

Winter Cover Crop Impacts on Erosion and Nitrate Losses in Tile Drainage

Cover Crops and Soil Health: Harvesting the Potential
Environmental Impacts of Cover Crops Session
Tuesday Feb. 18, 2014



USDA-ARS
National Laboratory
for Agriculture and
the Environment
Ames, Iowa

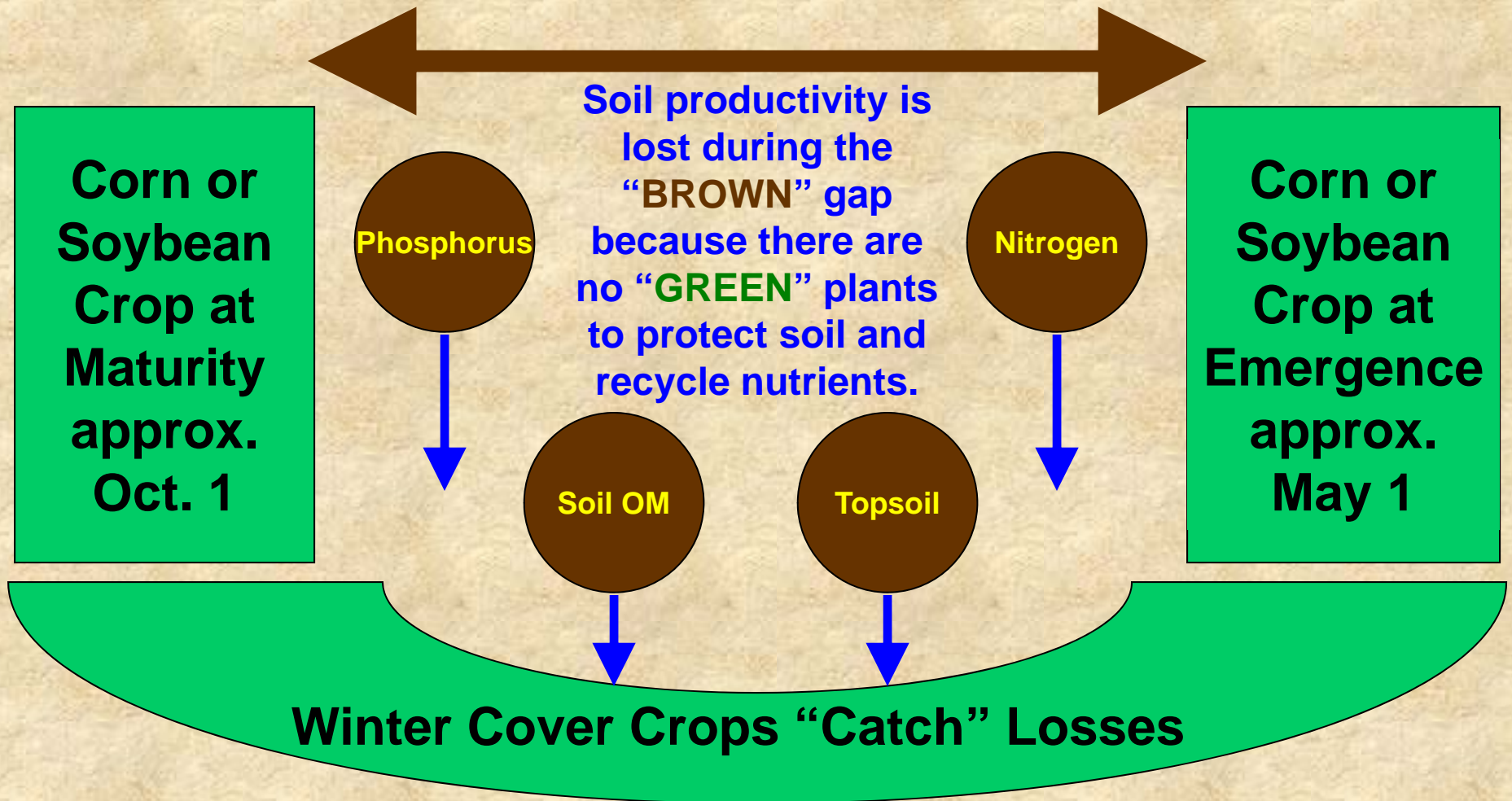
Tom Kaspar
Ben Knutson
Keith Kohler
Kent Heikens
Dan Jaynes
Tim Parkin
Tom Moorman
Rob Malone



Rye after Corn Silage



Corn and Soybeans have a 7 Month “BROWN” Gap



Cover Crops Fill the “BROWN” Gap with “GREEN” Plants

Erosion Measurements with Simulated Rainfall



NO COVER CROP



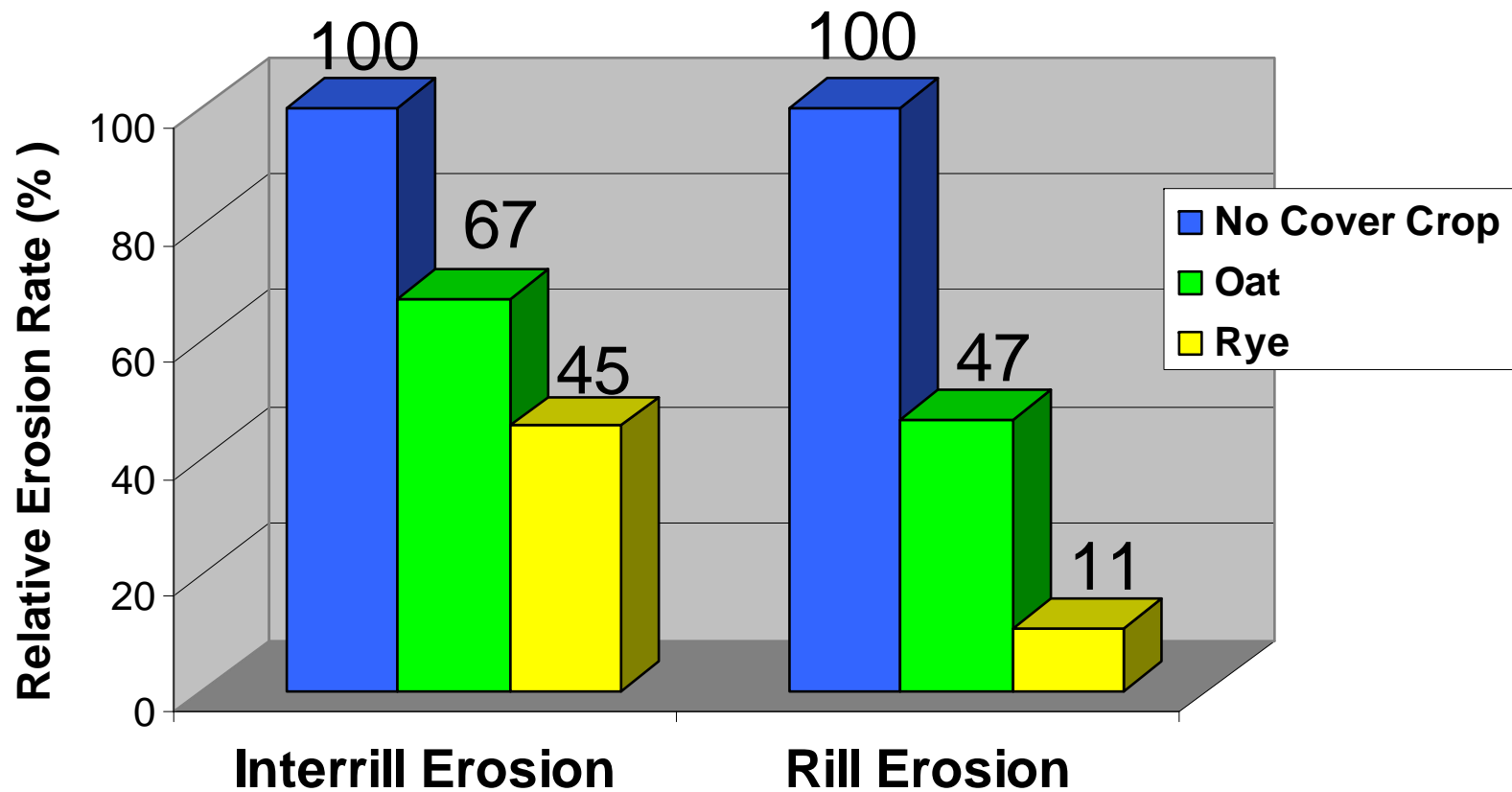
OAT COVER



RYE COVER

Relative Erosion

Relative Rill and Interrill Erosion Rate in No-till Soybean as Affected by Cover Crops



Kaspar et al., 2001, J. Soil Water Conserv.



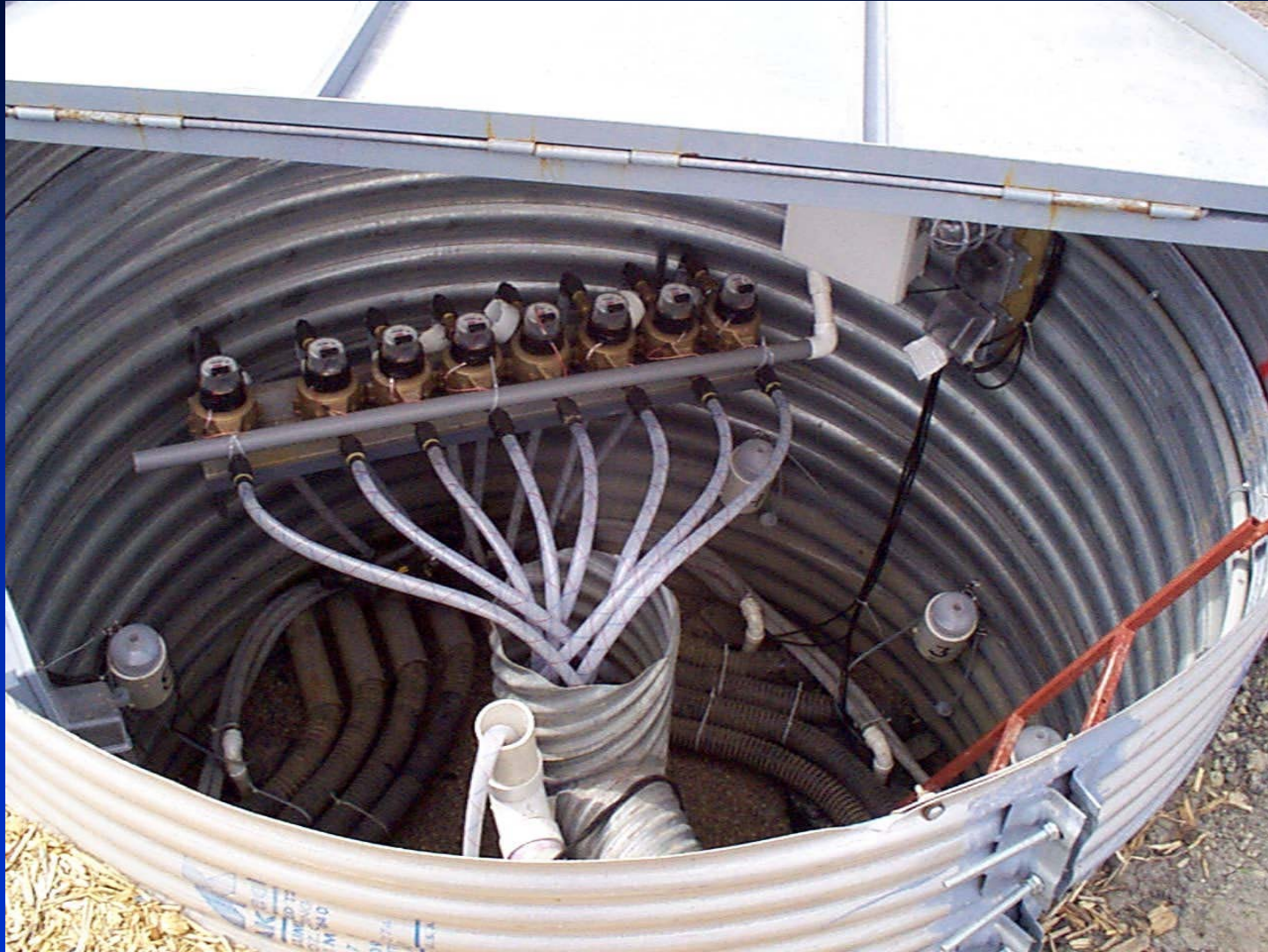
Nitrate Loss in Tile Drainage



Nitrate Loss in Tile Drainage Measurements



Flow Meters & Sample Collectors



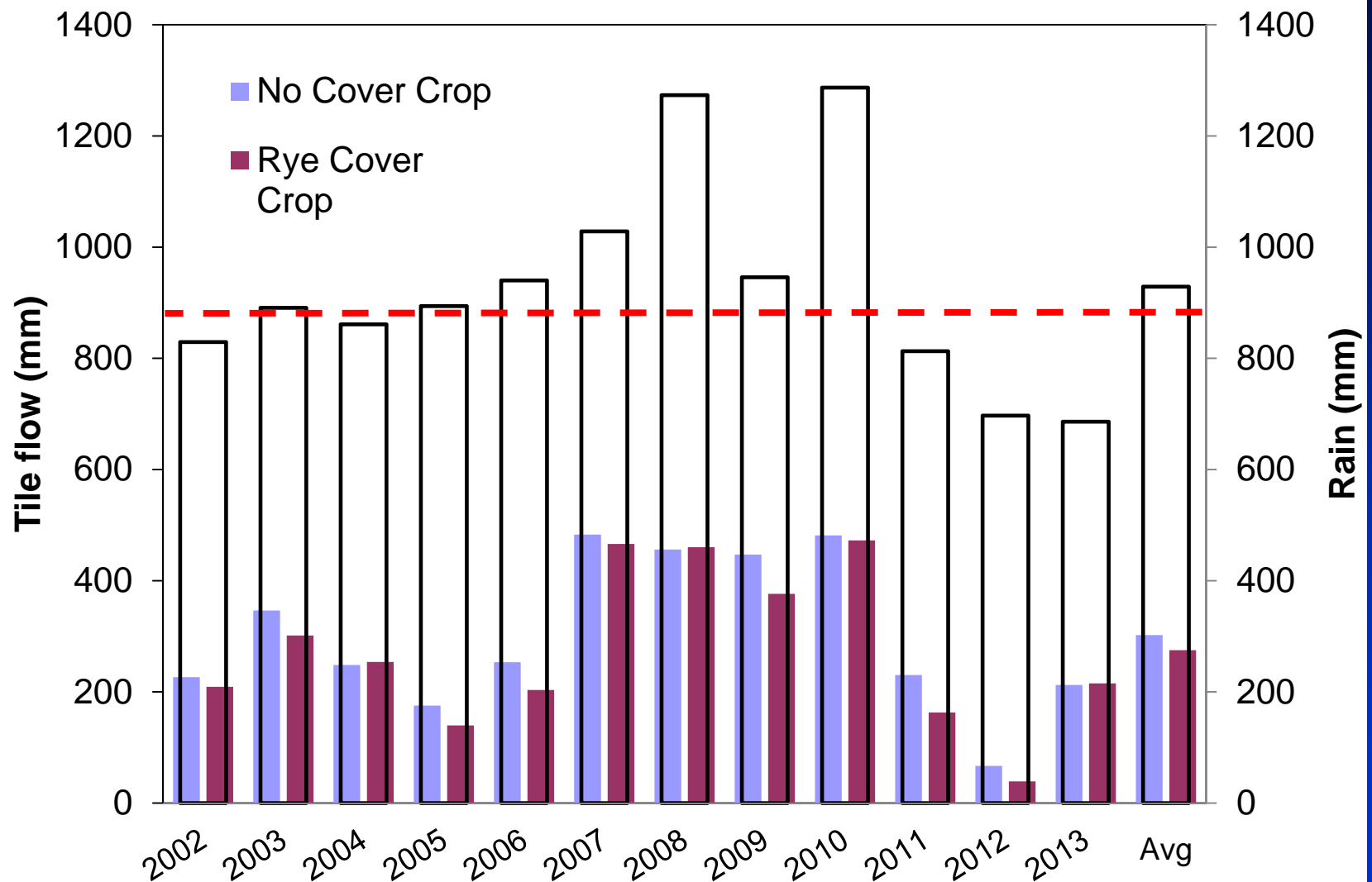
Kaspar et al. J. Environ. Qual. 36:1503-1511.

KELLY PLOT 13 SOY/RYE CC 4-16-04



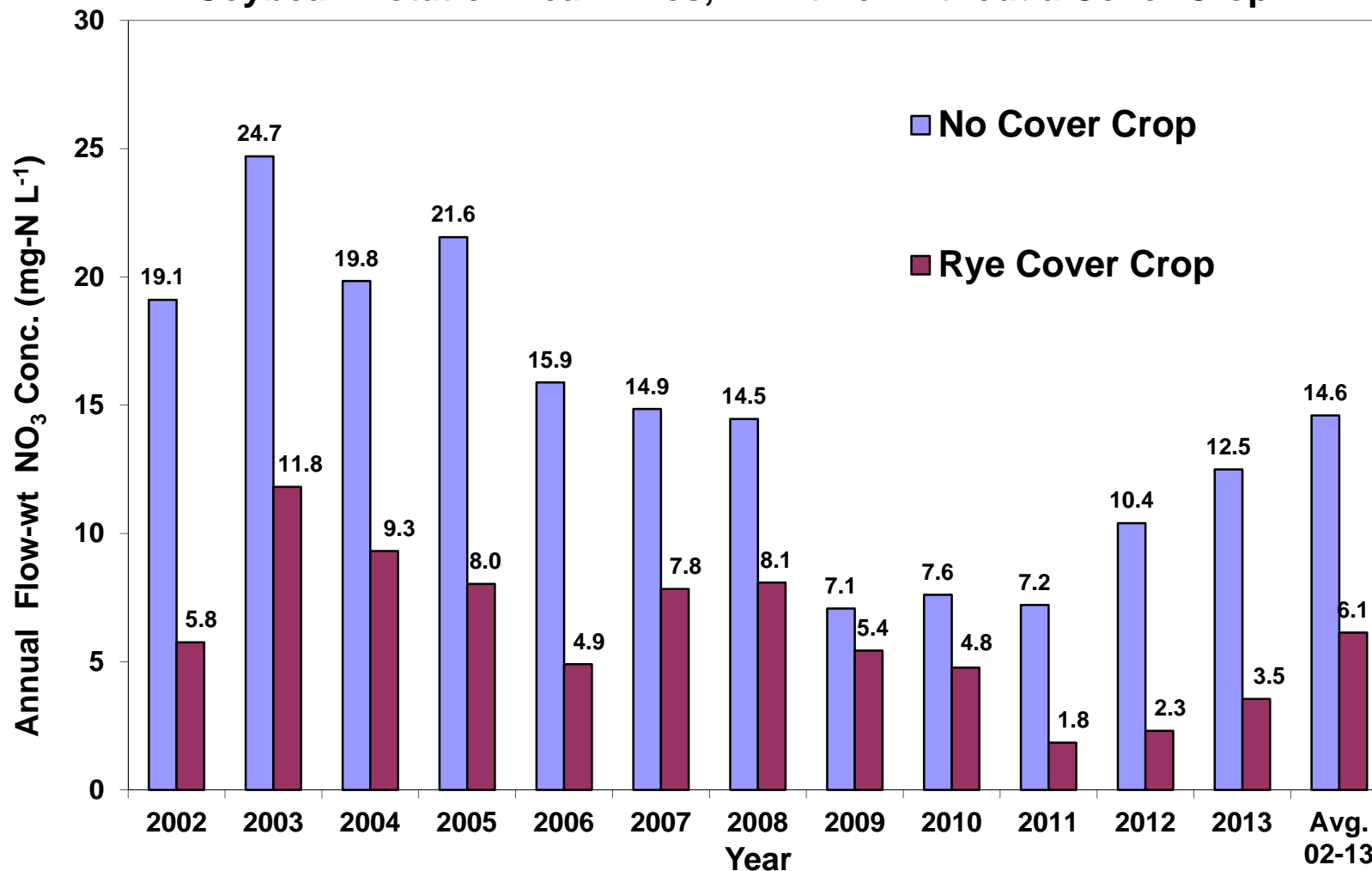
APR 16 2004

Cumulative Annual Drainage



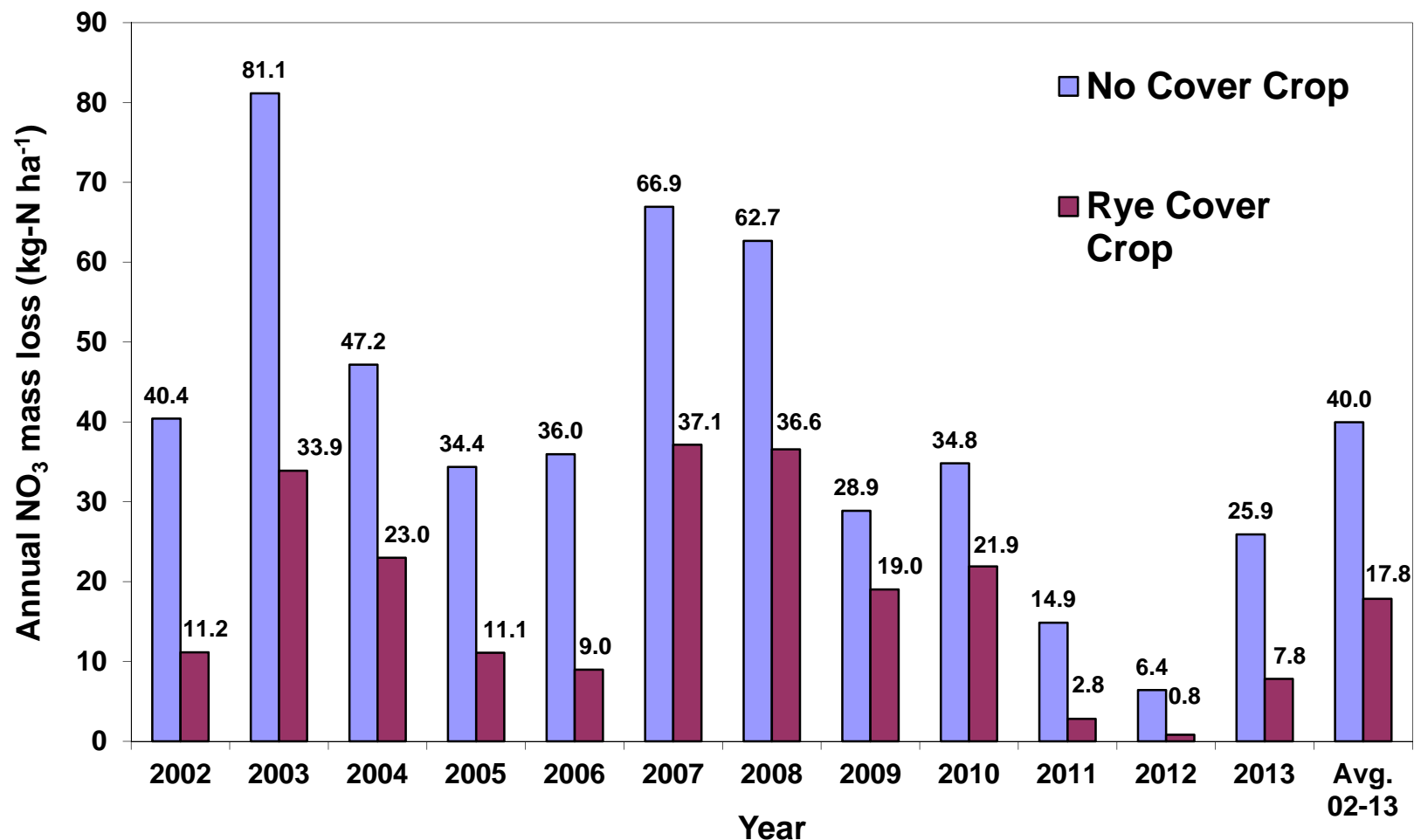
Nitrate-N Concentration

Annual Flow-wt NO₃ Concentration of Tile Drainage for Corn-Soybean Rotation near Ames, IA with or without a Cover Crop



Cumulative Nitrate-N Load

Annual N Loss in Tile Drainage for a Corn-Soybean Rotation With and Without a Rye Cover Crop



Total Nitrate-N Lost 2002-2013

<u>Treatment</u>	<u>Nitrate-N Lost</u>	
	<u>12-yr sum</u>	<u>12-yr avg.</u>
	----- kg/ha -----	
Corn-soybean	480	40
Corn-soybean with rye	<u>214</u>	<u>18</u>
Total Reduction	266	22
<u>% Reduction</u>	<u>55%</u>	

	Cover Crop Shoot Biomass	Cover Crop Shoot N Concentration	Cover Crop Shoot N Content	Cover Crop Reduction of Drainage N Loss
	Mg/ha	%	kg N/ha	kg N/ha
Avg 02-13	1.71	2.86	42.7	22.1
Sum 02-13	20.52		512.2	265.4

Estimated Change in Soil Total N Balance over 4 years (2002-2005)

Fertilizer N added

Estimated N Fixation by Soybean - estimate relative to yield

N in Rainwater

N Removed in Grain

N Lost in Drainage Water

Change in Inorganic Soil N

Gaseous losses of N - ?????? – assume not different

Corn-Soybean with rye cover crop increased 82 kg N/ha

Corn-Soybean without cover crop decreased -18 kg N/ha

Change in total soil N - ??????

So where is the nitrogen the cover crops took up?

Can N fertilizer rates be decreased at some point in the future?

Will losses of N in drainage increase after cover crops have been used for many years?

Do soybeans fix more or less N when following rye or oat cover crops?

Good questions without good answers.

Reduction of Nitrate Leaching with Rye – Four Other Iowa Sites

- Nashua, Iowa 22 – 29%
- Gilmore City, Iowa 15 -20%
- COBS Experiment, Kelly, Iowa 36%
- Tim Smith farm, Eagle Grove, Iowa 48%

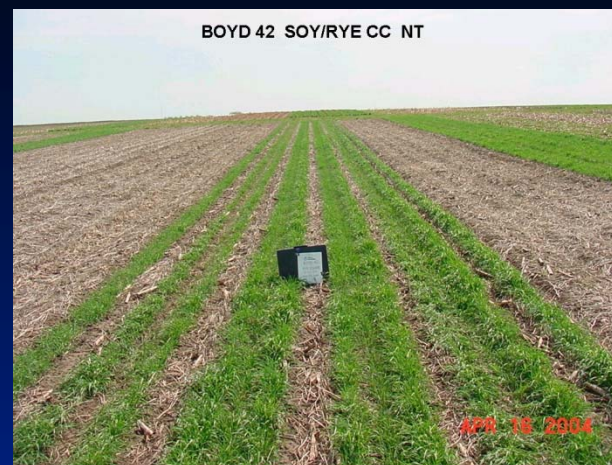
Data from Matt Helmers, Eileen Bader, Tim Smith, and A.L. Daigh

Why Does Cover Crops Effectiveness Vary from Site-to Site?

- Would expect it to vary
- Different amounts of cover crop growth
- Different weather at the sites
- Different soil types – OM, texture
- Tile spacing, tile depth, effectiveness
- Different crop management
- Different field history

Nitrogen Summary

- Winter cover crops reduce N losses in tile drainage by taking up N and reducing nitrate concentrations in soil and drainage water. There is some lag between cover crop N uptake and reduced nitrate concentrations.
- Winter cover crops don't seem to have a large impact on the total annual amount of drainage, but could have seasonal effects.
- Impact of cover crops on nitrate losses depends on cover crop growth, soil type, weather, and when drainage occurs.



Questions?

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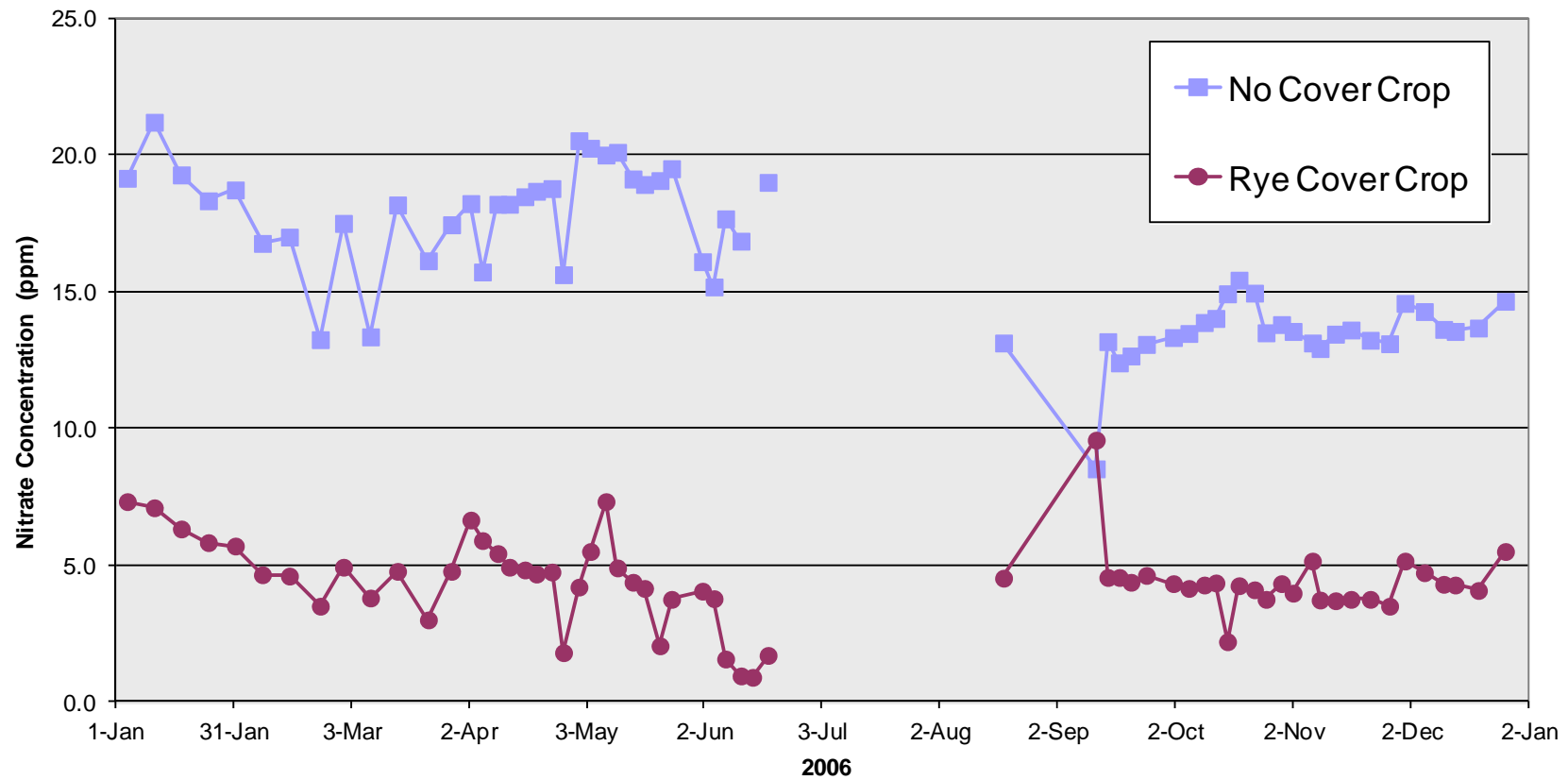
RUSLE2 Erosion Estimates Using Beta Version of Cover Crop Vegetation Files

- Corn–Soybean rotation, NT, spring anhydrous, 5% slope, 150 ft slope length, Ames, IA
 - without rye cover crop = 2.1 t/ac/yr
 - with rye cover crop = 1.2 t/ac/yr
- Continuous Corn Silage, NT, spring anhydrous, 5% slope, 150 ft slope length, Ames, IA
 - without rye cover crop = 4.8 t/ac/yr
 - with rye cover crop = 1.9 t/ac/yr

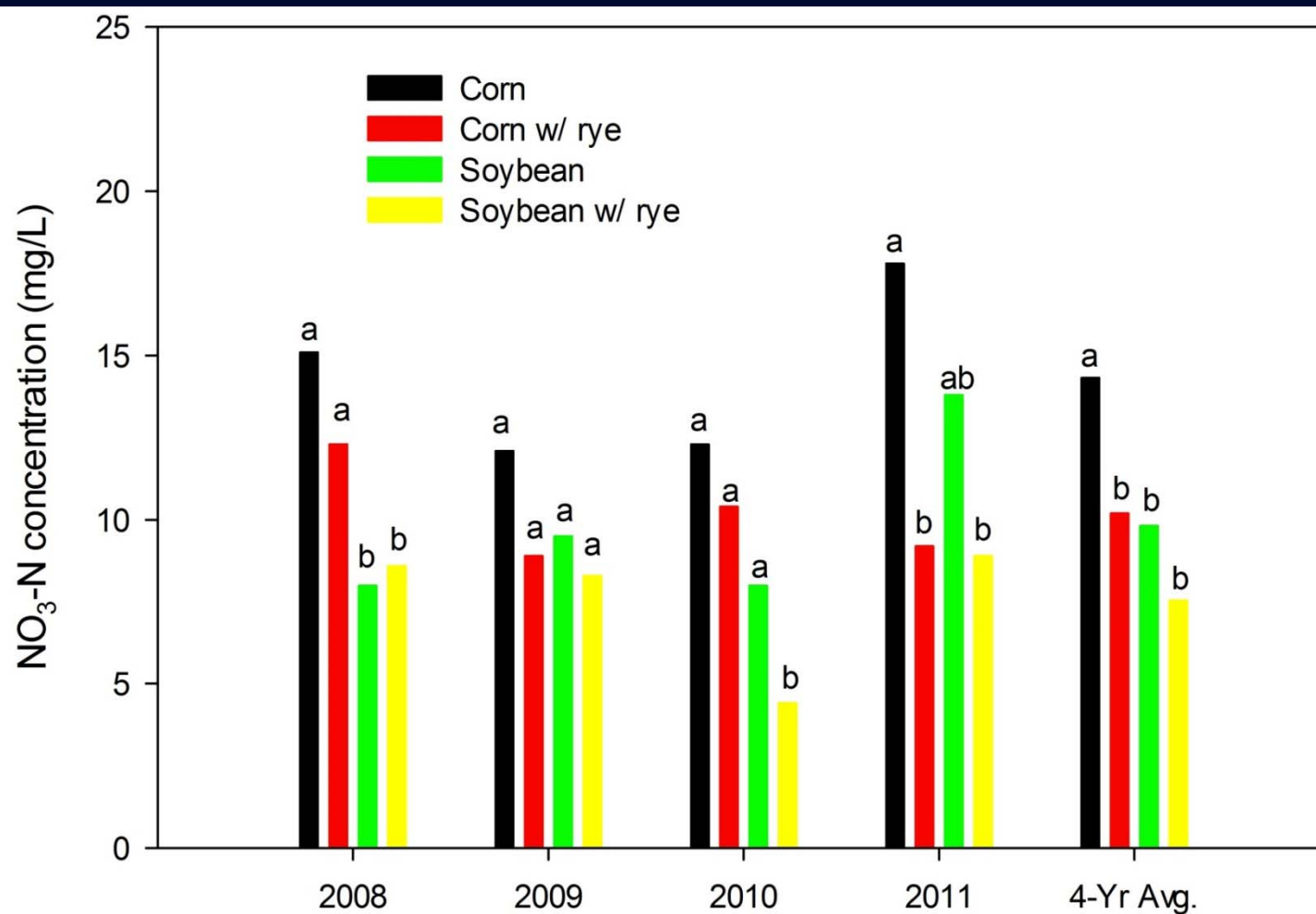
Rye Cover Crop Effect on Soil Quality in a Corn Silage System after 10 years

- A rye cover crop increased total soil organic matter (SOM) in the top 4 inches from 4.8% to 5.3% or $\frac{1}{2}\%$ change in SOM
- Very rough estimates would say a $\frac{1}{2}\%$ change in SOM would result in an additional $\frac{1}{2}$ inch of water and 11 kg/ha of mineralized soil N.
- 48% greater Potential N mineralization
- Rough estimates would say this would be 9-11 kg/ha of mineralized soil N.
- These are really hard measurements to make

2006 Nitrate Concentration of Tile Drainage Water Over Time



Impacts of Cover Crops – Nashua

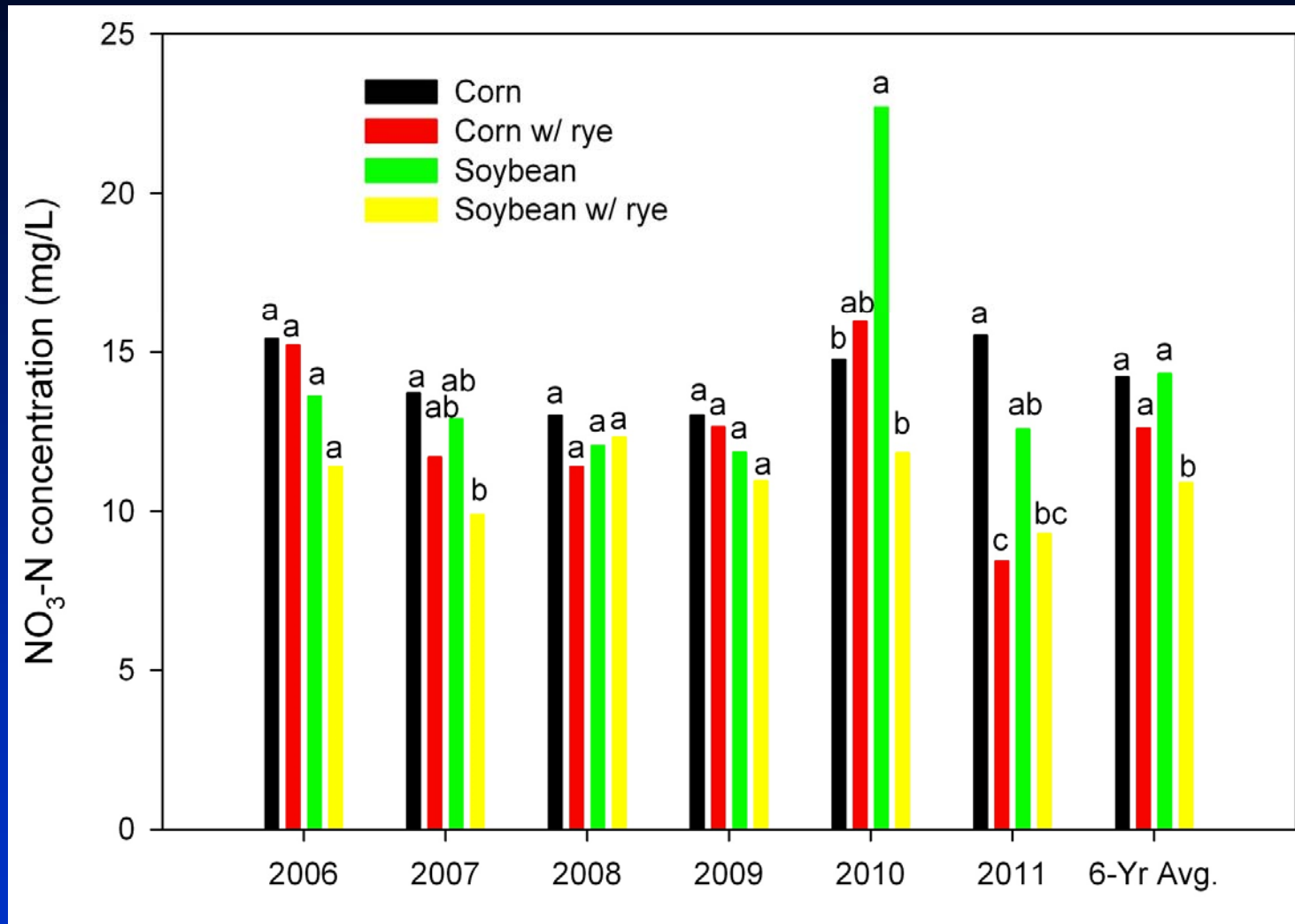


Matt Helmers Iowa State University

29% reduction in corn
22% reduction in soybean



Impacts of Cover Crops – Gilmore City



~15-20% Reduction in Nitrate-N Concentration
With Annual Rye Cover Crop

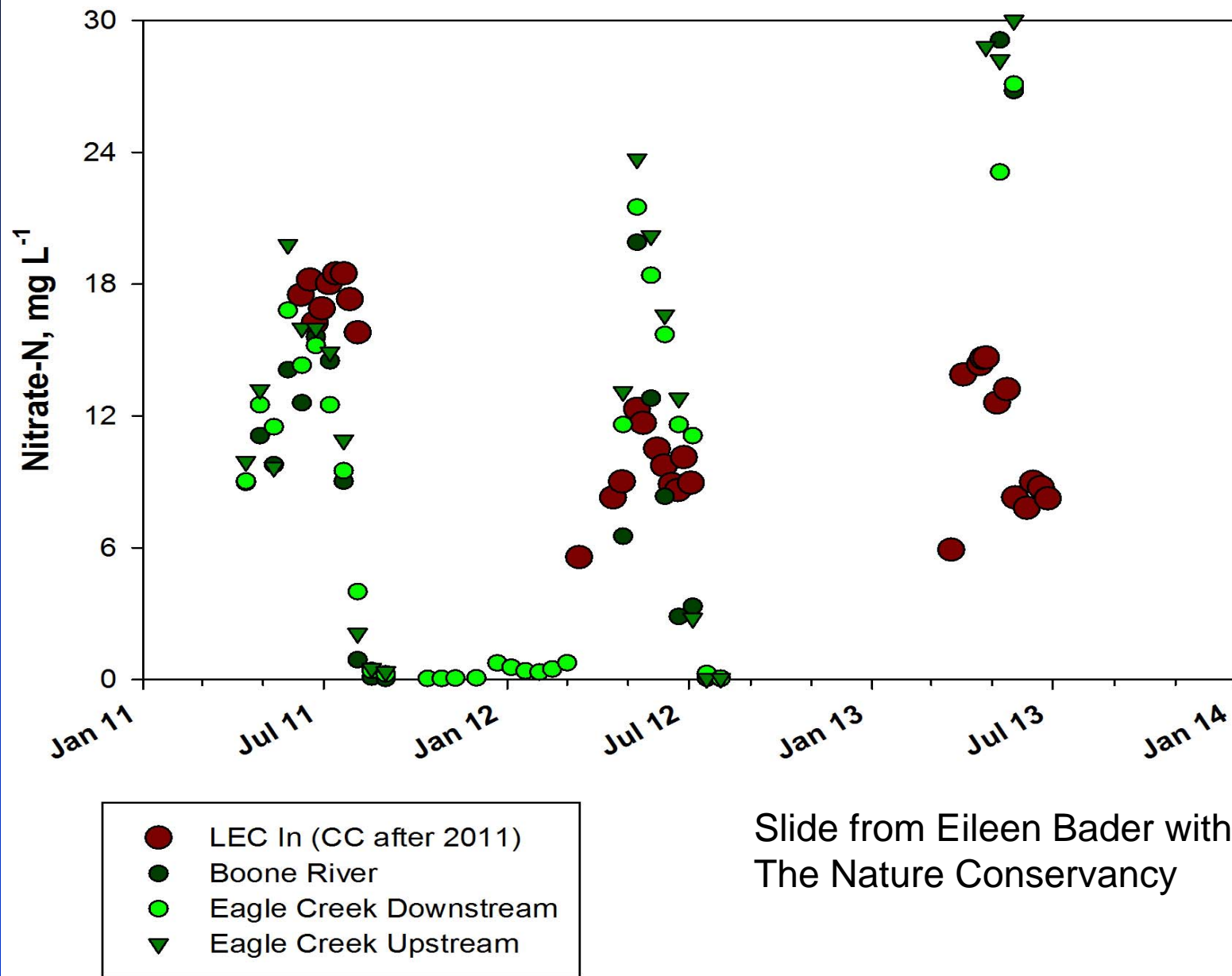
Matt Helmers Iowa State University



Impacts of Cover Crops – COBS site Ames

Treatment	3-Year Avg. Nitrate-N Lost	
	Conc <u>mg/L</u>	Load <u>kg/ha</u>
Continuous corn	8.3	12.4
Continuous corn with winter wheat cover crop	<u>5.3</u>	<u>4.0</u>
Total Reduction	3.0	8.4
<u>% Reduction</u>	36%	68%

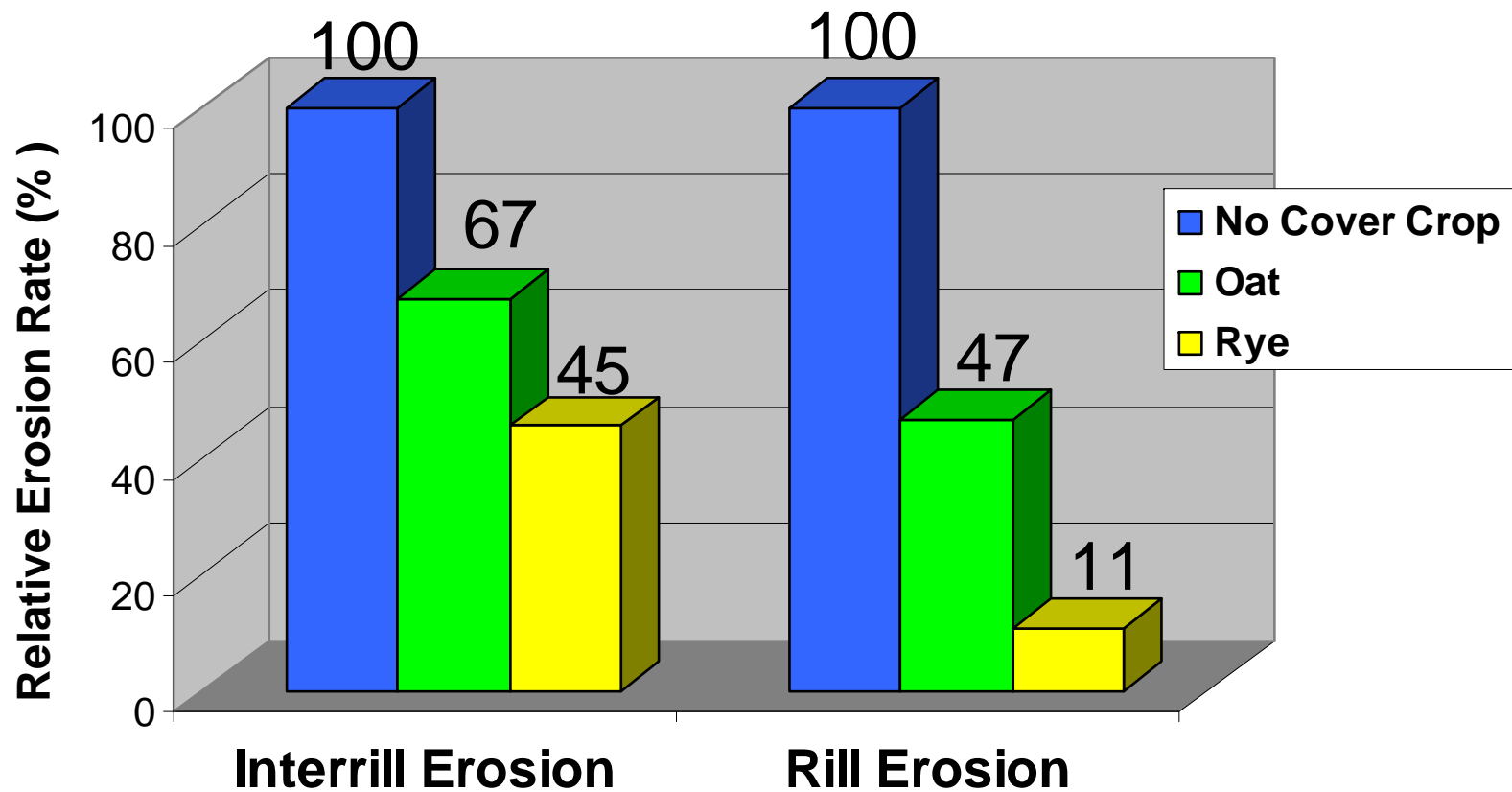
Multiple Scale Monitoring



Slide from Eileen Bader with
The Nature Conservancy

Relative Erosion

Relative Rill and Interrill Erosion Rate in No-till Soybean as Affected by Cover Crops



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