O emissions

Methods

The Site

Imagery courtesy Google Maps (2013)




Irrigated Field
Dryland Field

Field Setup

Field Setup

- 125 m transects

Photo by: Cody David (2012)

Field Setup

- 125 m transects
  - 20 gas chambers per transect; 6.5 m interval

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Field Setup

- 125 m transects
  - 20 gas chambers per transect; 6.5 m interval
  - PRS™ Probes at every chamber
  - Plant samples taken prior to harvest

Photo by: Cody David (2012)

Field Setup

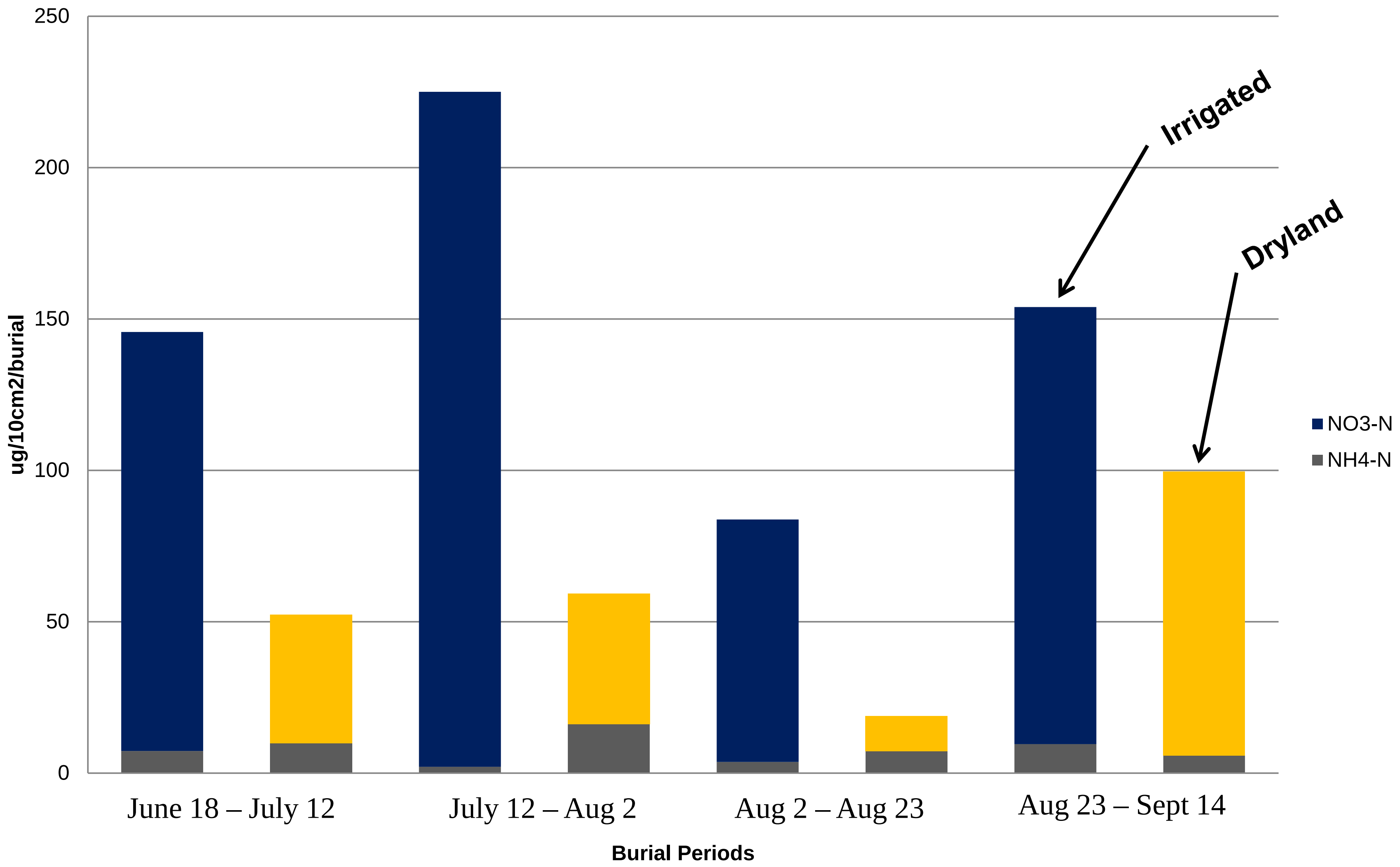
- Rectangular acrylic chambers that are inserted into the ground
- Leave a 10 cm headspace for gas to accumulate in
- A sample is extracted at 15, 30 and 45 minutes after the lid is secured

Picture by Jui Ferdous (2012)

Field Setup

- Collaborator managed the two fields as he does in a normal year
  - Dryland field received 65 lbs / acre of nitrogen fertilizer
  - Irrigated field received 98 lbs / acre of nitrogen fertilizer

Results



250
200
150
100
50
0
ug/10cm2/burial
Irrigated
Dryland
NO3-N
NH4-N
June 18 – July 12
July 12 – Aug 2
Aug 2 – Aug 23
Aug 23 – Sept 14
Burial Periods

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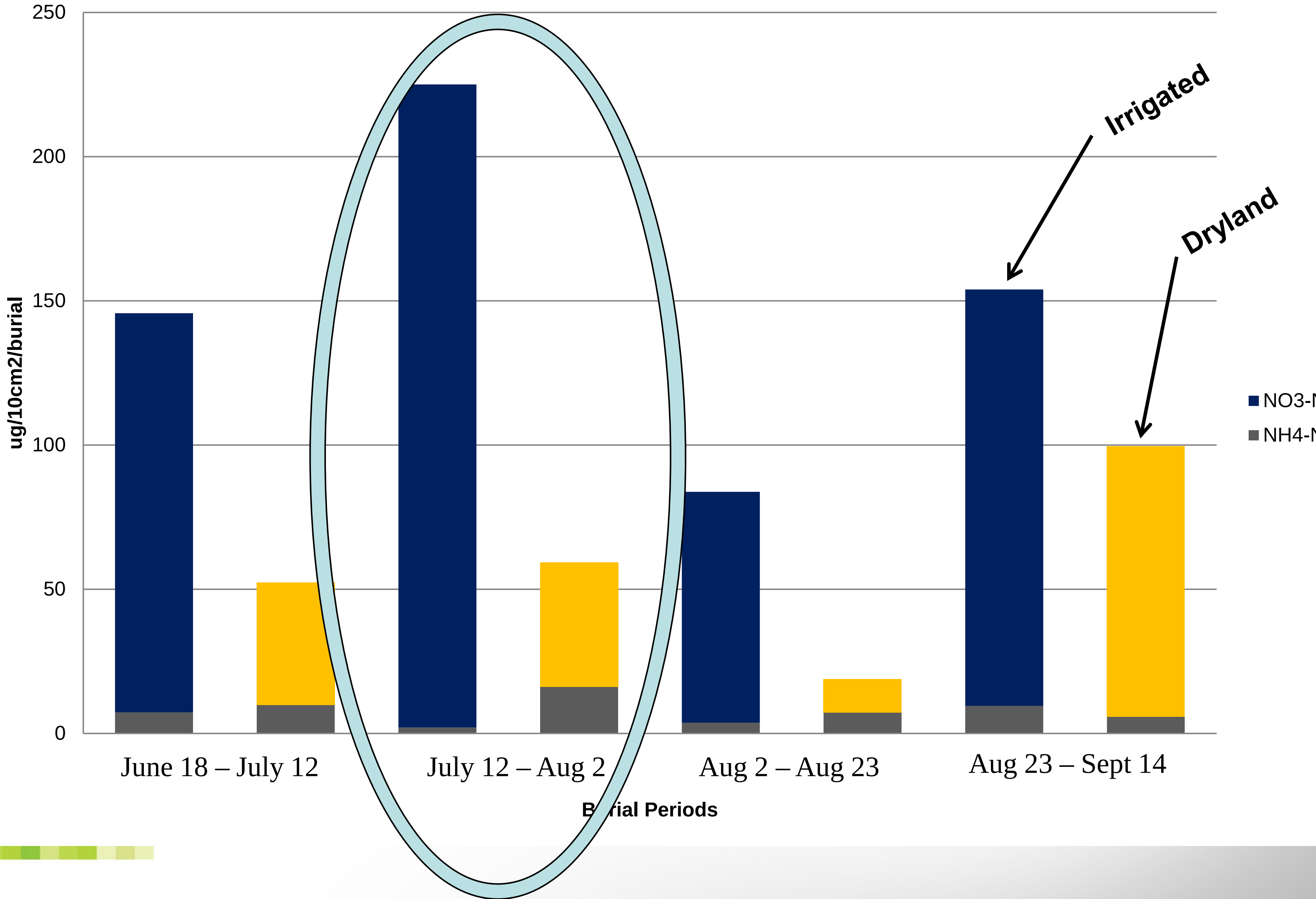
Results



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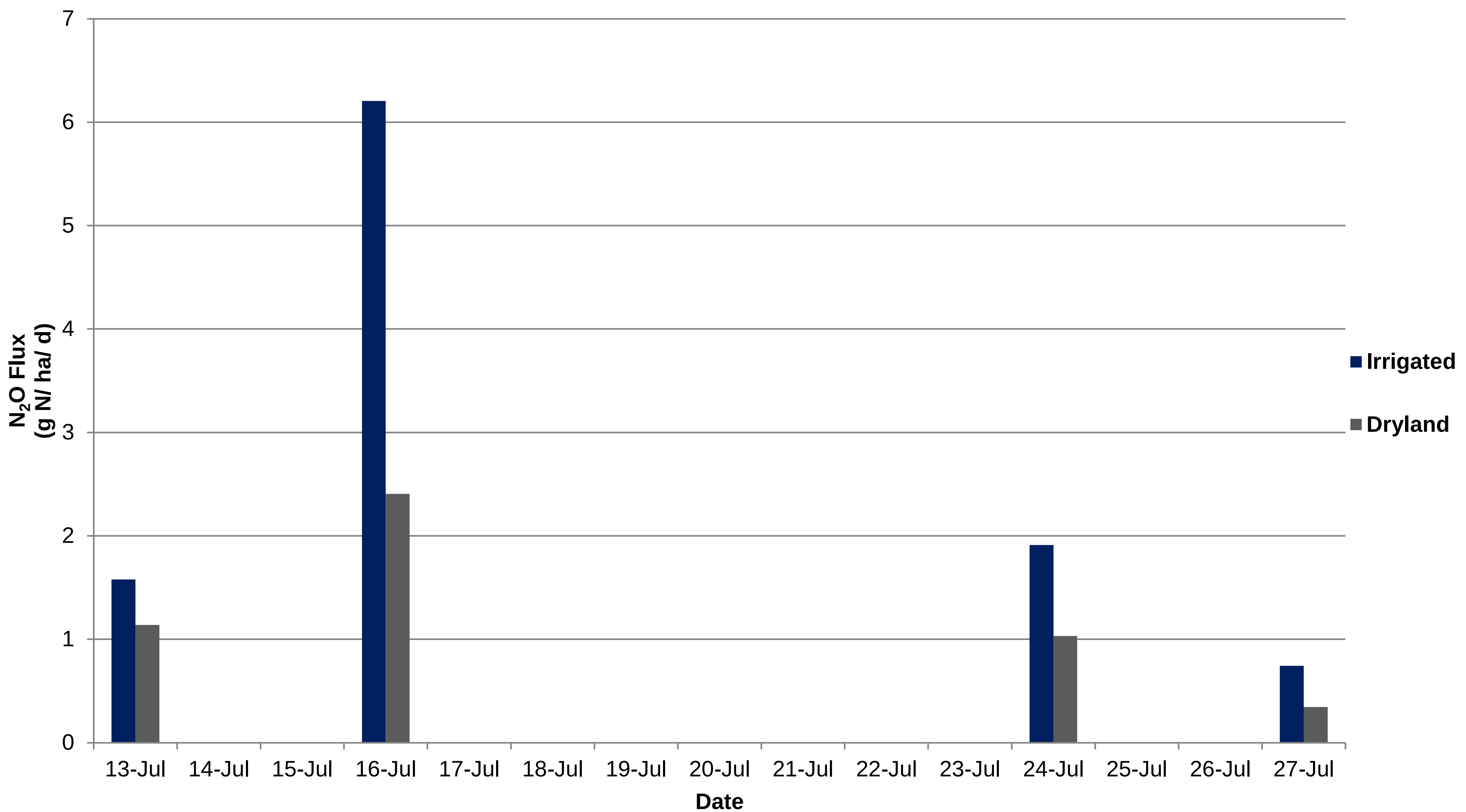
Results - N_2O



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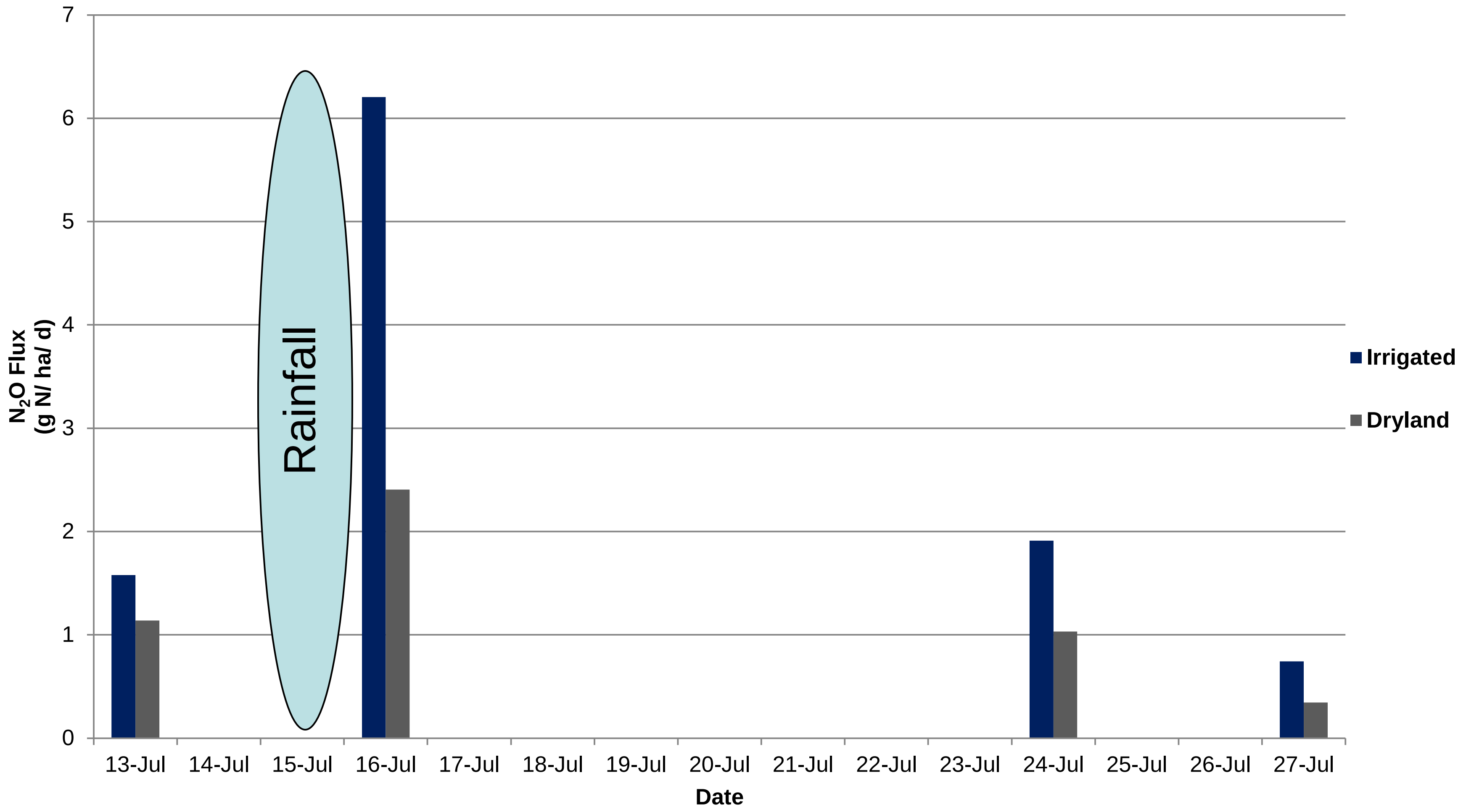


7
6
5
4
3
2
1
0
N2O Flux (g N/ ha/ d)
Rainfall
13-Jul
14-Jul
15-Jul
16-Jul
17-Jul
18-Jul
19-Jul
20-Jul
21-Jul
22-Jul
23-Jul
24-Jul
25-Jul
26-Jul
27-Jul
Date
Irrigated
Dryland

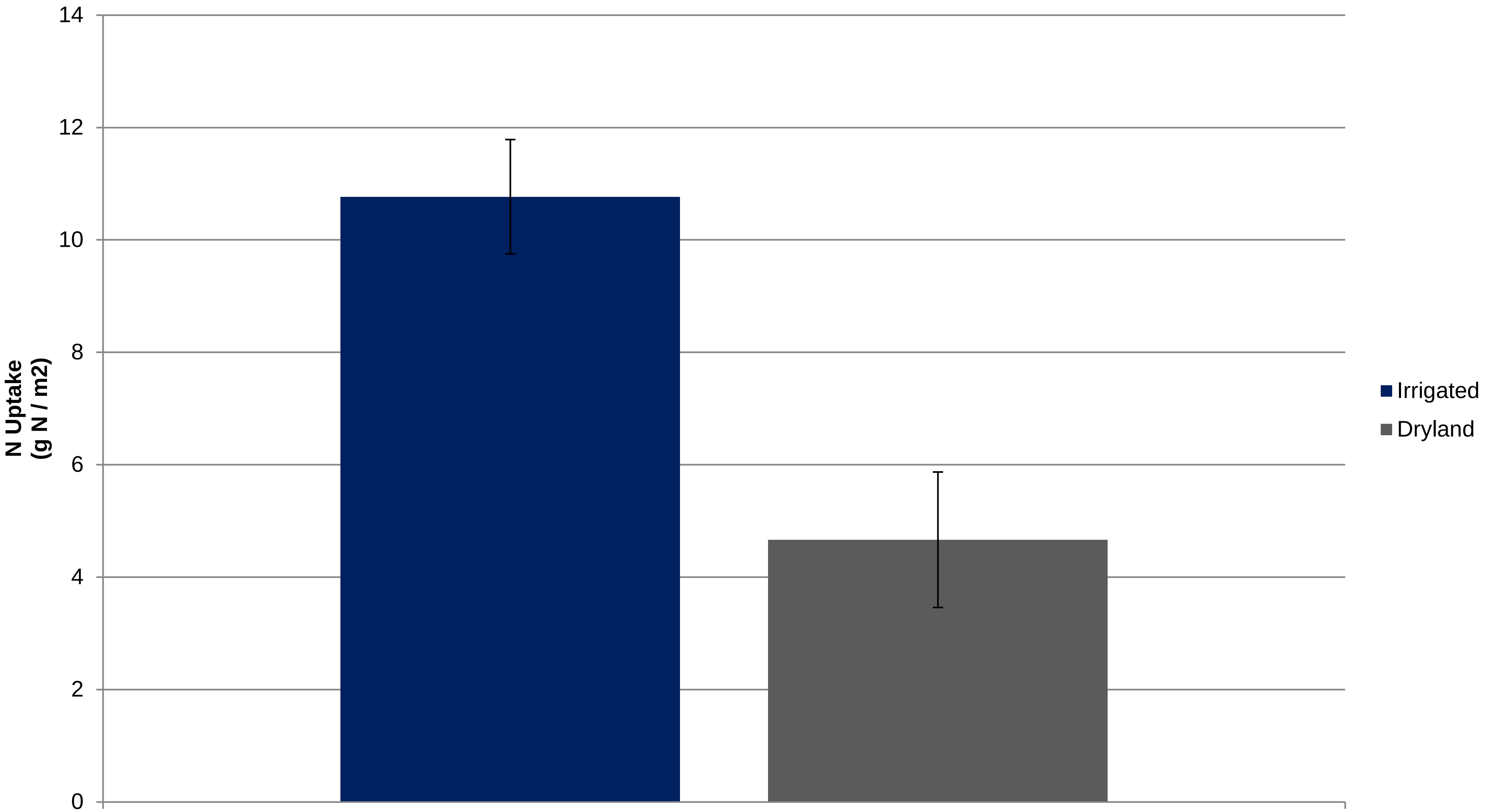
Results

- This trend was also evident in a laboratory experiment
- Used an acetylene block to force denitrification to occur
- Measured how quickly the soil community was able to convert a nitrogen source to N_2O

Results

- By the end of the run samples from the irrigated field were producing N_2O 2-3 times faster than the dryland samples

Results – Plant N Uptake



Conclusion

- Irrigated fields can produce higher yields than dryland fields when conditions are right for plant growth
    - However the soil community in irrigated fields can also favor denitrifying microorganisms
    - This can result in large losses of applied N if there is a large reserve of inorganic N in the soil

Future Research

- Measuring what pathway of the nitrogen cycle is causing the evolution of N_2O in the field using new techniques
- Examining whether mobile nutrients are being leached out of the rooting zone
- Exploring whether irrigated management has an effect on the mineralization rate of the field

Acknowledgements

Supervisors:

- Richard Farrell
- Reynald Lemke

Collaborator:

- Garth Weiterman

Funding Agency:

- Agriculture and Agri-Food Canada Agricultural Greenhouse Gas Program (AGGP)

Technical Support:

- Cody David and Jui Ferdous
- Darrell Hahn, Frank Krijnen and Darin Richman
- The University of Saskatchewan

- Questions?