Benchmarking yield and input-efficiency of irrigated corn in the Tri-Basin NRD

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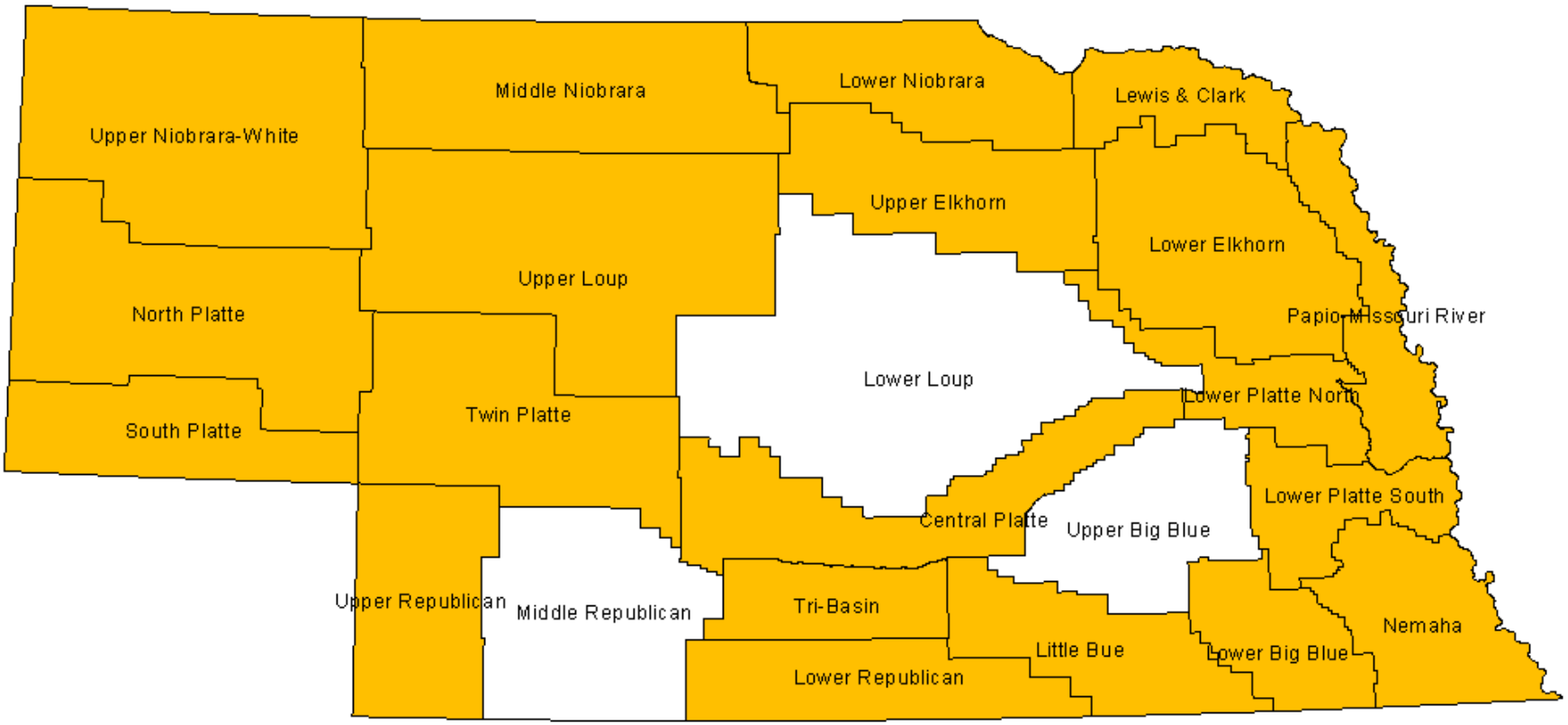
Department of Agronomy and Horticulture
University of Nebraska-Lincoln

Nebraska Natural Resources Districts (NRD)

20 of 23 NRDs collaborated on this project



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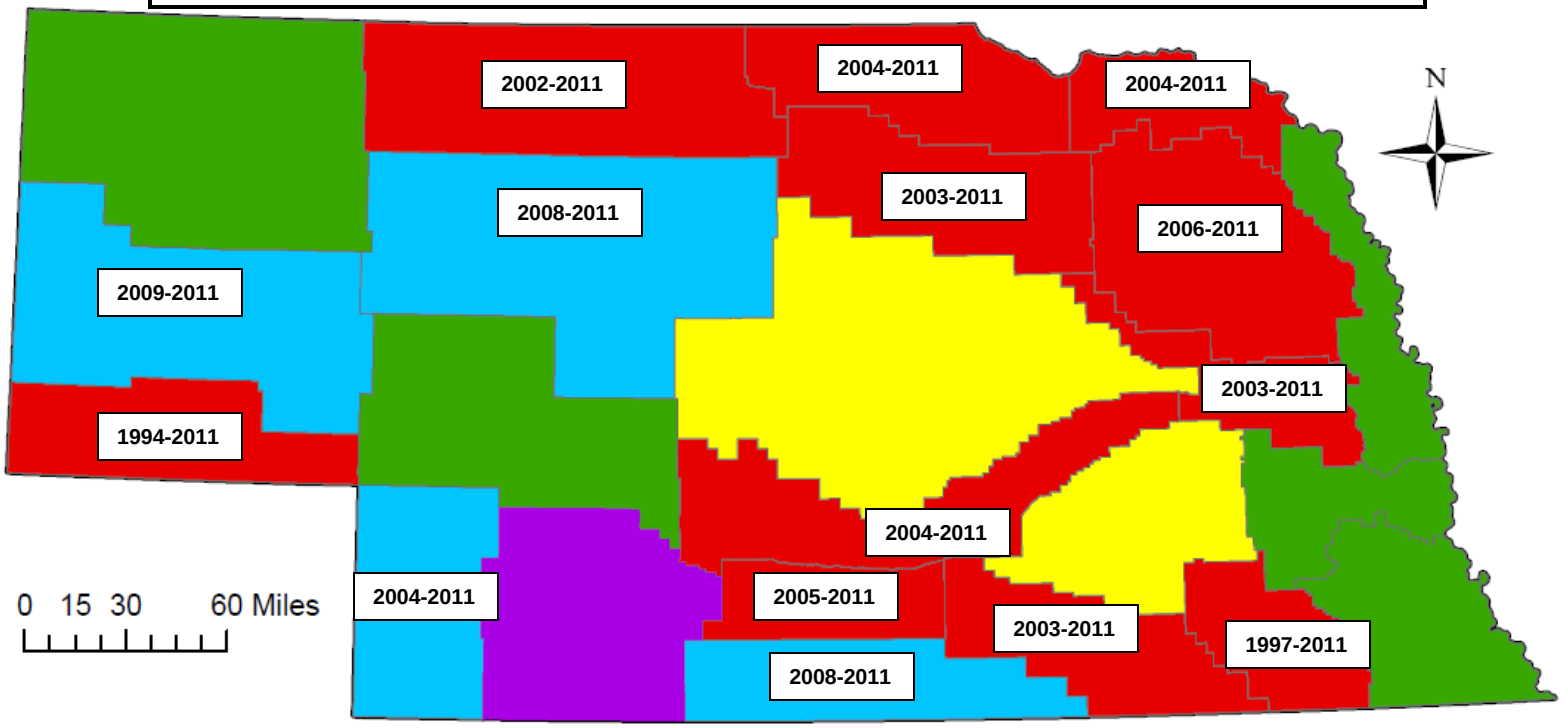
Nebraska's NRDs Helping You Conserve Natural Resources for 35 Years 1972-2007

Nebraska CornBoard

NRD databases: available data

Time intervals for which data are available are indicated for each NRD



Collaborating NRDs (20 of 23):

- All data (Yield, N fertilizer, Irrigation)
- Only irrigation water data available
- Data not collected so not available

Other NRDs (3 of 23):

- All data available in these NRDs
- Only irrigation water data available in this NRD

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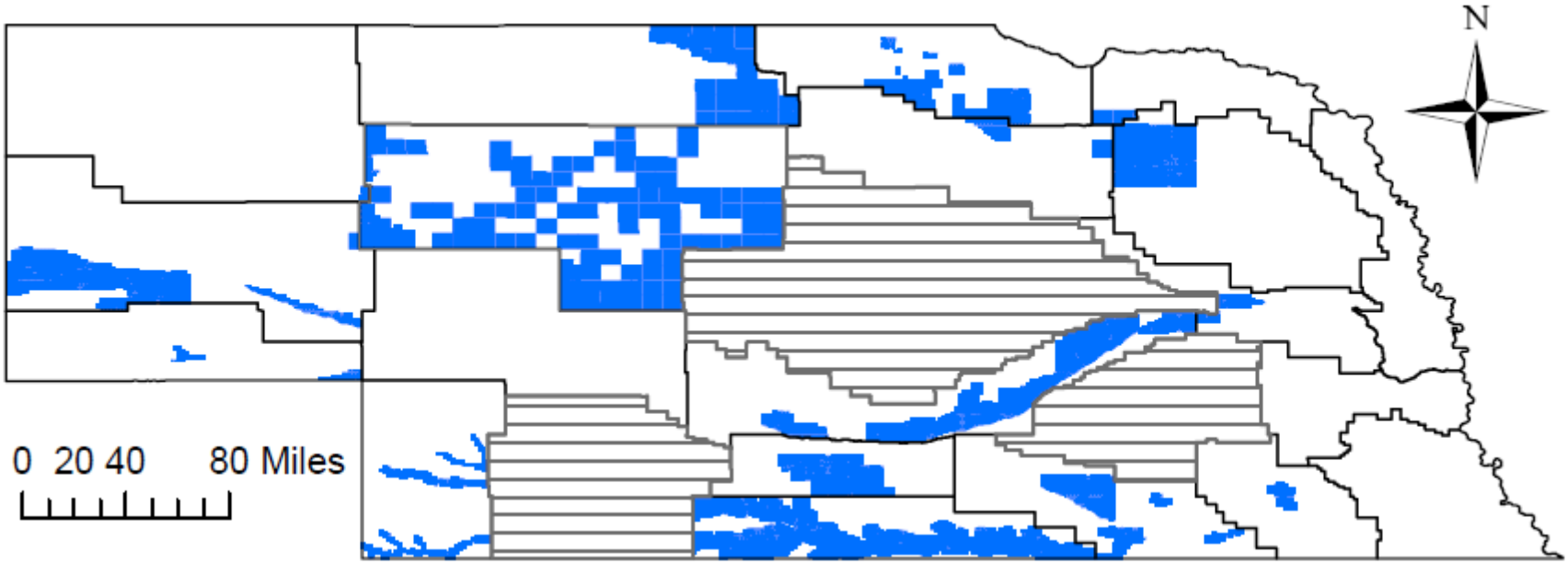
NRD Phase II data reporting areas

Producers with fields located within the areas shown in blue must report data to the NRD.
20 out 23 NRDs have collaborated on this project; the other NRDs are shown hatched.



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Tri-Basin NRD

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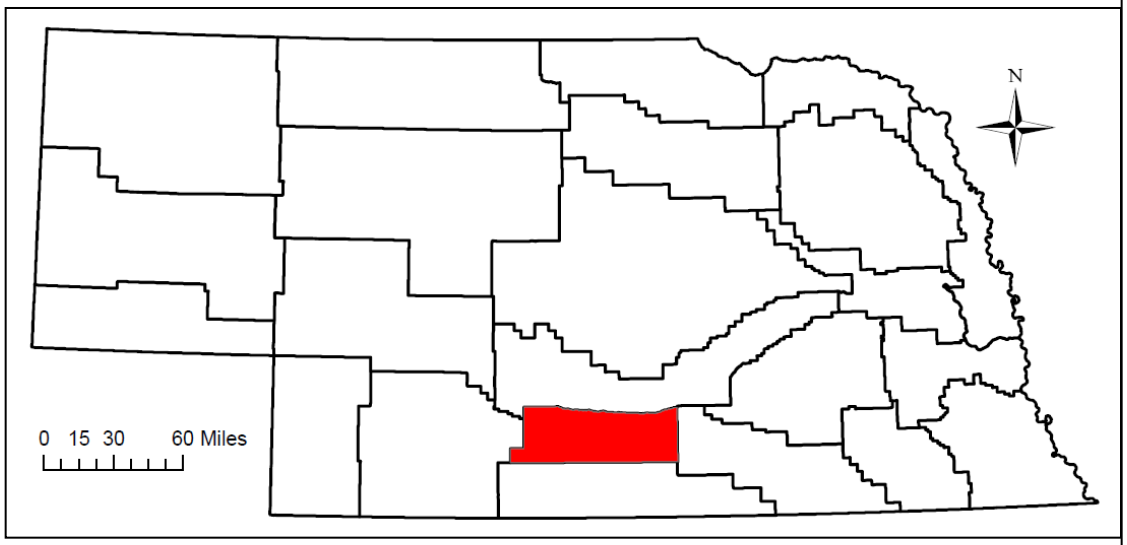

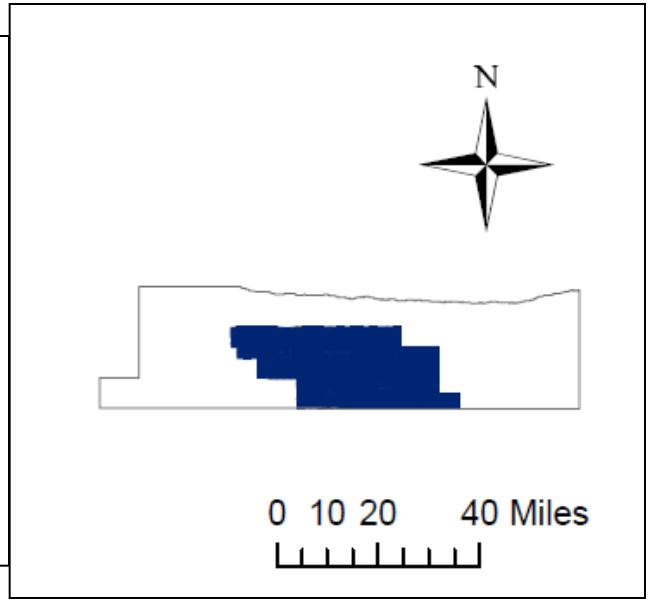

<u>Counties that overlap with data reporting area</u>: Phelps, Gosper, Kearney

<u>Type of reported data</u>: field location, planted crop, actual yield, yield goal, previous crop, fertilizer N rate, manure application, residual soil nitrogen, irrigation water amount, irrigation system type, water nitrates content, tillage method

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Summary Table: Tri-Basin NRD data

IRRIGATED CORN	2005	2006	2007	2008	2009	2010	2011	Mean (CV, %[a])
Number of fields	203	200	319	206	298	218	475	
After corn (%)	30	39	42	40	43	22	34	36
After soybean (%)	70	61	58	60	57	78	66	64
Irrigated yield (bu/ac)	216	198	205	213	224	216	187	208 (17)
After corn	211	196	201	210	221	209	188	205 (19)
After soybean	222	200	208	216	228	222	186	212 (15)
Rainfed yield (bu/ac)[b]	75	78	133	122	139	135	130	116 (4)
Irrigation (in)								
After corn	13.9	10.6	8.5	10.6	11.7	6.3	8.4	10 (4)
After soybean	13.7	9.9	8.3	10.1	10.0	5.7	8.0	9.4 (4)
IWUE (bu/ac-in)[c]	10.4	11.9	8.6	8.6	8.0	13.2	7.2	9.7 (4)
N rate (lb N/ac)	165	167	163	176	181	184	190	175 (17)
After corn	175	175	173	191	198	191	201	186 (16)
After soybean	155	158	153	160	164	178	179	164 (16)
Fertilizer NUE (bu/lb N)[d]	1.3	1.2	1.3	1.2	1.3	1.2	0.9	1.2 (9)
After corn	1.2	1.2	1.2	1.1	1.1	1.1	0.9	1.1 (9)
After soybean	1.5	1.3	1.4	1.4	1.4	1.3	1.0	1.3 (8)

[a] CV = inter-annual coefficient of variation (the larger the CV, the greater the variation among years)

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Rainfall (in)								(4)
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Why do producers prefer C-S over C-C?

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[b] Rainfed yields were retrieved from USDA-NASS yield data reported for the counties that overlap with the NRD reporting area.

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WUE (bu/ac-in)								7 (4)
N rate (lb N/ac)	165	167	163	176	181	184	190	175 (17)
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Is irrigated yield increasing over time?

[a] CV = inter-annual coefficient of variation (the larger the CV, the greater the variation among years)

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[b] IWUE = irrigation-water use efficiency calculated as the ratio between (irrigated yield - rainfed yield) and irrigation

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Does C-S save water compared with C-C?

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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What are the factors that explain the changes in fertilizer N rate over time?

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After soybean	1.5	1.3	1.4	1.4	1.4	1.3	1.0	1.3 (13)

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[b] **NUE = Nitrogen-use efficiency calculated as yield-to-N fertilizer ratio. Fields that received manure application were not included.**

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Irrigation (in)								
After corn	13.9	10.6	8.5	10.6	11.7	6.3	8.4	10 (25)
After soybean	13.7	9.9	8.3	10.1	10.0	5.7	8.0	9.4 (26)
IWUE (bu/ac-in)[c]	10.4	11.9	8.6	8.6	8.0	13.2	7.2	9.7 (23)
N rate (lb N/ac)	165	167	163	176	181	184	190	175 (6)
After corn	175	175	173	191	198	191	201	186 (6)
After soybean	155	158	153	160	164	178	179	164 (6)
Fertilizer NUE (bu/lb N)[d]	1.3	1.2	1.3	1.2	1.3	1.2	0.9	1.2 (11)
After corn	1.2	1.2	1.2	1.1	1.1	1.1	0.9	1.1 (11)
After soybean	1.5	1.3	1.4	1.4	1.4	1.3	1.0	1.3 (13)

[a] CV = inter-annual coefficient of variation (the larger the CV, the greater the variation among years)
[b] Rainfed yields were retrieved from USDA-NASS yield data reported for the counties that overlap with NRD reporting area.
[c] IWUE = irrigation-water use efficiency calculated as the ratio between (irrigated yield - rainfed yield) and irrigation
[d] NUE = Nitrogen-use efficiency calculated as yield-to-N fertilizer ratio. Fields that received manure were not included.

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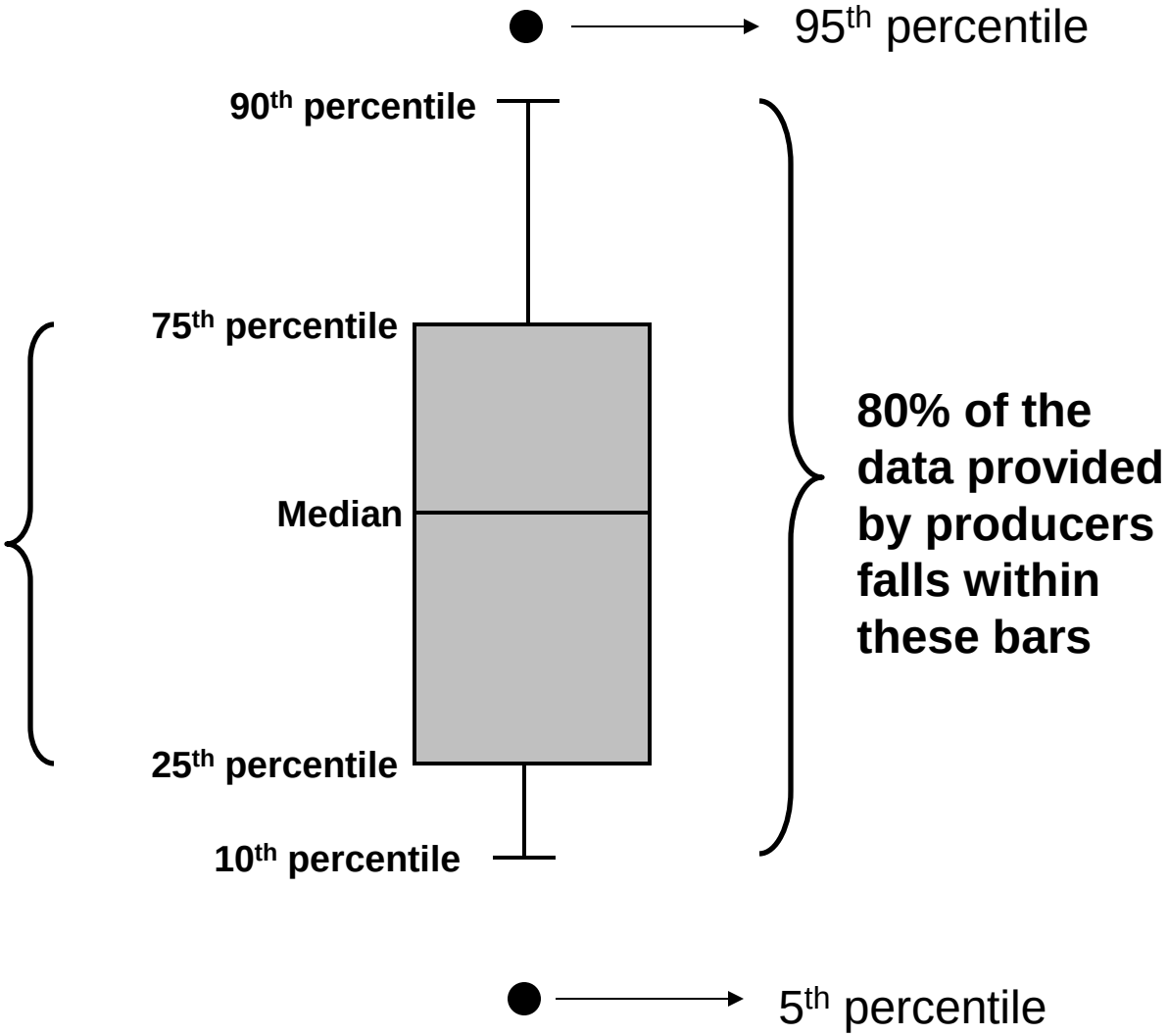
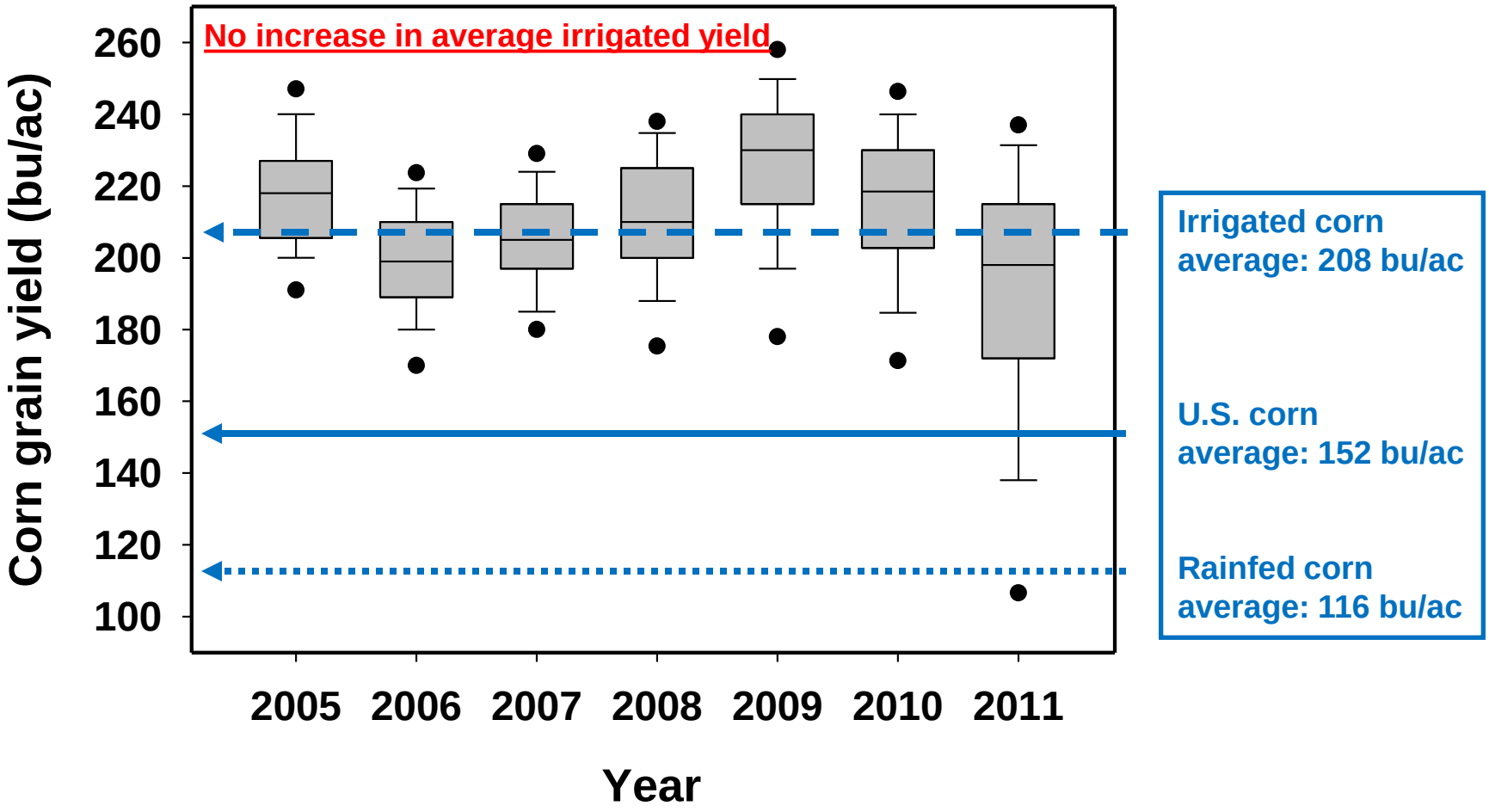
Explanation of Box Plots



Irrigated CORN yield – Tri-Basin NRD



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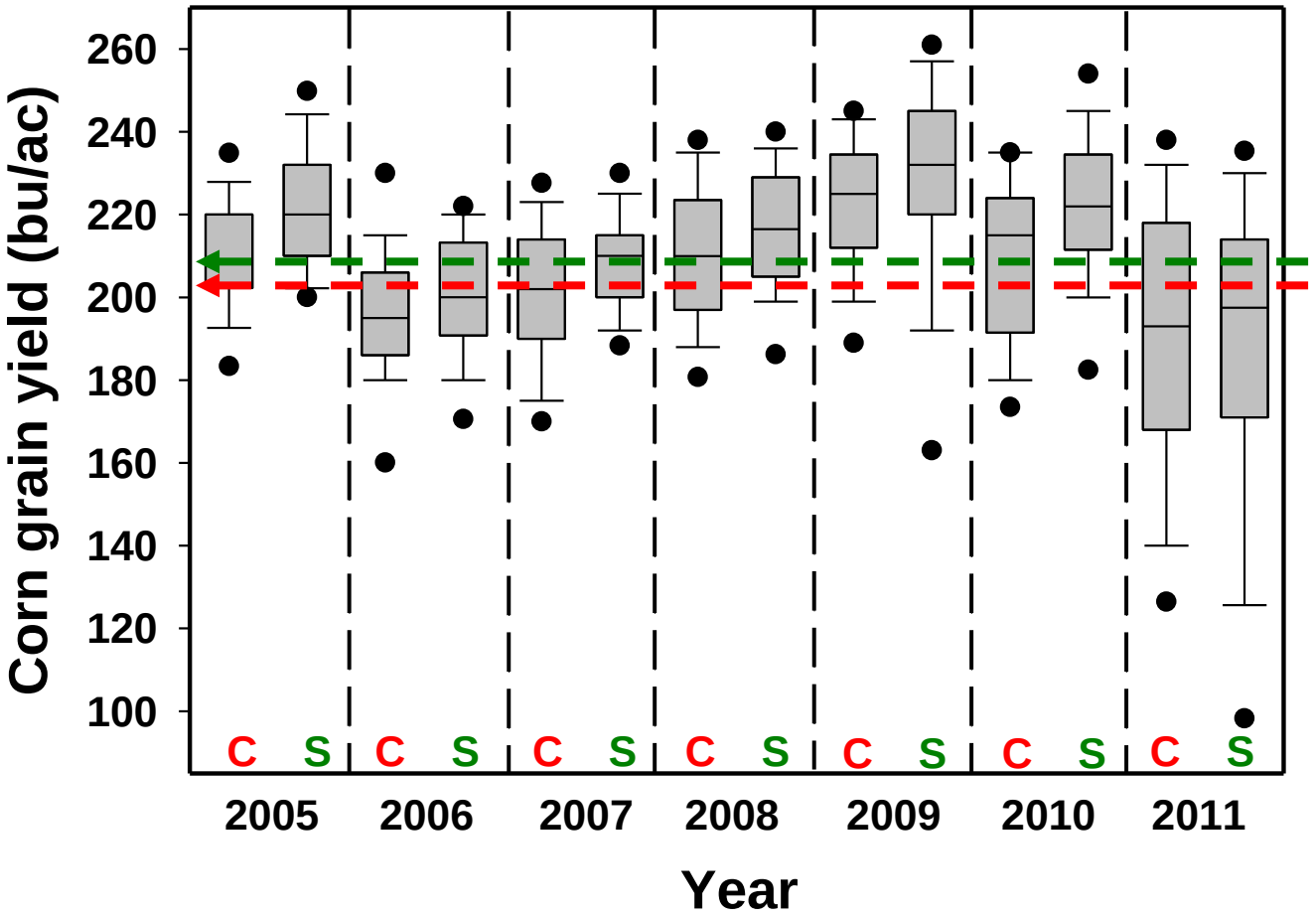
Irrigated CORN Yield - Tri-Basin NRD – Rotation Effect



Average corn yield (bu/ac):
Corn-Soy rotation: 212
Corn-Corn sequence: 205
Corn-Soy advantage: 7

Previous crop:
C: corn
S : soybean

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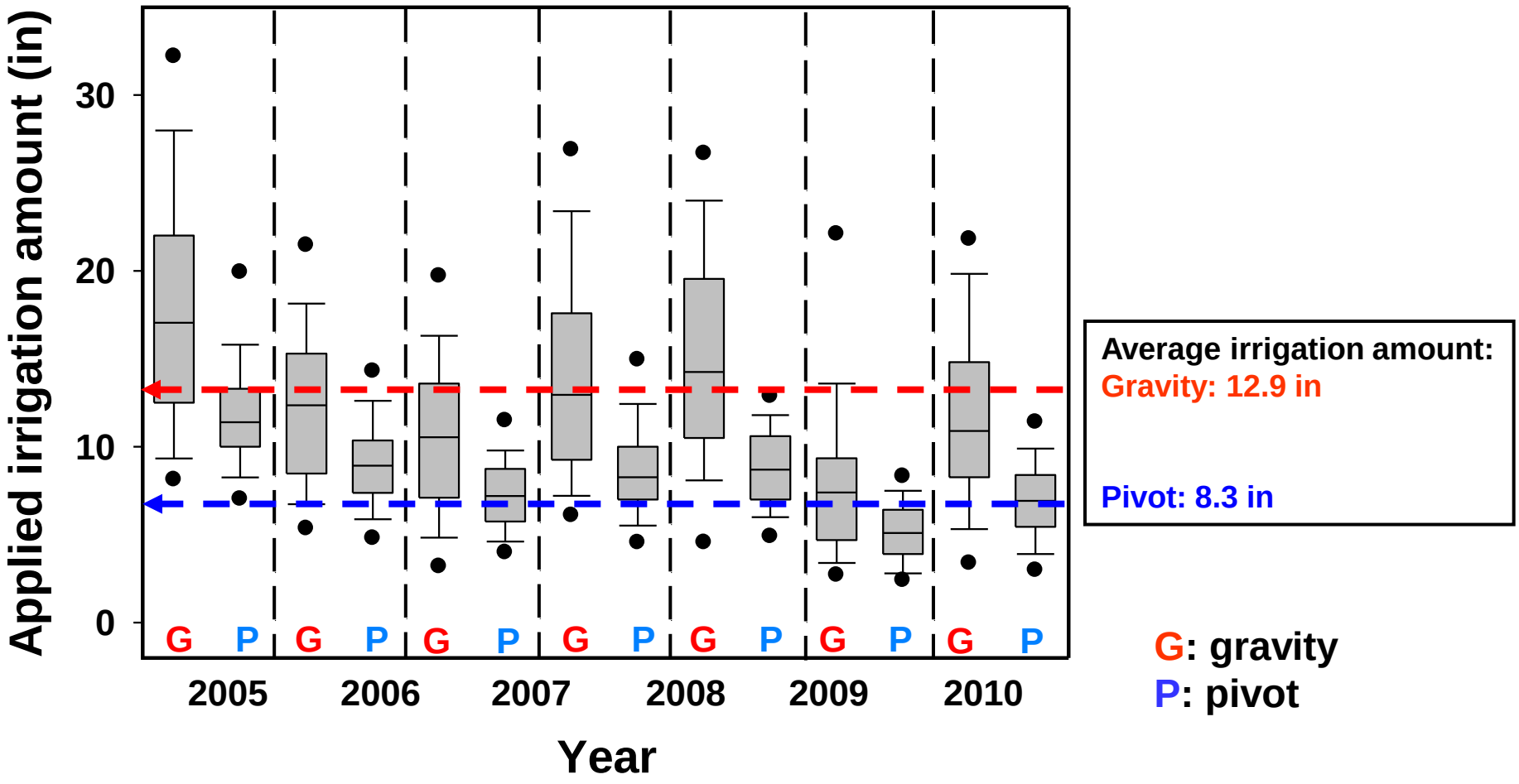
CORN - Tri-Basin NRD - Irrigation Water

Approximately 30 and 70% of the irrigated fields were gravity and pivot irrigated, respectively.



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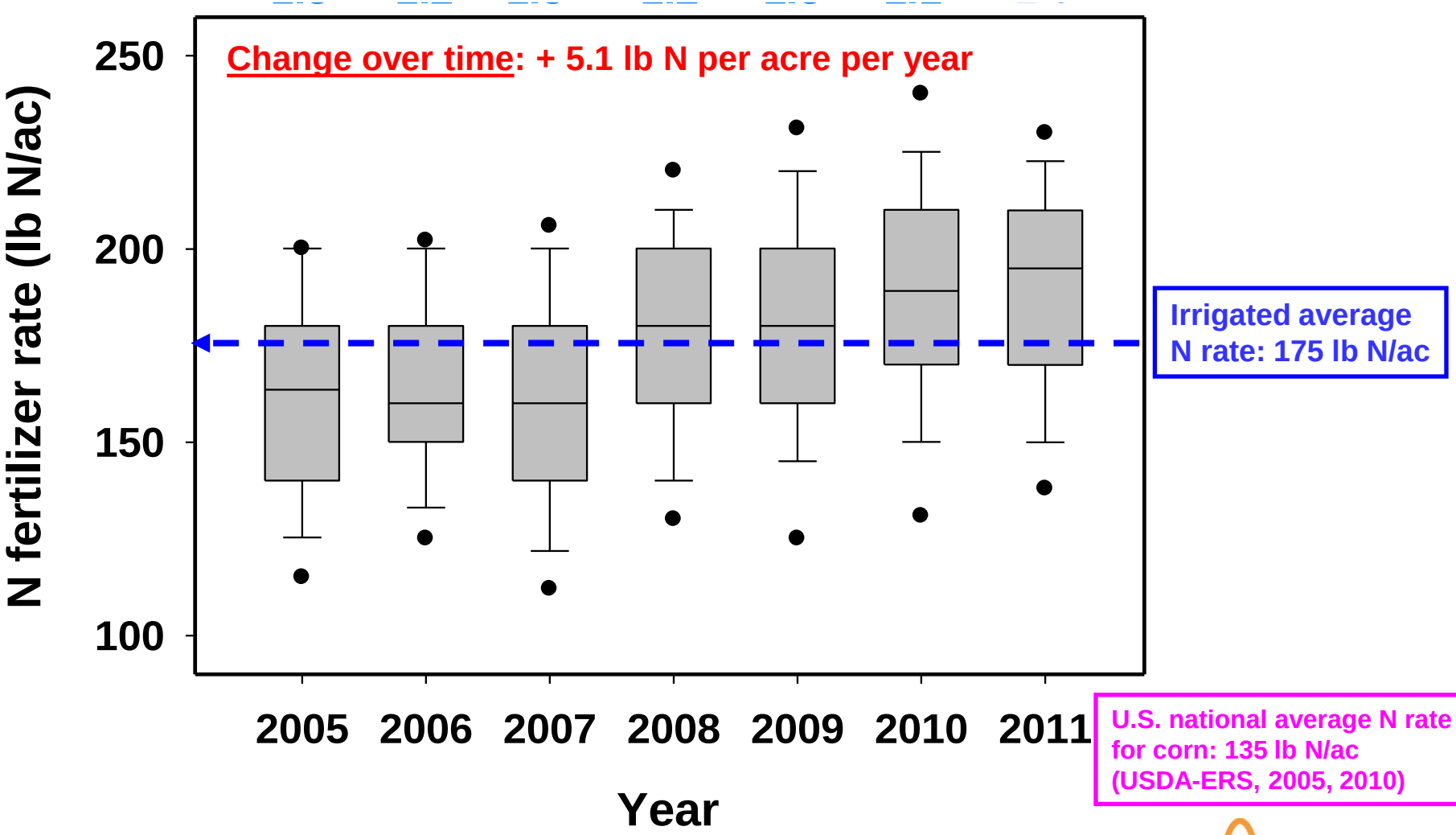
Irrigated CORN - Tri-Basin NRD - N fertilizer rate



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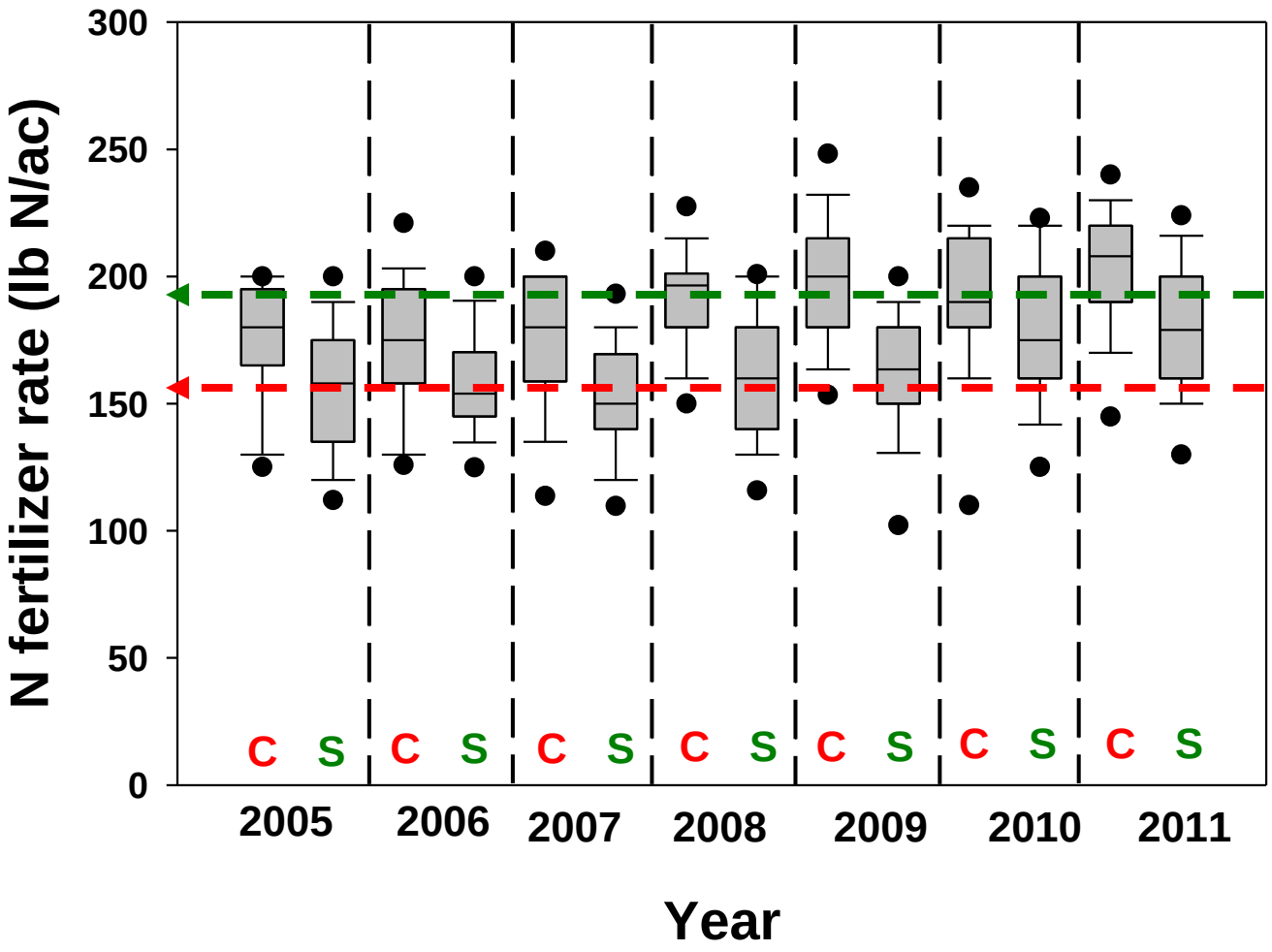
Irrigated CORN - Tri-Basin NRD - N fertilizer rate



Irrigated average N rate (lb N/ac):
Corn-Corn: 186

Corn-Soy: 164

U.S. national average N rate for corn: 135 lb N/ac (USDA-ERS, 2005, 2010)

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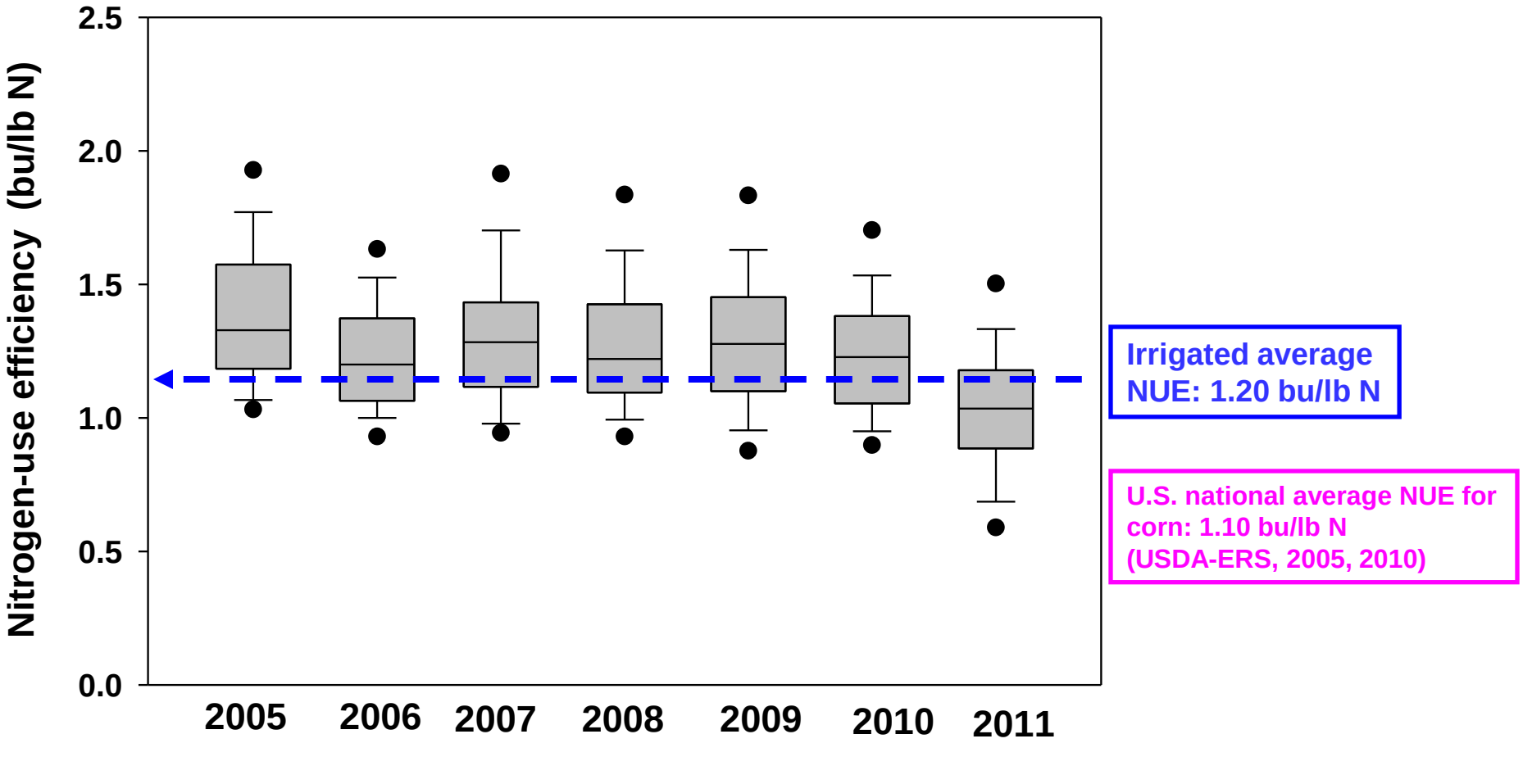
Irrigated (I) CORN - Tri-Basin NRD – N-use efficiency

Nitrogen-use efficiency (NUE): bushels of corn per lb of applied N fertilizer



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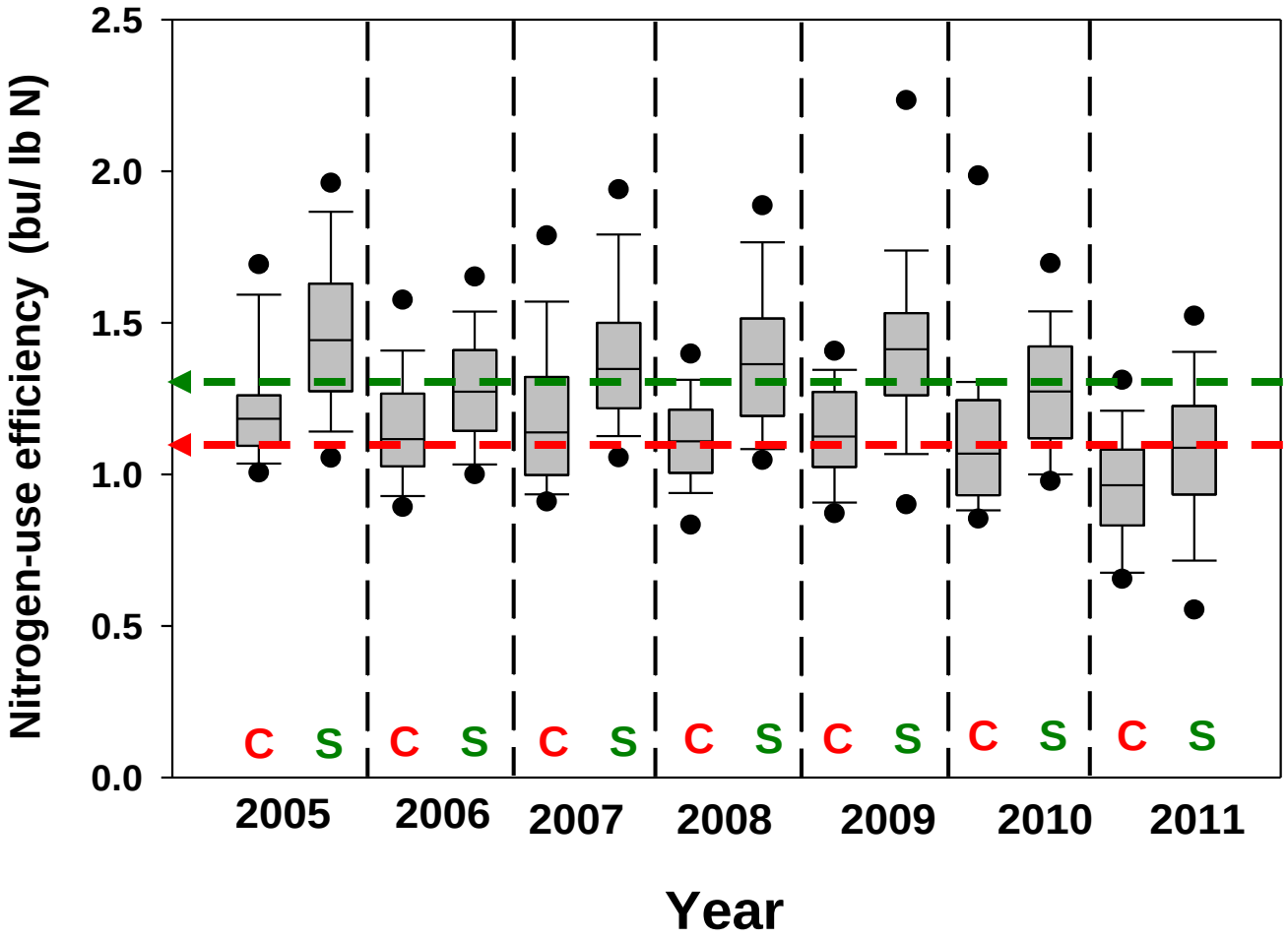
Irrigated CORN - Tri-Basin NRD – Fertilizer N-use efficiency

Fertilizer nitrogen-use efficiency (NUE): bushels of corn per lb of applied N fertilizer



Irrigated average NUE (bu/lb N):
Corn-Soy: 1.3

Corn-Corn: 1.1

U.S. national average NUE for corn: 1.10 bu/lb N (USDA-ERS, 2005, 2010)

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Annual change in N fertilizer at different NRDs

NRD	Annual N change (lb N per acre per year)	*P*-value*
Central Platte	+4.8	*<0.001*
Lewis and Clark	+5.1	*0.007*
Little Blue	+2.1	*0.028*
Lower Big Blue	*+2.6*	*0.095*
Lower Elkhorn	+0.4	*0.770*
Lower Niobrara	*+2.6*	*0.039*
Lower Platte North	*+4.4*	*0.002*
Middle Niobrara	+3.7	*0.013*
South Platte	+4.3	*0.002*
Tri-Basin	+5.1	*0.002*
Upper Elkhorn	+3.0	*0.006*

*** A small value (P<0.05) indicates the presence of an statistically significant trend**

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Annual change in N fertilizer at different NRDs

NRD	Annual N change (lb N per acre per year)	*P*-value*
Central Platte	+4.8	<0.001
Lewis and Clark	+1.1	0.007
Little Blue	+2.1	0.028
Lower Big Blue	+2.6	0.095
Lower Elkhorn	+0.4	0.770
Lower Niobrara	+2.6	0.039
Lower Platte North	+4.4	0.002
Middle Niobrara	+3.7	0.013
South Platte	+4.3	0.002
Tri-Basin	+5.1	0.002
Upper Elkhorn	+3.0	0.006

Change in N rate in 10 of the 11 NRDs

* A small value (P<0.05) indicates the presence of an statistically significant trend

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Annual change in irrigated corn yield at different NRDs

NRD	Annual change (bu per acre per year)	*P*-value*
Central Platte	-0.3	*0.825*
Lewis and Clark	*+2.6*	*0.202*
Little Blue	*+1.5*	*0.517*
Lower Big Blue	*+0.1*	*0.939*
Lower Elkhorn	*-1.2*	*0.495*
Lower Niobrara	*-0.7*	*0.691*
Lower Platte North	*-0.7*	*0.850*
Middle Niobrara	*-0.7*	*0.662*
South Platte	*-0.4*	*0.890*
Tri-Basin	*-1.3*	*0.622*
Upper Elkhorn	*+0.8*	*0.602*

*** A small value (P<0.05) indicates the presence of an statistically significant trend**

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Annual change in irrigated corn yield at different NRDs

NRD	Annual change (bu per acre per year)	*P*-value *
Central Platte	-0.3	0.825
Lewis and Clark	+2.6	0.202
Little Blue	+1.5	0.511
Lower Big Blue	+0.1	0.939
Lower Elkhorn	-1.2	0.455
Lower Niobrara	-0.7	0.691
Lower Platte North	-0.7	**0.850**
Middle Niobrara	-0.7	**0.662**
South Platte	-0.4	**0.890**
Tri-Basin	**-1.3**	**0.622**
Upper Elkhorn	**+0.8**	**0.602**

No change in yield in all NRDs

*** A small value (P<0.05) indicates the presence of an statistically significant trend**

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Rotation effect on irrigated corn : Average (2005-2011) difference (Δ) in yield, N fertilizer, and irrigation in corn-soybean *versus* continuous corn*

NRD	Average corn yield (bu/ac)**	% of fields under rotation	Δ Yield (bu/ac)	Δ N rate (lb N/ac)	Δ Irrigation (inches)
Central Platte	182	9	-9	-18	-2.8
Lewis and Clark	197	55	+11	-15	-1.0
Little Blue	199	53	+3	-8	-
Lower Big Blue	177	64	+6	-5	-
Lower Elkhorn	198	62	+2	-10	0
Lower Niobrara	198	39	+5	-14	-1.0
Lower Platte North	192	39	+4	-21	-0.6
Middle Niobrara	182	-	-	-	-
South Platte	160	-	-	-	-
Tri-Basin	208	64	+7	-22	-0.6
Upper Elkhorn	201	25	-5	-14	-1.8

* Difference in each parameter was calculated as corn-soybean minus continuous corn
** Overall average corn yield, including both corn-soybean and continuous-corn fields

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Key questions

- **What are the factors that explain change in N rate over time (2005-2011) despite no change in yield?**
- **What are the productive and economic benefits of corn-soybean rotation compared with continuous corn?**
- **What are the available options to increase farm irrigated yields and efficiencies in the use of N and irrigation in systems were yields and efficiency are ALREADY high?**
- **What other specific issues would YOU like us to address?**

How do we continue this collaboration?

- **We want to THANK YOU for sharing the data with us and your trust in our research team**
- **We are ready to present the results, at NO COST for you, at fertilizer/irrigation workshops, education programs, etc., that you may sponsor**
- **NRD data provide a fantastic opportunity to justify and fine tune current management practices… so, let's work together (Producers + NRD + UNL) to get the most out of these data!**
- **Contact: Patricio Grassini (pgrassini2@unl.edu)**

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