Exploring and Modeling the Continuous Corn Yield Penalty

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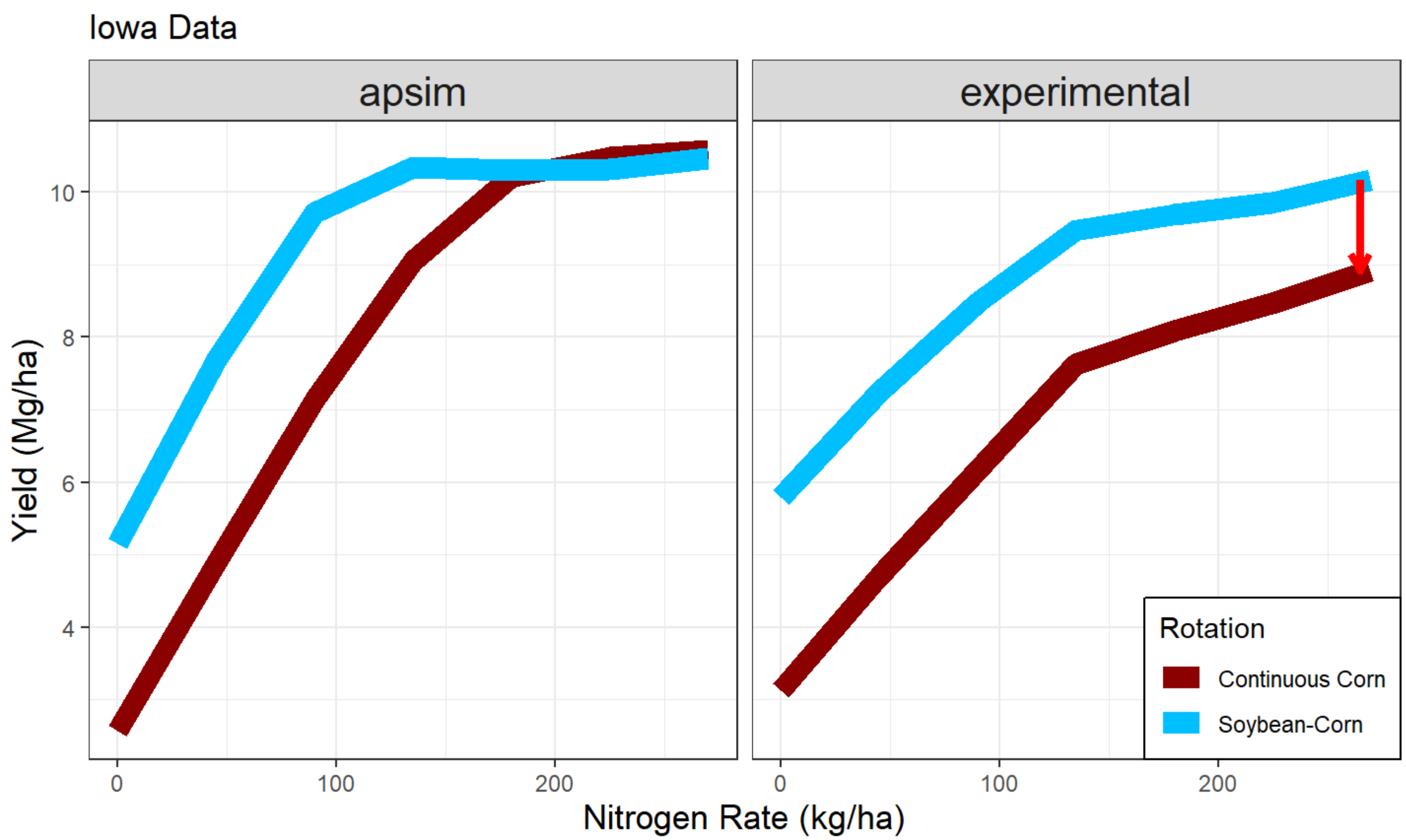
Motivation



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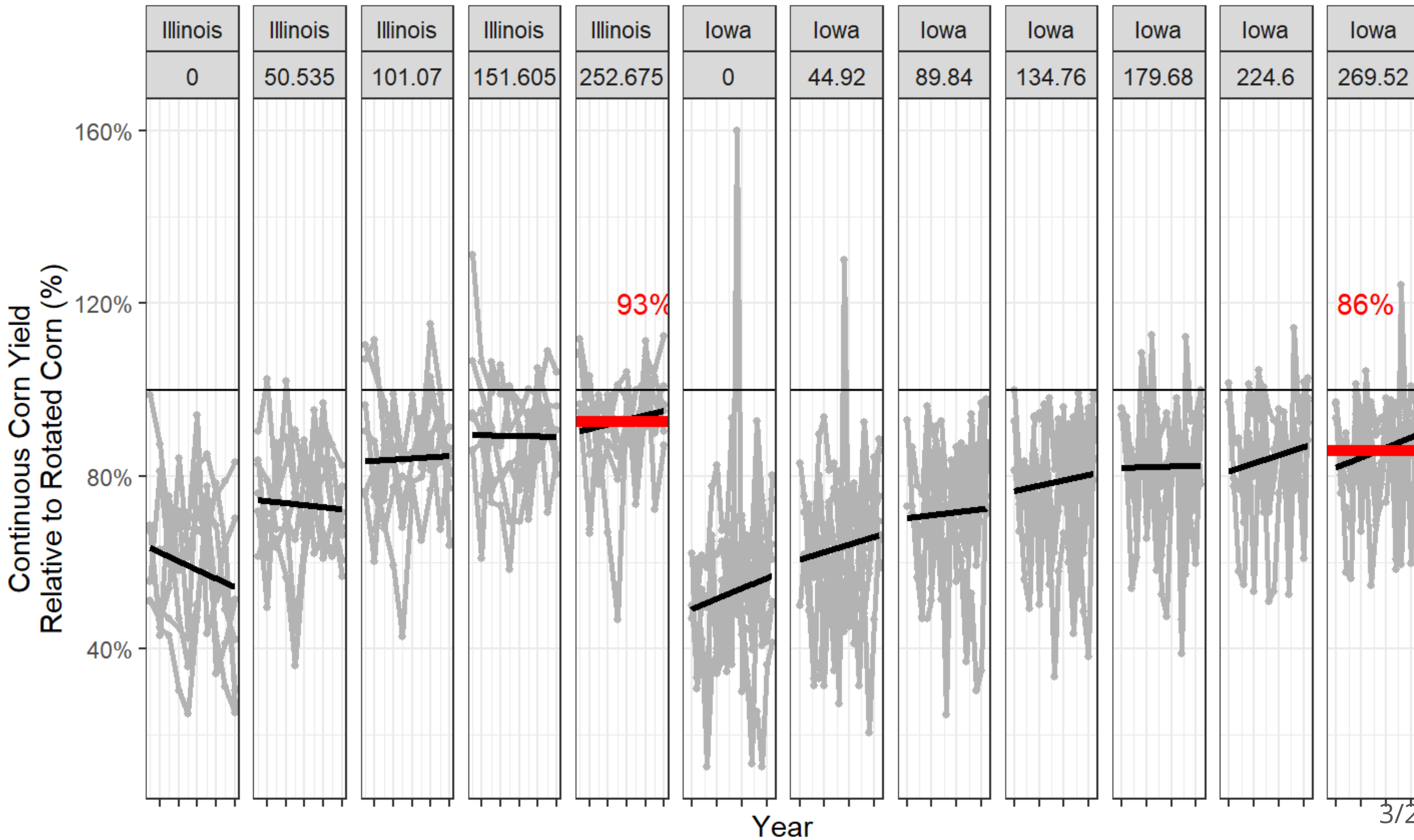
Continuous Corn Yields Relative to Rotated Corn Yields



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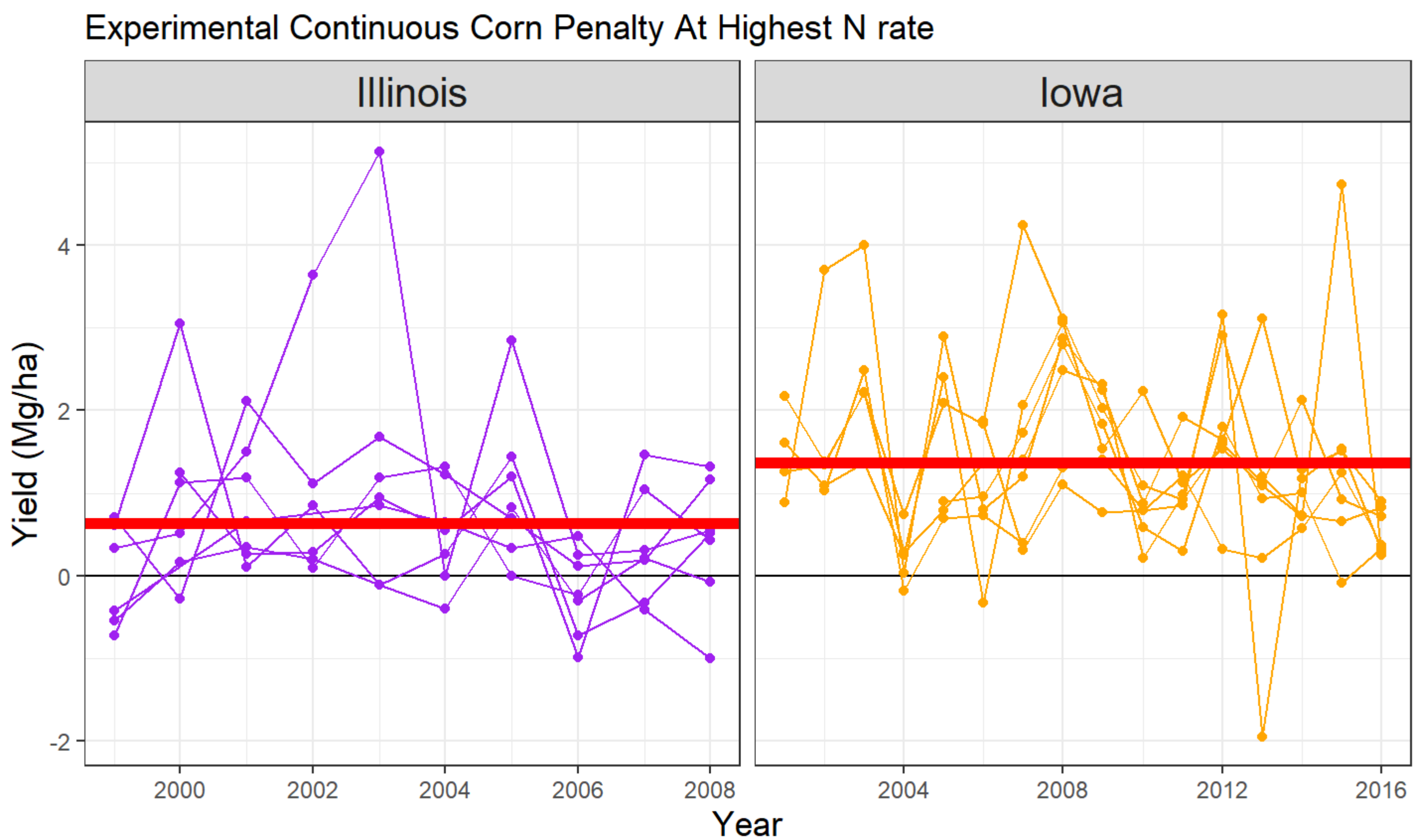
Gap at highest N-rate, absolute values



Previous work

Nothing has been done on a mid-level scale

- Limited to one or two sites (5 studies), or uses satellite data (1 study)
- Statistical models from one site (ex. Gentry et al. 2013) do not work in Iowa (we tried)
- Explore limited explanatory variables

Hypotheses and Objectives

Objectives:

- Use statistical models and experimental data to find environments associated with higher contin. corn penalties
- Use literature to identify physical manifestations of cont. corn penalty
- Use results to incorporate cont. corn yield penalty into APSIM algorithms

Hypotheses and Objectives Cont.

Hypotheses:

H_1 The continuous corn penalty is not random and can be captured and described by a process-based model.

H_0 The penalty is related to biotic phenomena (disease) that cannot be captured by a process-based model that only captures abiotic processes.

Preliminary Approach, Iowa

- Gather variables
- Identify variables with sufficient variation
- Assess colinearity, eliminate highly correlated variables

Resulting Iowa-based variables

Management-based

Management Variables Included In Models				
Variable	units	mean	min	max
Year of experiment	factor	2009	2000	2016
Cont. corn gap at max N rate	kg/ha	1371	-330	4734
Cont. corn gap at max N rate as % of SC yield	%	14	-4	45
Prev year CC yield at max N rate (indicative of residue amount)	kg/ha	8749	2376	13645
Avg yield at max N at that site	kg/ha	9981	8531	11086
Number of Years in Cont Corn	numeric integer	8	1	18

Resulting Iowa-based variables

Weather-based

Weather Variables Included In Models

Variable	units	mean	min	max
# Days w/Tmax > 30oC from planting to 120 DAP (WEA)	days	28	5	70
# Days after planting to acheive 140 GDDs (WEA)	days	24	10	40
Total Precip 2 weeks after planting (WEA)	mm	54	0	252
Total Precip 2 weeks before planting (WEA)	mm	42	0	113
Mean low temp 4 weeks around planting (WEA)	degC	7	1	14
# of days < 4degF Jan 1 - planting (WEA)	days	19	3	50
GDDs 0-2mo after planting (WEA)	10degC base, 30degC max	517	246	797

Resulting Iowa-based variables

Soil-based

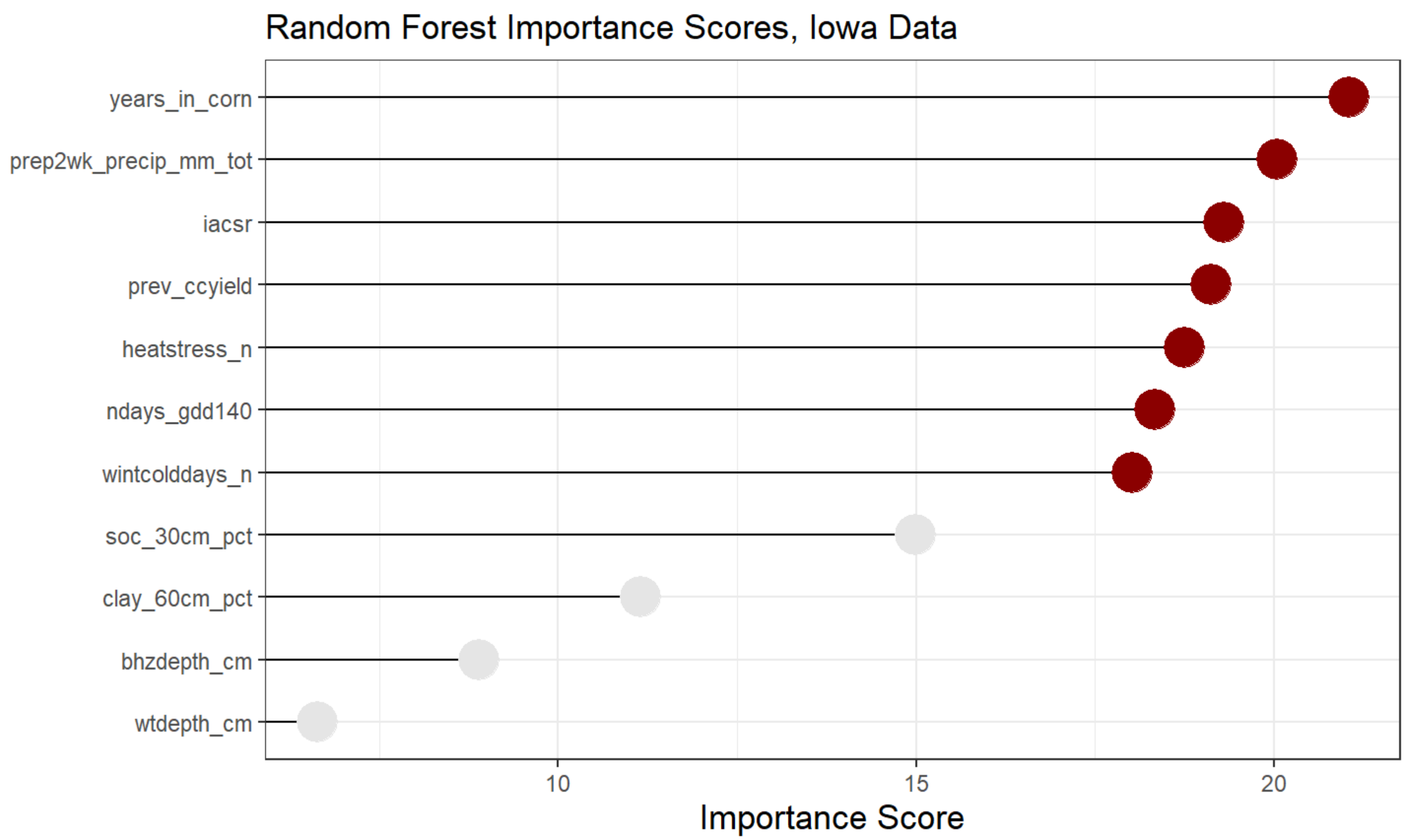
Soil Variables Included In Models

Variable	units	mean	min	max
Depth to Water Table (SSURGO)	cm	142	120	230
Iowa Corn Suitability Rating (SSURGO)	unitless	87	74	97
Depth to B horizon (SSURGO)	cm	33	28	37
0-60cm % clay (SSURGO)	%	20	18	22
0-30cm % organic carbon (SSURGO)	%	2	1	2
0-150cm plant-available-water (SSURGO)	mm	268	225	310

What environments are associated with higher yield gaps in Iowa?

- Random forest models to identify important variables to include in regression analysis
- LASSO regression to quantify magnitude and direction of important associations

Random forest model results



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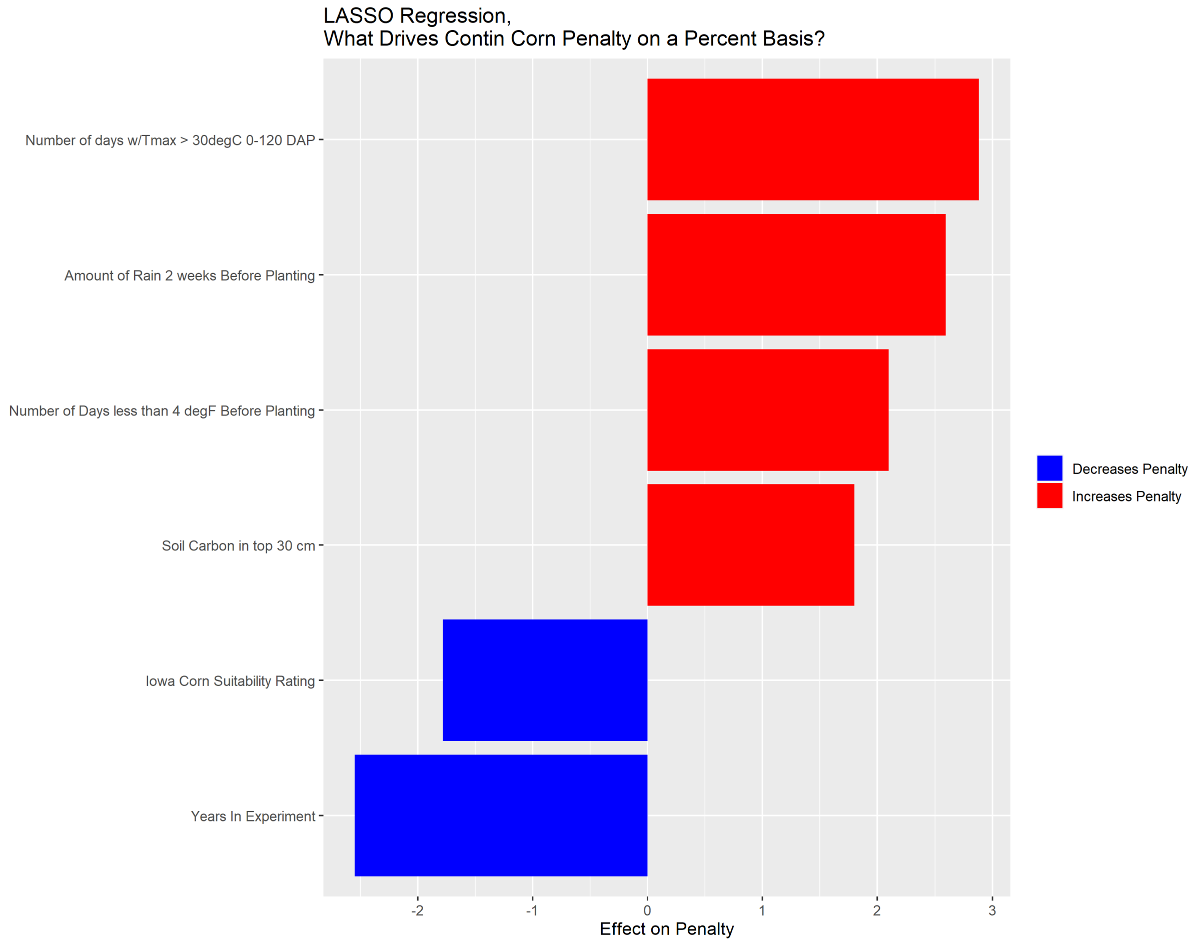
LASSO regression results



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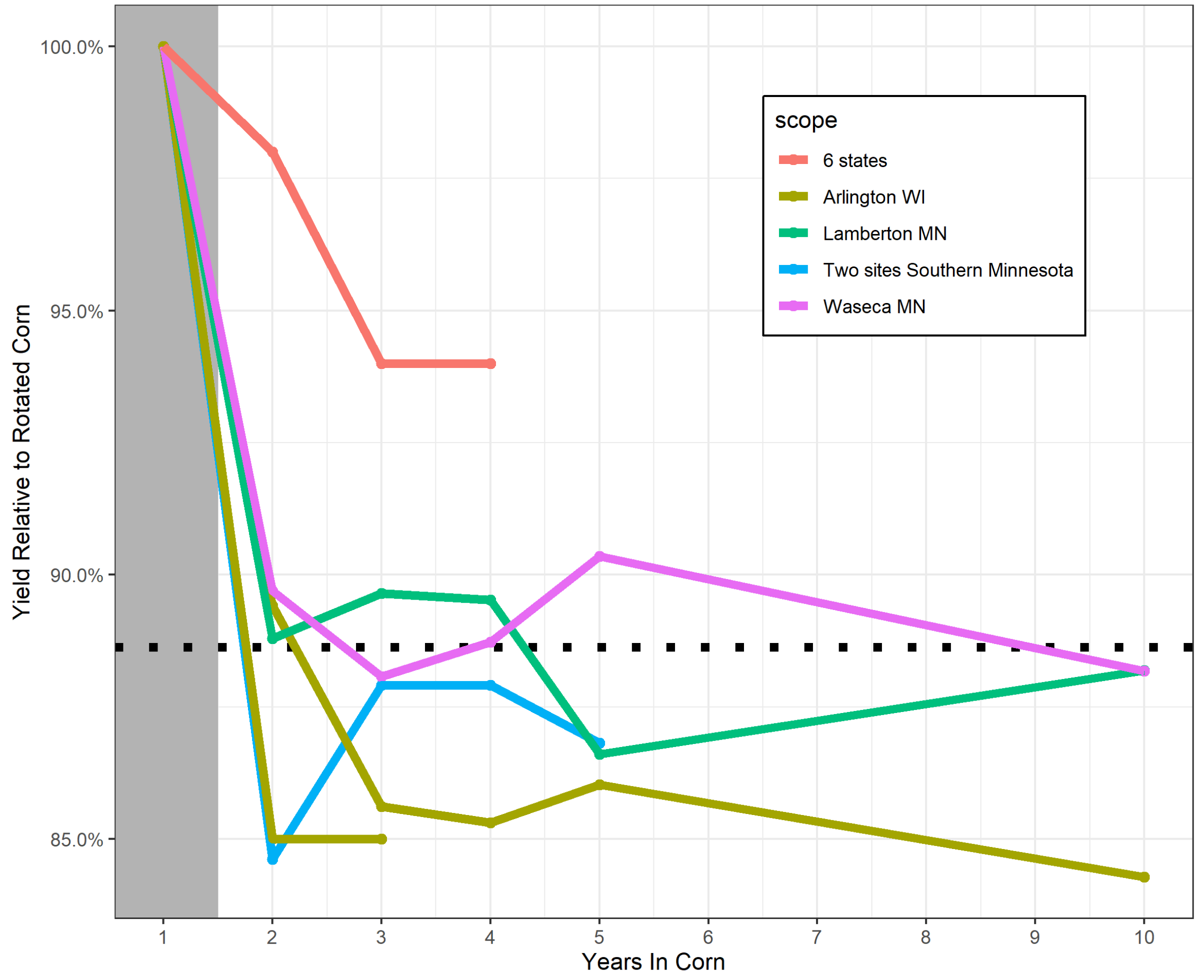
Does the penalty increase over time?



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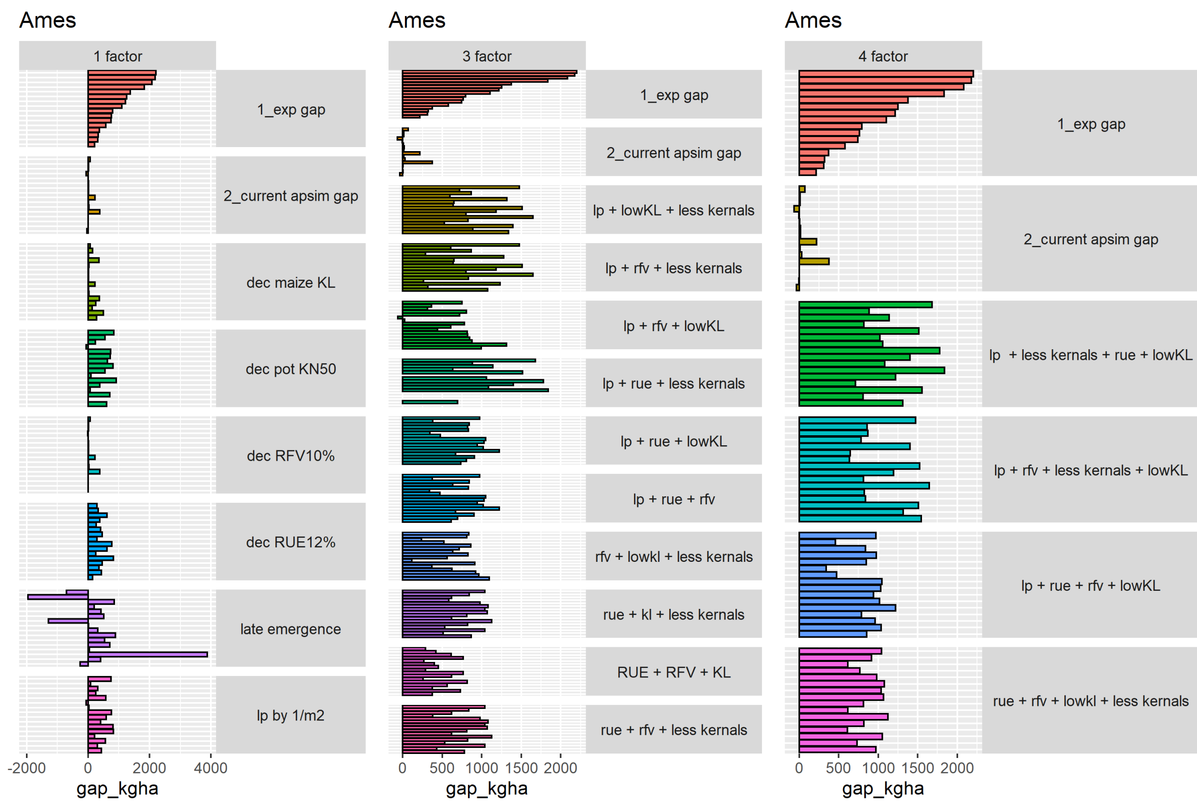
Summary of preliminary results (Iowa-based)

Summary:

- Cold wet springs and hot early growing seasons enhance cont. corn penalty at high N rates
- Penalty is only sensitive to previous year’s crop (number of years in corn not important)

Possible targets in APSIM?

Don’t worry about the acronyms, the point is the magnitude



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APSIM targets

Summary:

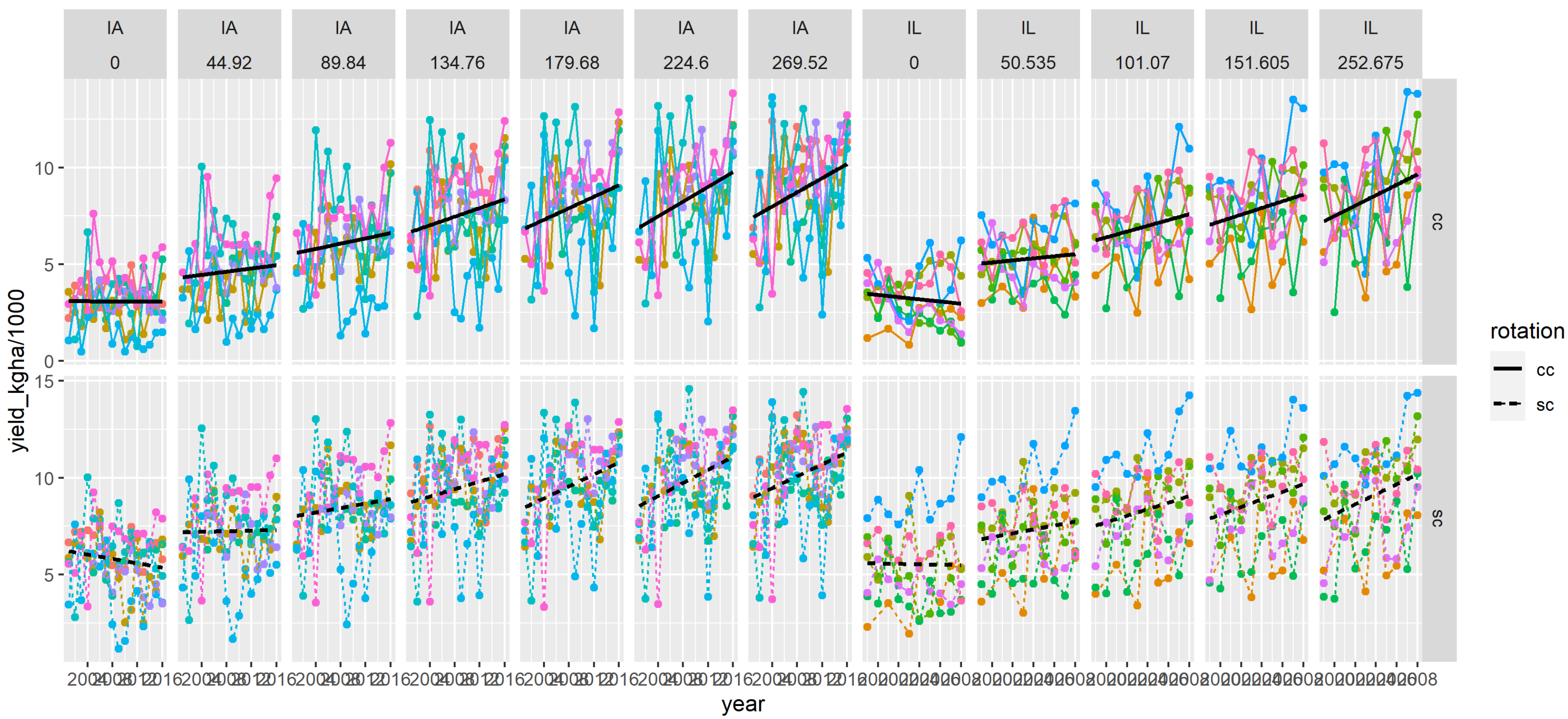
- There are parameters that can be changed that, in combination, re-create the magnitude of the cont. corn penalty
- Creating an algorithm that adjusts these parameters based on soil/weather/management has the potential to capture the patterns

Next steps

Next:

- Include IL data in random forest variable selection and LASSO regression
- Re-evaluate implementation of APSIM adjustments
- Implement select changes in APSIM, assess how model performs

Iowa and Illinois Yields Over Time



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