CORN STOVER REMOVAL AND SOIL FERTILITY

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QUESTION

- Is there a negative effect of stover removal in the short-term?

- Yield reductions
- Loss of SOC

- Continual corn silage rotations
- Use of corn silage as a feedstock for biofuel

OUTLINE

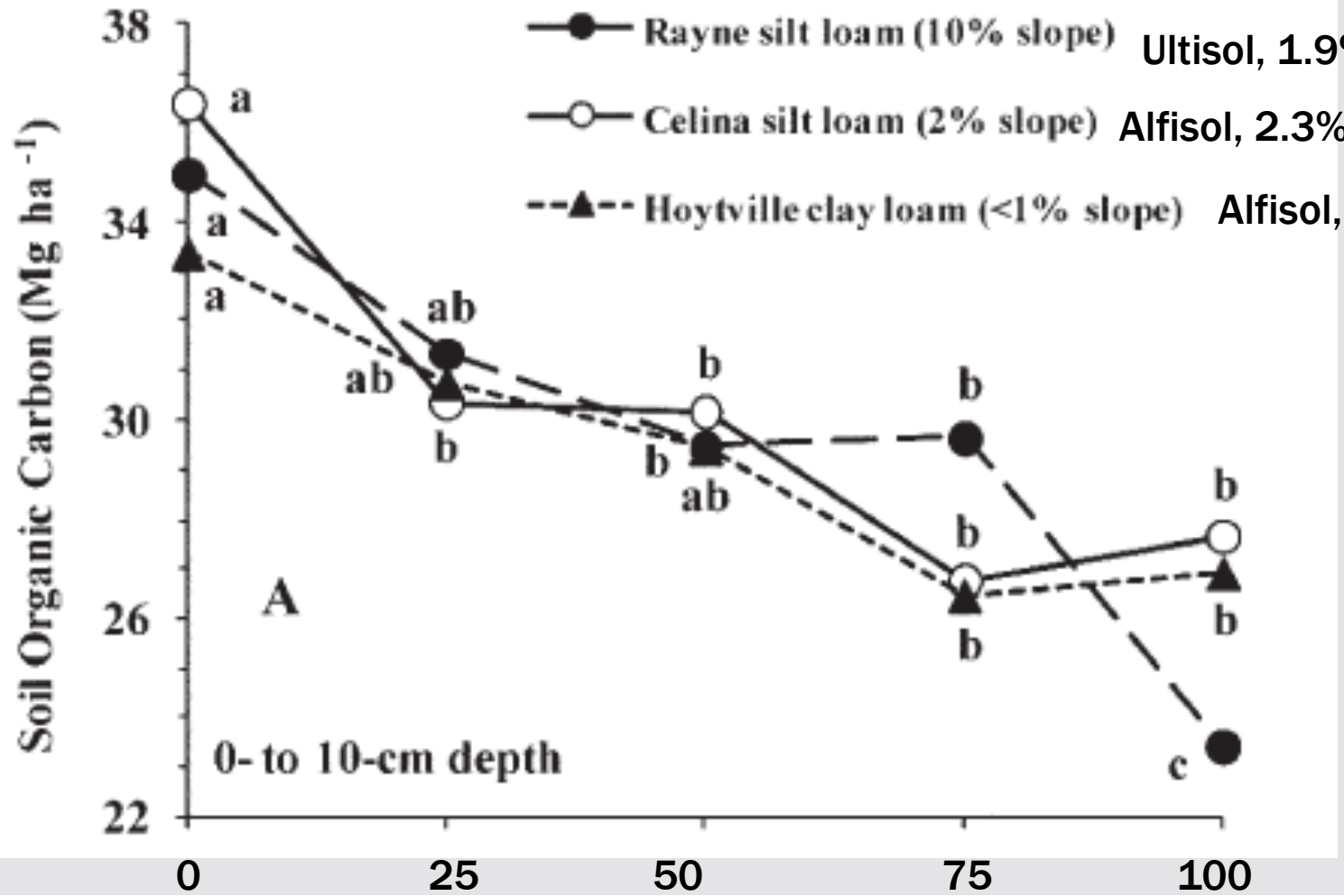
- Review current research on effects of stover removal.
- Show research from stover removal trials in Wisconsin.
- What would a recommendation be for stover removal?

STOVER REMOVAL AND CORN YIELD

- IA: removal of stover, no effect on NT yield in 10 of 13 years (silty clay loam) (Morachum et al., 1972)
- SC: 3 yr study, increase, decrease, no effect (sandy loam) (Karlen et al., 1984)
- NE: removal reduced yield in 2 of 4 years (Wilhelm et al., 1986)
- In Texas, removing sorghum stover decreased SOM over four years, but increased yields when no N was applied (Powell and Hons, 1991)
- In Ohio, removing 50% of biomass reduced corn yields by 26 bu/ac and removing 100% reduced corn yields by 50 bu/ac…but in only one of three sites. Ultisol, with 10% slope. (Blanco-Canqui and Lal, 2009)

OHIO – 3 YRS OF STOVER REMOVAL

Blanco-Canqui and Lal, 2009

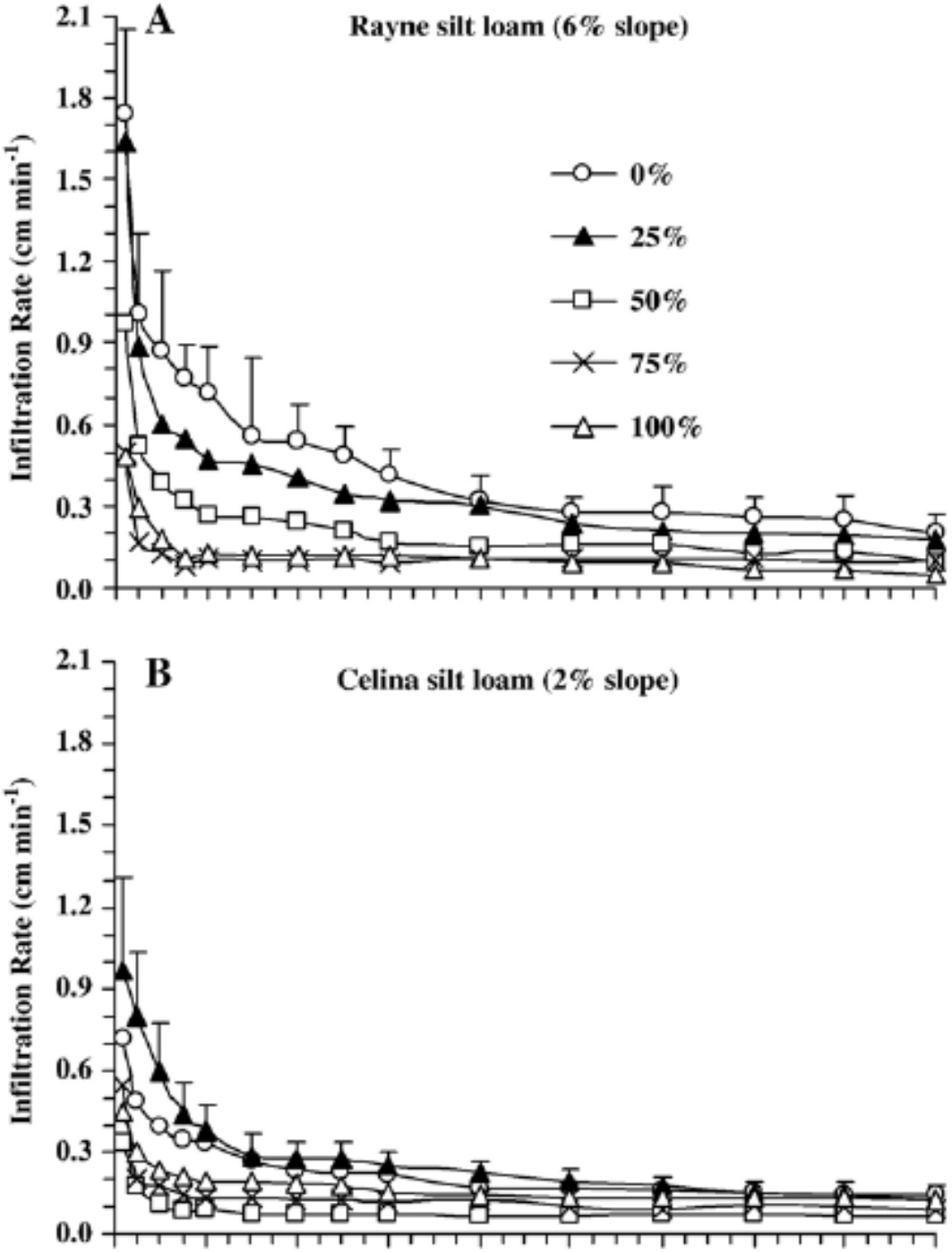


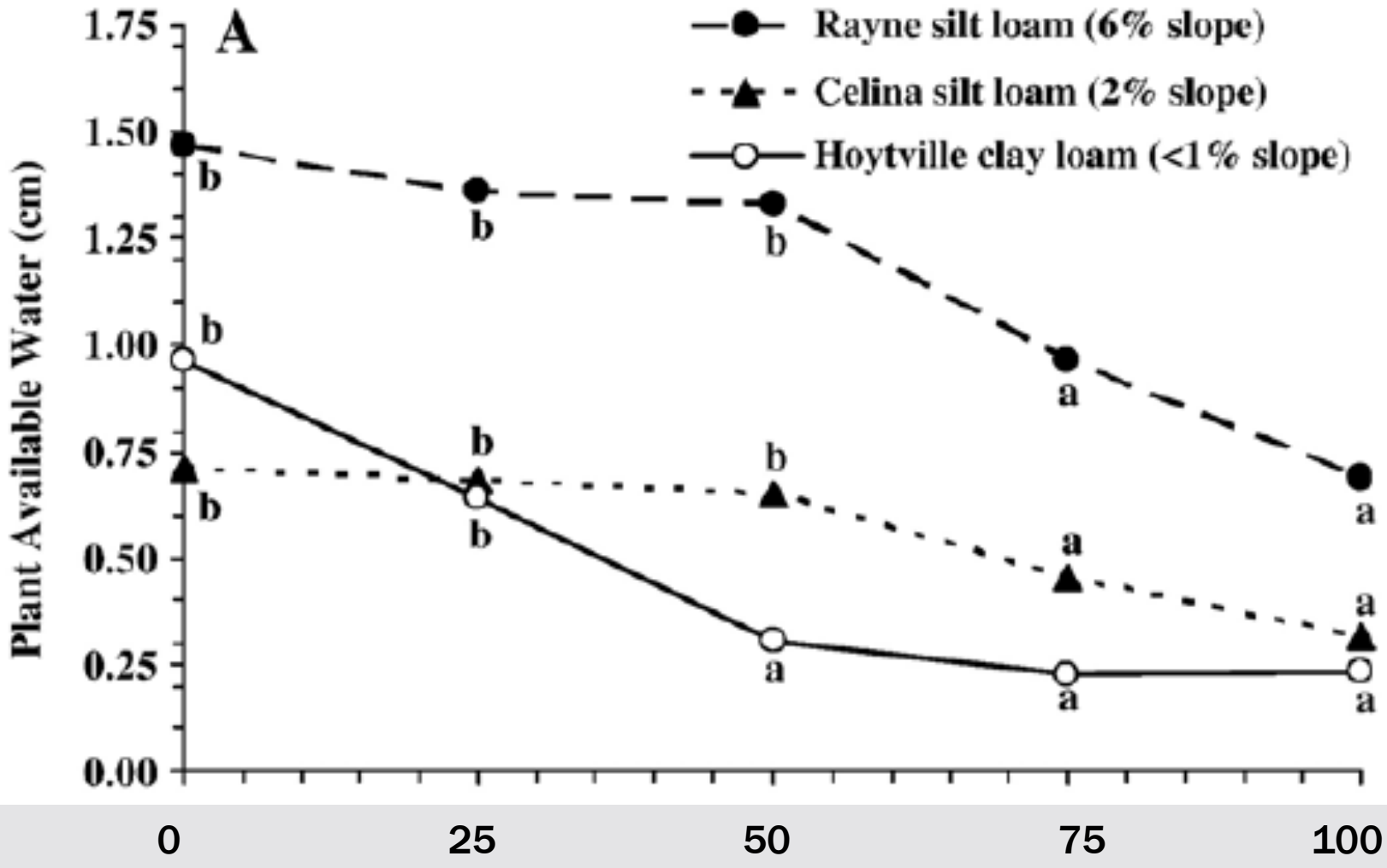
Ultisol, 1.9% SOC

Alfisol, 2.3% SOC

Alfisol, 2.5% SOC

Blanco-Canqui and Lal, 2007





Blanco-Canqui and Lal, 2007

LANCASTER, WI – 10 YR OF REMOVAL

Karlen et al., 1994

Year	Yield w/ removal	Yield w/ no removal
1981	153	132
1982	92	85
1983	116	108
1984	115	120
1985	155	166
1986	164	177
1987	57	59
1988	128	172
1989	155	163
1990	155	156

LANCASTER, WI – 10 YR OF REMOVAL

Karlen et al., 1994

Rozetta silt loam (Alfisol)

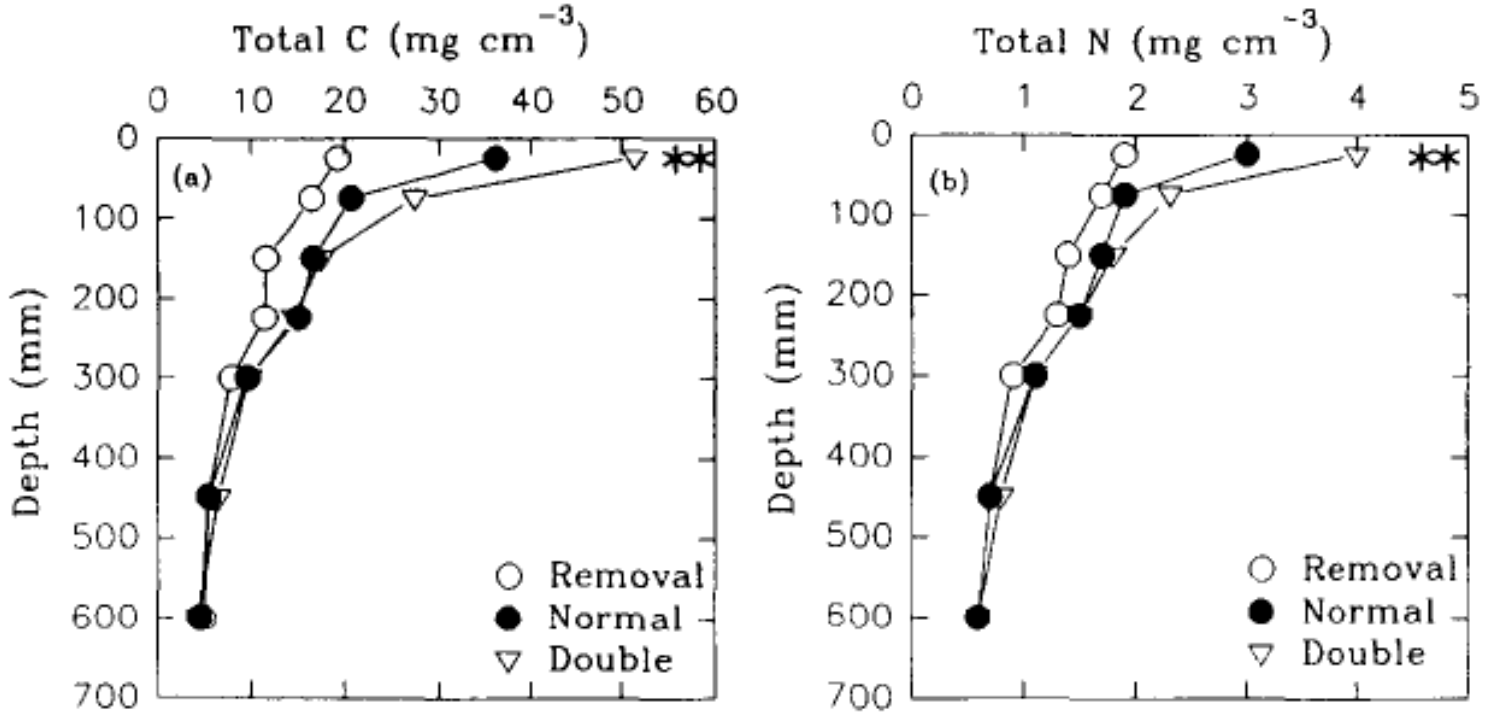


Fig. 1. Long-term crop residue removal, maintenance, or addition effects on total carbon and nitrogen within the upper 600 mm of a silt loam soil following 10 years of continuous corn. An ** indicates a significant difference among crop residue treatments at $P \leqslant 0.05$ at the depth specified.

LANCASTER, WI – 10 YR OF REMOVAL

Karlen et al., 1994

Stover treatment	Water content (%)	Earthworms (#/m^2)	Plant available water (%)
w/ removal	26.7	53	23.2
No removal	32.4	78	24.5

ROSEMOUNT, MN – 19 YR OF REMOVAL

Laird and Cheng, 2013

90% stover removal (Mollisol):

- Reduced soil C by 12%
- Reduced soil N by 13%
- Reduced CEC by 7.3%
- Reduced N mineralization potential by 28%

WISCONSIN RESEARCH

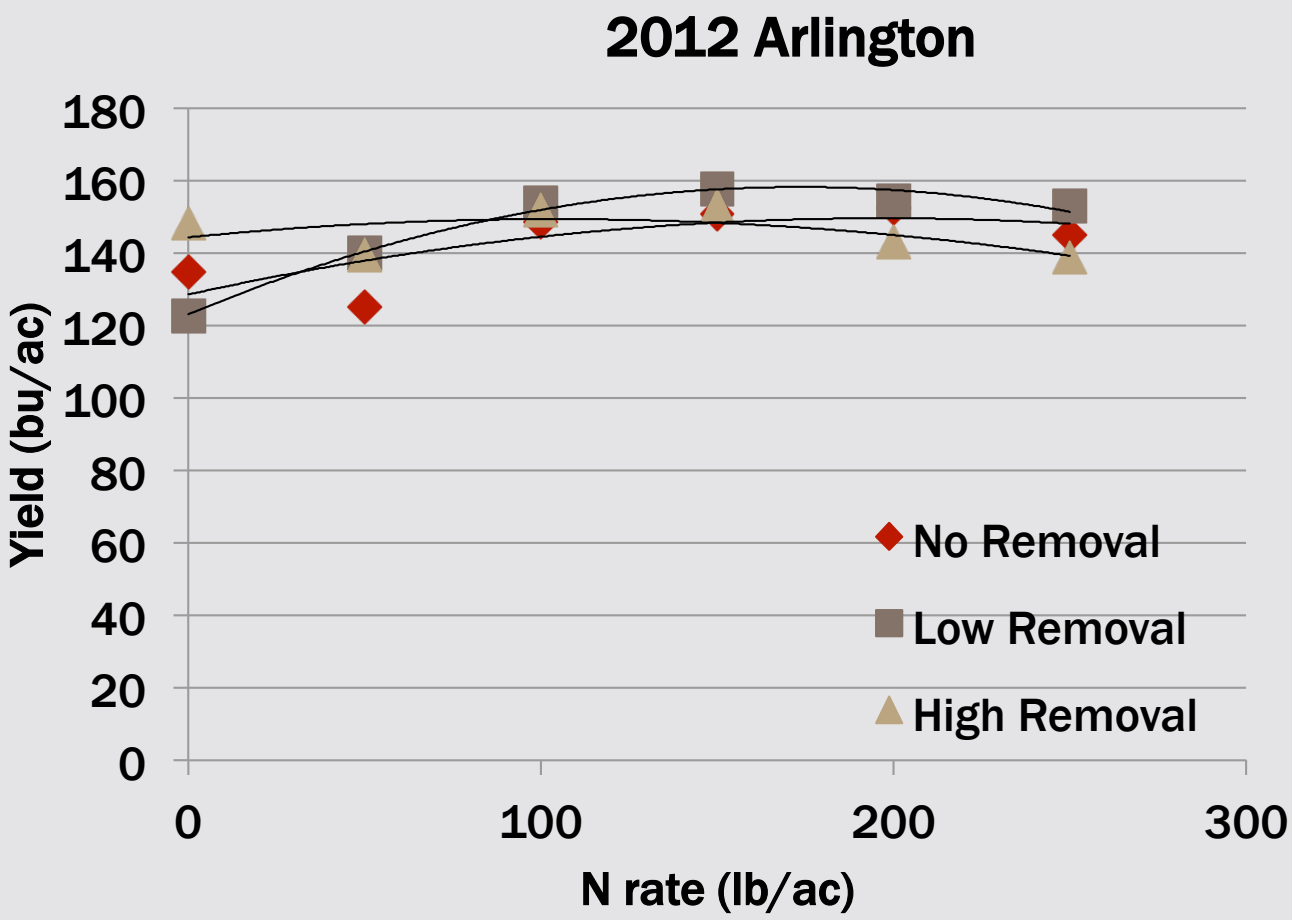
- Originally conceived as a biofuel study to assess “safe” removal rates of stover
- Funded by Wisconsin Fertilizer Research Council
- Three locations:
  - Arlington
  - Lancaster
  - Marshfield
- 2009 establishment year
- 2010-2012 study years

WISCONSIN RESEARCH

- Evaluating a two-pass system (harvest & stover removal)
- Three rates of stover removal
  - None
  - Low (~25%)
  - High (~50%)
- Six N rate to subsequent corn crop
  - 0, 50, 100, 150, 200, and 250 lb/ac of N as preplant urea

STOVER REMOVAL

YIELD EFFECTS

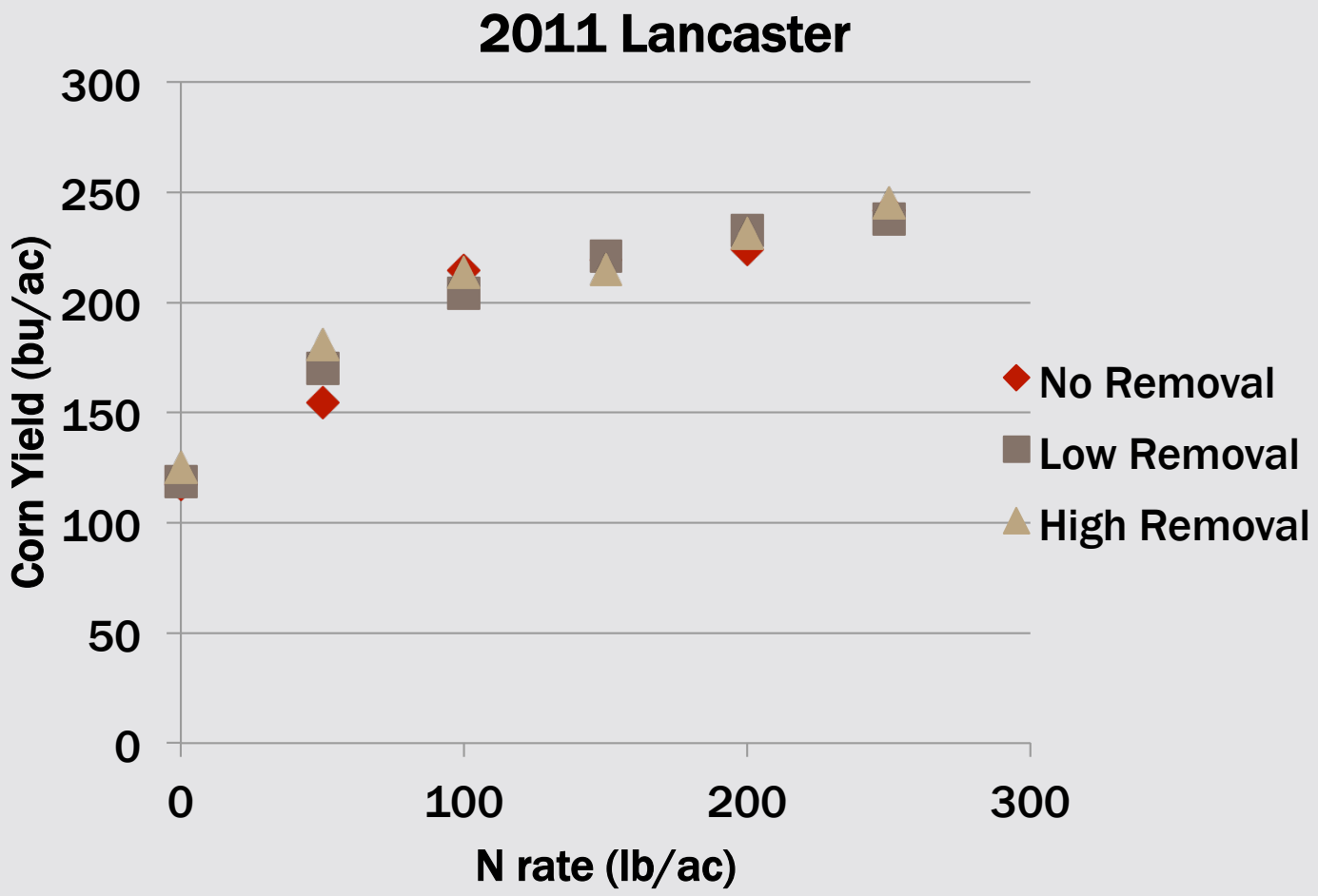


(No removal)
$R^2 = 0.58$

(Low removal)
$R^2 = 0.98$

(High removal)
$R^2 = 0.37$

YIELD EFFECTS



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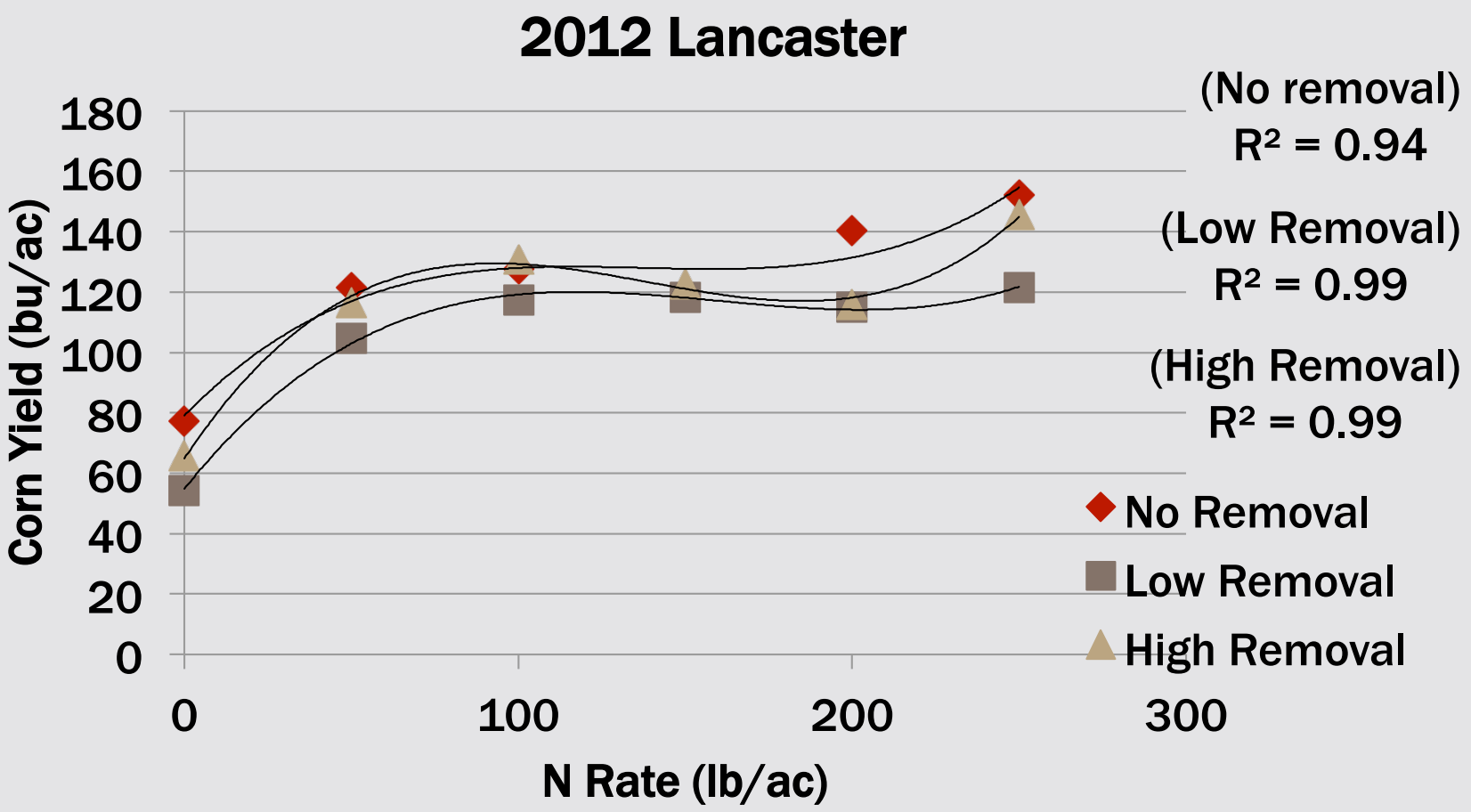
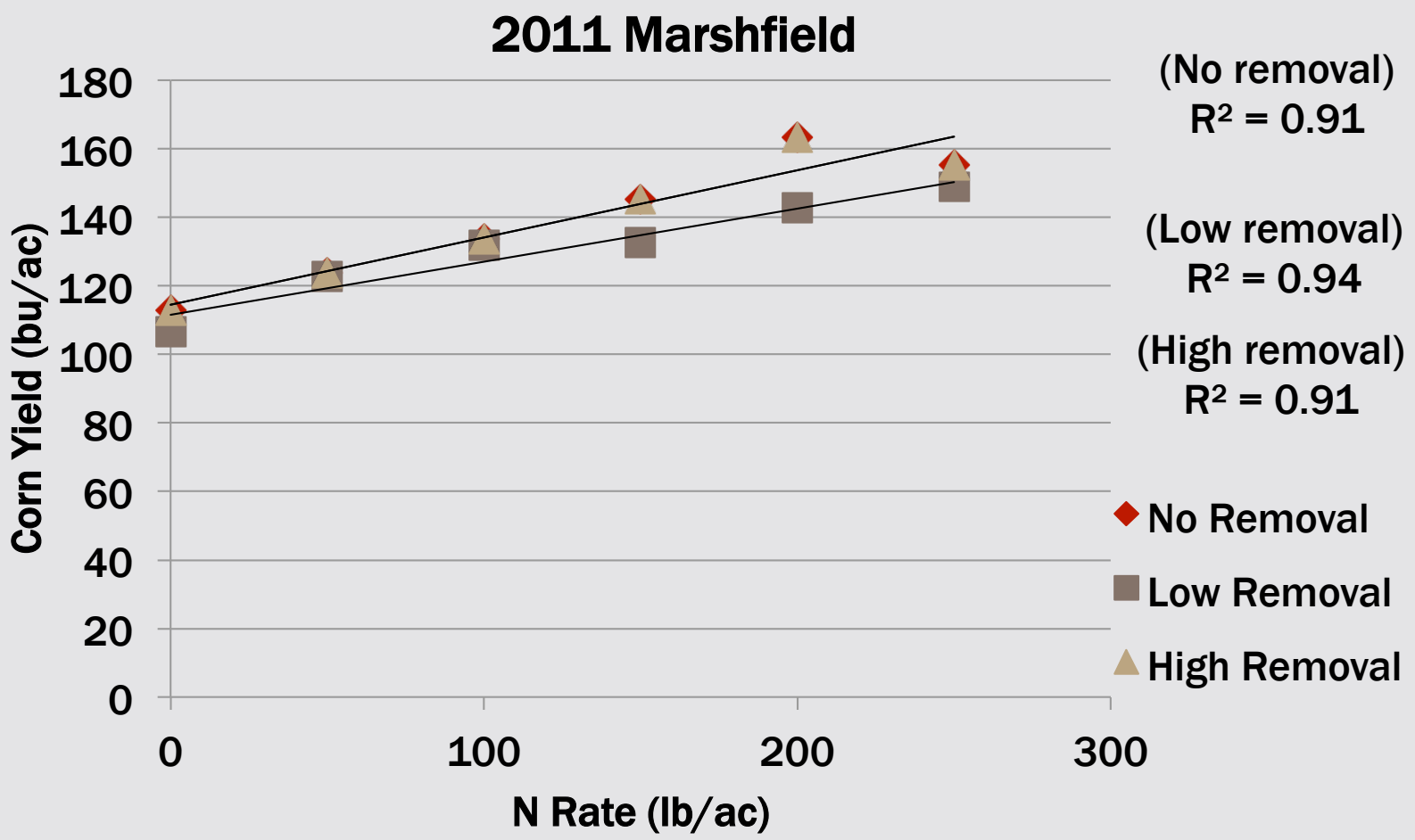


YIELD EFFECTS



SOIL FERTILITY

- Routine soil analysis (ph, OM, STP, STK) on all plots in 2009 and 2012
- No change in pH over three years
- Slight decrease in SOM over three years at all sites – and this was consistent across all stover removal rates and N rates

SOIL TEST P

STOVER	ARL (EXH)	LAN (HIGH)	MAR (EXHIGH)
	Reduction in STP (ppm)		
NONE	11	5	16
LOW	11	3	19
HIGH	13	4	16

SOIL TEST K (2009 VS 2012)

- ARL (High)
  - No removal – reduction by 14 ppm
  - Low removal – reduction by 21 ppm
  - High removal – reduction by 54 ppm
- LAN (Low STK) & MAR (Low STK)
  - Increases of 10 to 14 ppm
  - No effect of stover removal

STOVER REMOVAL AND P AND K VALUE

Fixen (2007)

Table 4. Impact of changing from corn grain to corn grain + stover harvest.

Harvested portion	Removal, lb/A/yr		
	N	P_2O_5	K_2O
Grain, 150 bu/A	135	57	41
Stover, 3.5 t/A	67	20	112
Stover, 1.4 t/A[1]	27	8	45
Total (grain + 40% of stover)	162	65	86
Change, %	20	14	110

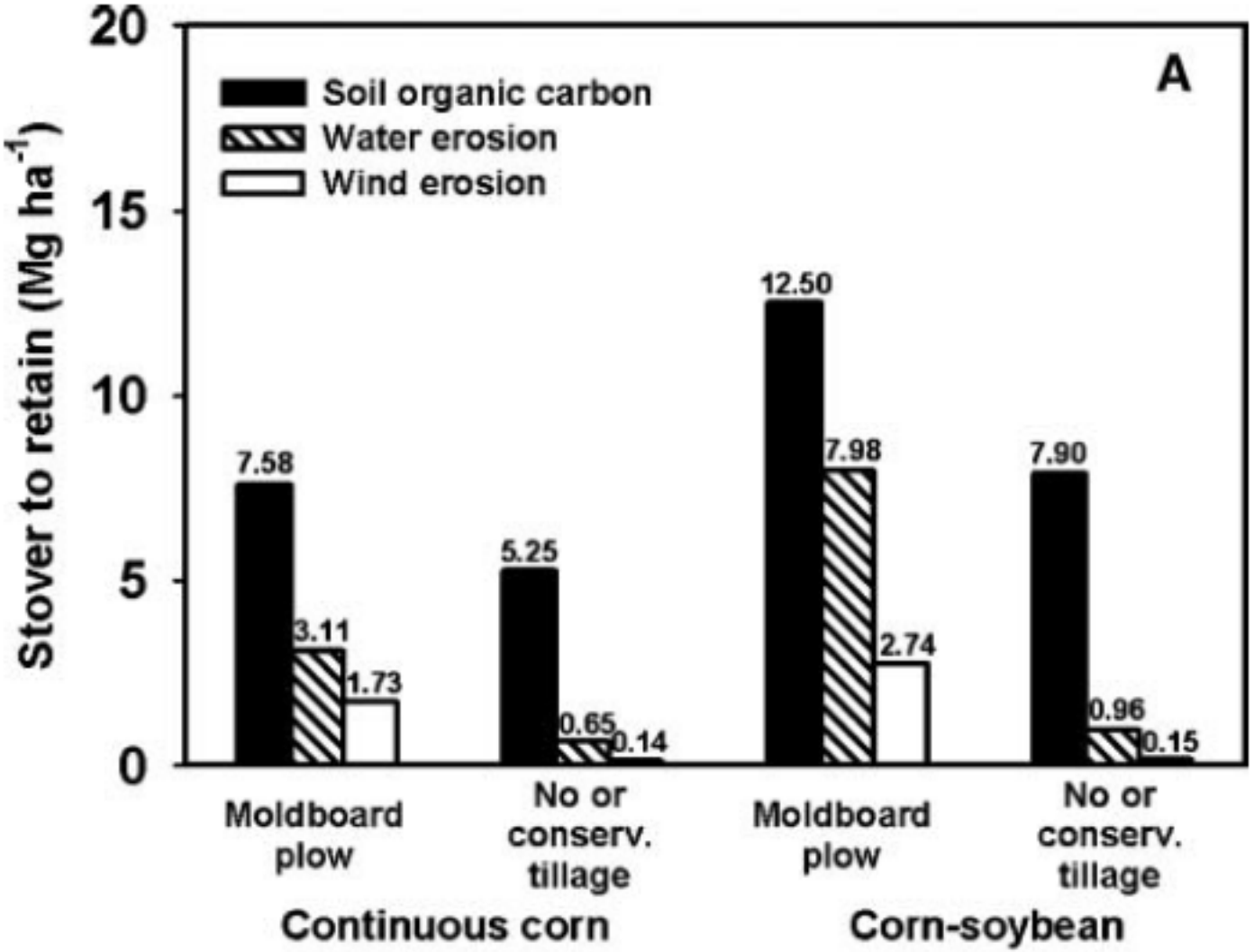
[1]Assuming 40% of stover can be removed sustainably. Estimates for average sustainable levels vary at least from 33 to 50%.

CAN WE DEVELOP A RECOMMENDATION?

- 2-3 years of removal will have little effect
  - Larger drawdowns of P and K on high testing soil
- Would not recommend more than 5 years of removal
- Other C inputs can offset negative impacts
  - Manure and compost – C that can be immediately assimilated
  - Cover crops – C that needs to be decomposed, a longer-term contribution to SOM
- Corn reside is not the only factor that affects SOM

CORN STOVER RETENTION

Wilhelm et al., 2007



THANK YOU

THOUGHTS?
QUESTIONS?
CONCERNS?

Table 3. Nutrient content of corn stover.

Parameter	lb/dry ton		
	N	P_2O_5	K_2O
Range in 8 estimates of "typical"[1]	9-22	3.6-8.0	16-46.5
Average	19	5.7	32
	In 75 million tons of stover:		
1,000 tons	713	214	1,200
% of U.S. fertilizer use per year (04-06)	5.8	4.7	23

[1]U.S. and Canada sources

LANCASTER EXPERIMENT

1990 samples:

- CC: 12.2 to 14.0 SOC (g kg^{-1})
- Other: 15.3 to 16.3 SOC (g kg^{-1})

- CC: 1.02 to 1.21 SON (g kg^{-1})
- Other: 1.27 to 1.33 SON (g kg^{-1})