Session: Dryland No-Till Crop Selection for the High Plains

"Crop Selection in Permanent No-till in Northwest Kansas of the High Plains"

paper at www.agmanager.info

2007 High Plains No-Till Conference

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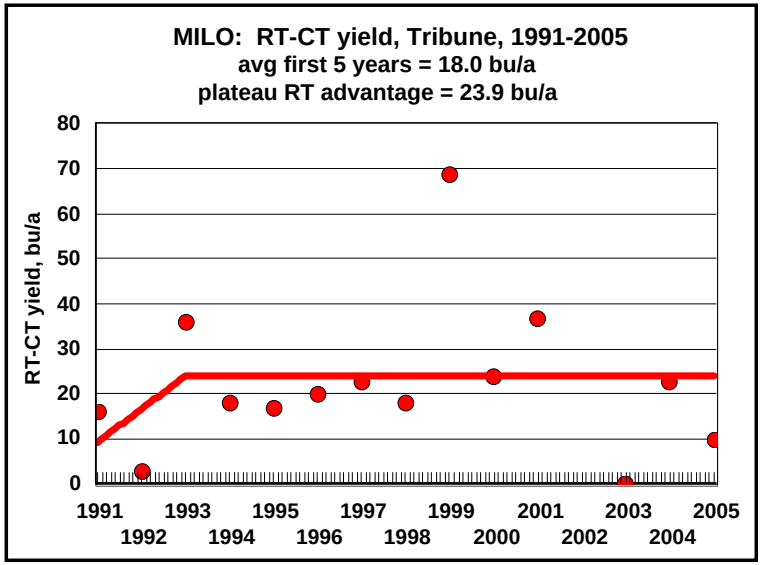
At 2006 "Cover Your Acres" we talked about . . .

- No-till is increasing in High Plains
- No-till is profitable
- Permanent no-till has additional benefits
  - i.e., no-till also ahead of the wheat crop
  - This merits a repeat
- Remember, we best learn when our biases and preconceptions are challenged, not when we merely seek out results that confirm those biases

Tribune Kansas WMF rotation (NT vs. CT)

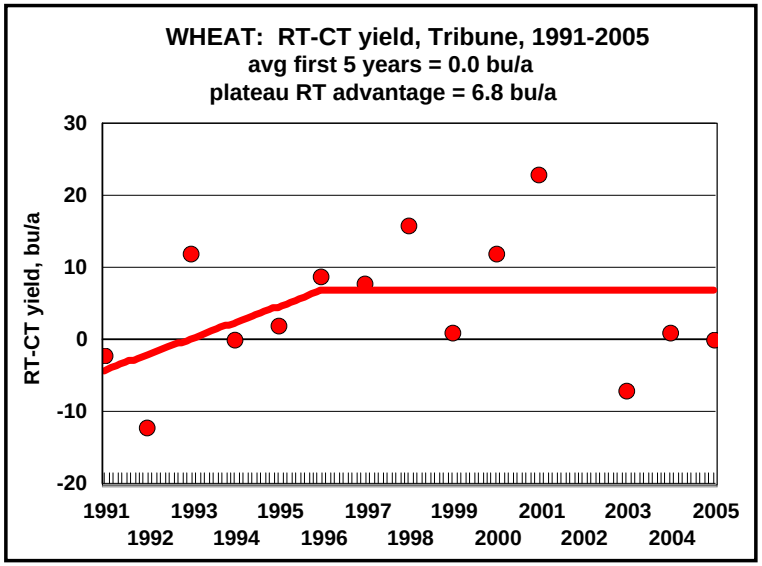
- Wheat
  - NT has 18% more ASW at planting
  - NT has 26% higher grain yields
  - NT has 23% higher WUE
  - NT ASW grows at 0.16 in. per year
  - NT WUE grows at 1.36 lb/in. per year
  - NT yield might grow 1 bu/acre per year
    - Using model of water on yield and growth in ASW and WUE
- Milo
  - NT has 28% more ASW at planting
  - NT has 95% higher grain yields
  - NT has 101% higher WUE
  - NT ASW grows at 0.09 in. per year
  - NT WUE grows at 10.15 lb/in. per year
  - NT yield might grow 3 bu/acre per year
    - Using model of water on yield and growth in ASW and WUE

RT is CT ahead of wheat and NT ahead of milo (milo goes to NT)



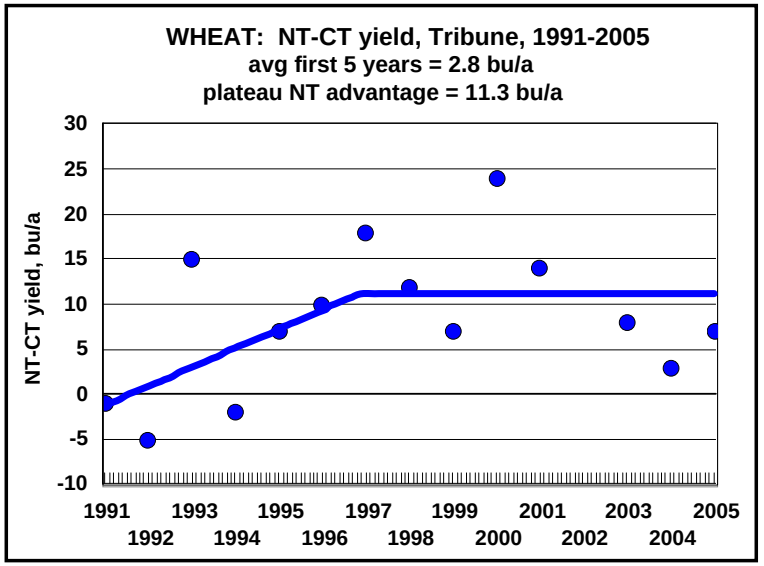
Don't need patience (immediate gains from NT on milo)

RT is CT ahead of wheat and NT ahead of milo (no change in wheat tillage)



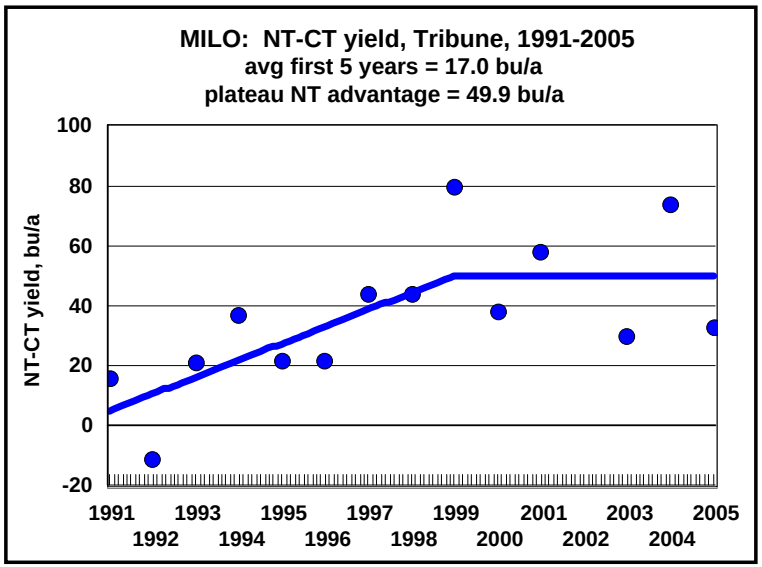
Must have a little patience here on the wheat leg (really, accidental)

NT here means chem-fallow ahead of wheat

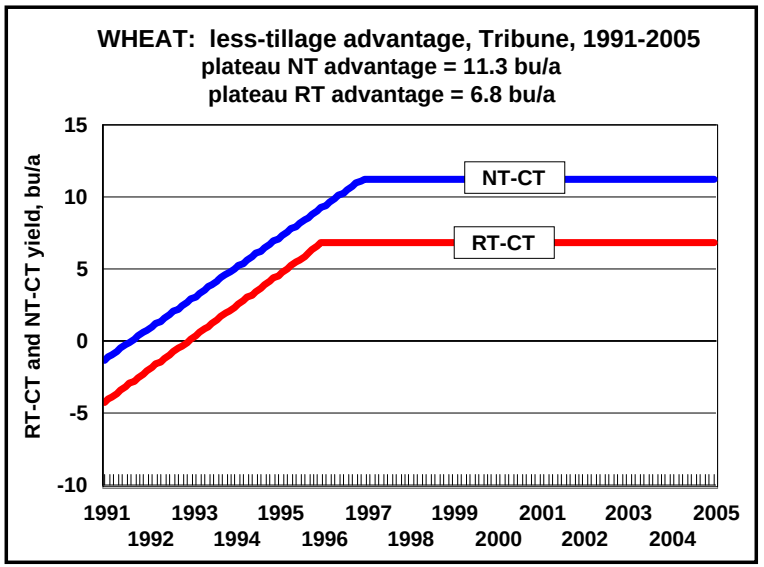


This is the "hard" part (hard ground; chemical vs. tillage $)

Remember, wheat is chem-fallowed here

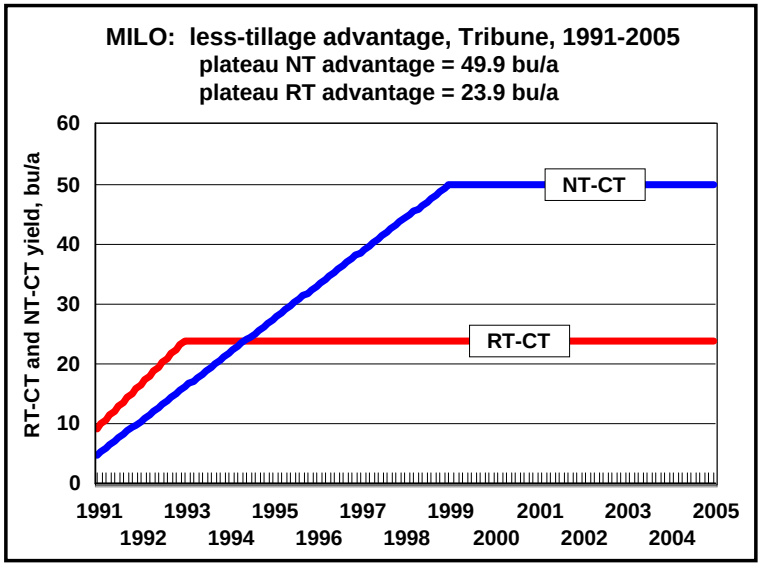


Milo yields continue to increase longer when wheat chem-fallowed

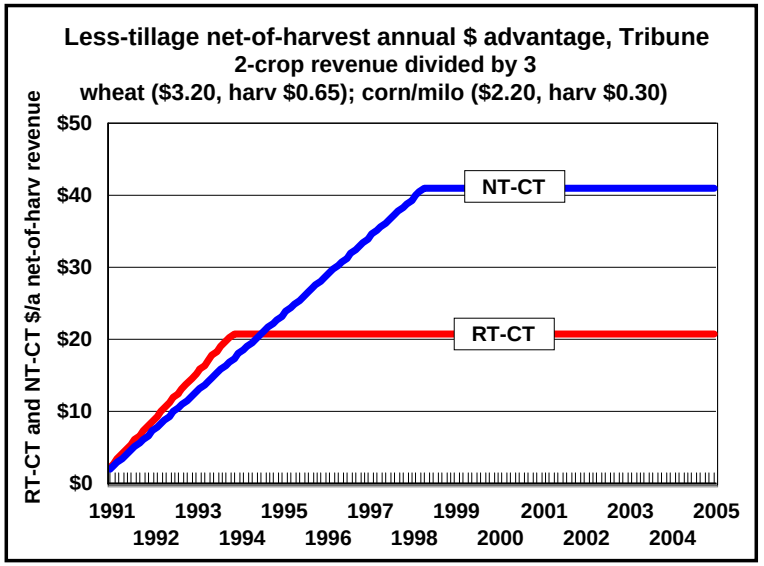


NT-over-RT: 4.5 bu/a (HUGE in this 35 bu/a environment)

Difference in lines is benefit to chem-fallow

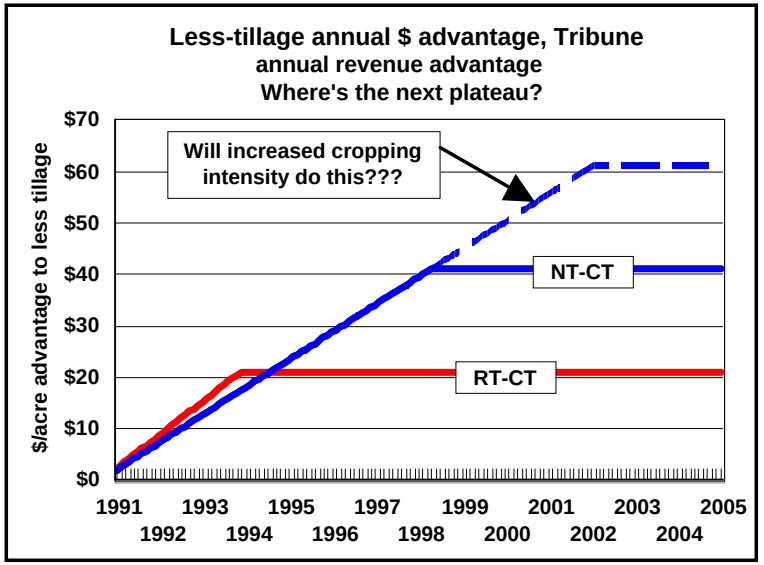


Okay to compare $ if cost of chem-fallow similar to tillage-fallow cost



Change in NT over CT advantage over time

- NT-CT yield difference appears to have grown for about 8-10 years, then leveled
- Do changes in soils and residue that improve water use stop after 8-10 years?
- Or, are we "leaving water on the table," implying that cropping intensity should be increased?
  - A potential advantage somewhat unique to drier areas of the country



What to think about . . .

- If you are currently in a wheat-milo-fallow CT program, move at least to ecofallow (i.e., NT ahead of milo), since well-proven:
  - Will gain 24 bu/a on milo nearly immediately
  - Will gain 6+ bu/a on wheat in 5-6 years
- Then think about continuous NT, i.e., chem-fallow on the wheat:
  - Will pick up *another* 4 bu/a on wheat in about 6-7 yrs
  - Will pick up *another* 26 bu/a on milo in about 7-9 yrs
- Then (or better yet, simultaneously) think about intensifying rotation:
  - To prevent "leaving water on the table"

In 2006, we should have added, "What about corn?"

The Problem

- Field research completed in "good" years suggests more corn and increased cropping intensity
- Field research completed in "tough" years suggests more wheat and more fallow
- Decisions always are made for next year and beyond
- Weather drives profitability and we remember recent weather
- What should we do if we consider a broader array of weather?

The Problem

- Schlegel's tillage study accomplished a lot
  - Challenges our bias about permanent no-till
- Can we extend its inferences to
  - Other crops (e.g., corn)?
  - Other areas in NW Kansas (Colby, Atwood)?
  - Other time periods (weather)?
- Think of this work as "pushing" Schlegel's findings as far as we dare
  - Especially to weaken the recency effect
  - We do run the risk of going "too far"

Mathematical Model

- $ASW_{plant} = f(ASW_{harv}, rain, water\ loss)$
- $Yield = f(ASW_{plant}, rain, water\ loss)$
- $ASW_{harv} = f(ASW_{plant}, rain, water\ loss, Yield)$
- Corn yields are determined by milo yields

Table A1. Data from Schlegel's tillage study of wheat-milo-fallow near Tribune, Kansas, 1991-2005, no-till only.

	Wheat				Milo			
	ASW prev harv	ASW planting	harvest yield	ASW harvest	ASW prev harv	ASW planting	harvest yield	ASW harvest
year	inches	inches	bu/acre	inches	inches	inches	bu/acre	inches
1991	0.33	2.54	15	1.38	0.00	4.91	39	0.40
1992	1.77	4.06	21	1.82	1.38	7.98	27	1.41
1993	0.40	8.23	58	0.76	1.82	5.89	68	2.38
1994	1.41	9.74	46	3.41	0.76	7.64	57	3.29
1995	2.38	6.21	56	3.28	3.41	9.97	59	2.37
1996	3.29	9.37	26	6.29	3.28	3.97	119	3.12
1997	2.37	9.77	52	3.02	6.29	9.74	115	13.44
1998	3.12	9.06	64	0.72	3.02	12.33	131	2.88
1999	13.44	10.48	83	3.33	0.72	7.58	99	5.23
2000	2.88	11.57	44	1.25	3.33	8.68	51	2.10
2001	5.23	5.81	31	2.97	1.25	9.00	64	1.32
2002	2.10	9.27	0	4.45	2.97	2.92	0	1.58
2003	1.32	2.40	30	3.06	4.45	7.11	37	1.64
2004	1.58	6.18	4	4.31	3.06	4.59	118	3.44
2005	1.64	8.13	39	3.03	4.31	7.28	61	3.07
avg.	2.88	7.52	37.93	2.87	2.67	7.31	69.67	3.18

Unsure how much ASW correlates with 6-foot ball rod measurements

Simulation was calibrated to 1991-2005

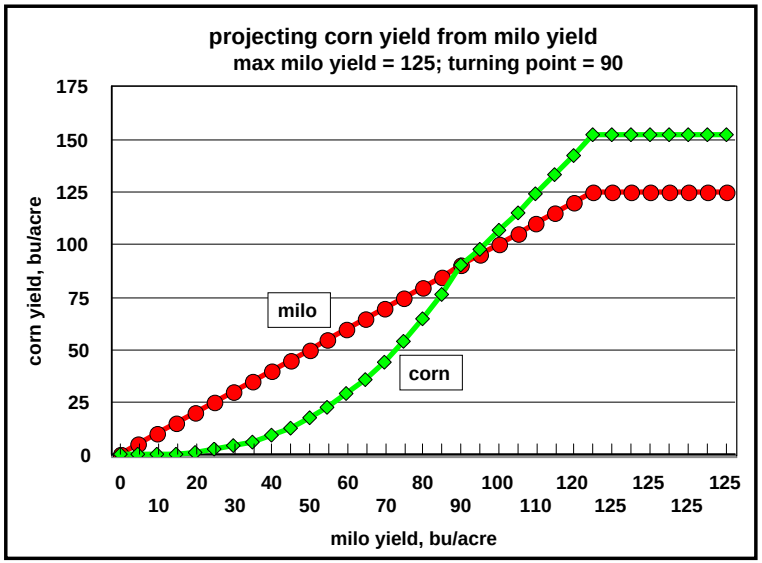
- We assume a good no-tiller in Colby or Atwood would do proportionately as well as Schlegel did in his county relative to the county averages

Mean 1991-2005 NASS and NT yield targets for calibrating simulation						
	NASS yields			NT yield targets in WMF or WCF rotation		
	Greeley Co. Tribune	Thomas Co. Colby	Rawlins Co. Atwood	Tribune	Colby	Atwood
Wheat	27.99	31.47	34.32	37.93	42.55	46.00
Milo	48.11	54.36	49.08	69.67	78.72	71.06
Corn	46.85	52.26	53.48	67.83	75.67	77.44
NASS yields are for wheat following fallow, and non-irrigated totals for milo and corn						
NT targets for Tribune wheat and milo are mean yields in Schlegel's study						

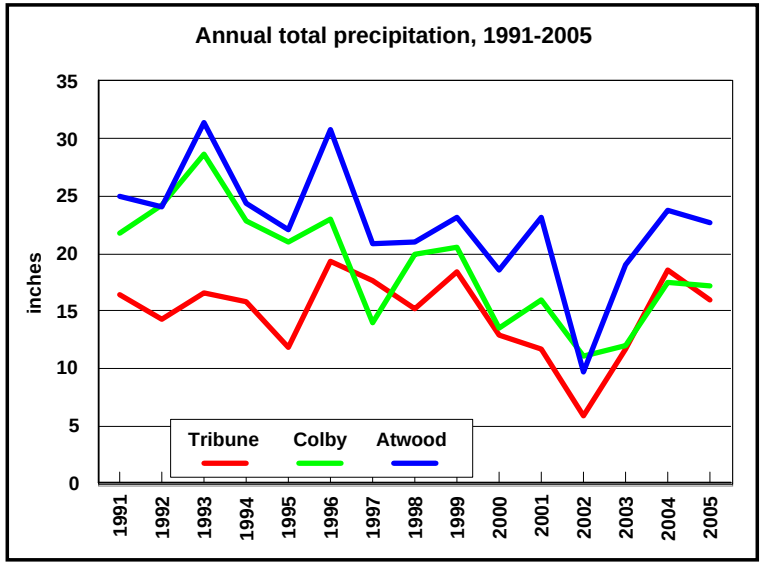
Notice the fairly "high" corn and milo yields targeted for the permanent no-tiller in Colby and Atwood during the time – despite drought in the 2000s. Notice also the corn-milo reversals between Colby and Atwood.

We calibrated models so observed weather gave targeted yields on average.

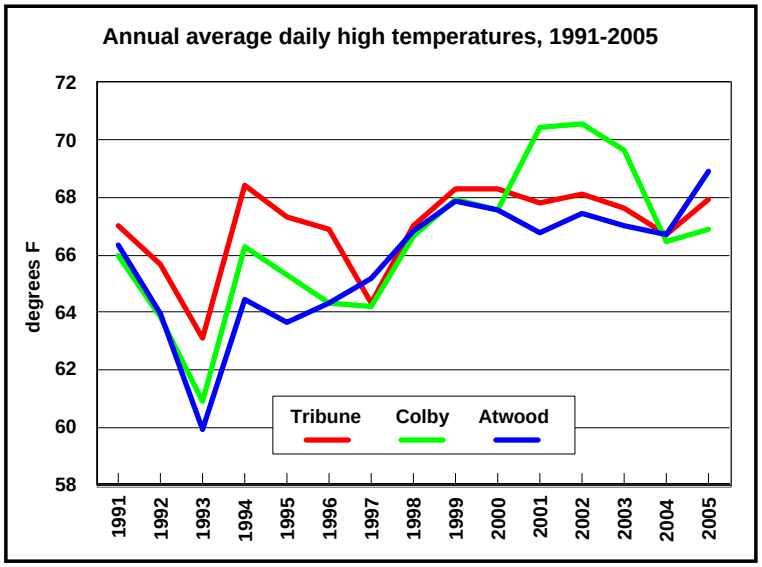
Determining corn yields from milo yields in simulations



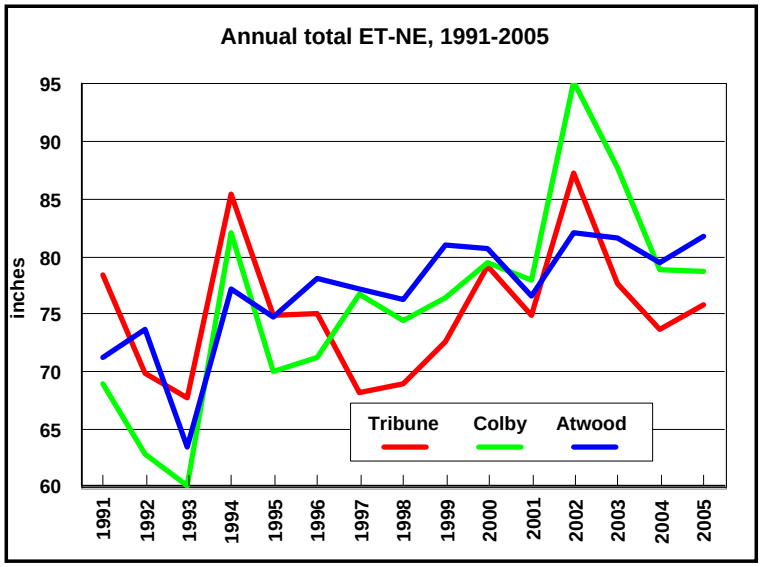
We kept the framework but let the turning point vary by location during the calibration exercise.



Avg. rain Tribune 14.83, Colby 18.88, Atwood 22.65



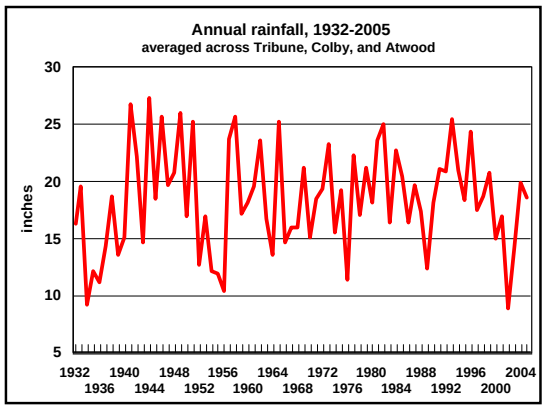
Avg. high temps Tribune 66.97, Colby 66.47, Atwood 65.80



ET-NE (a measure of reference evapotranspiration) is used to represent water loss

After calibration . . .

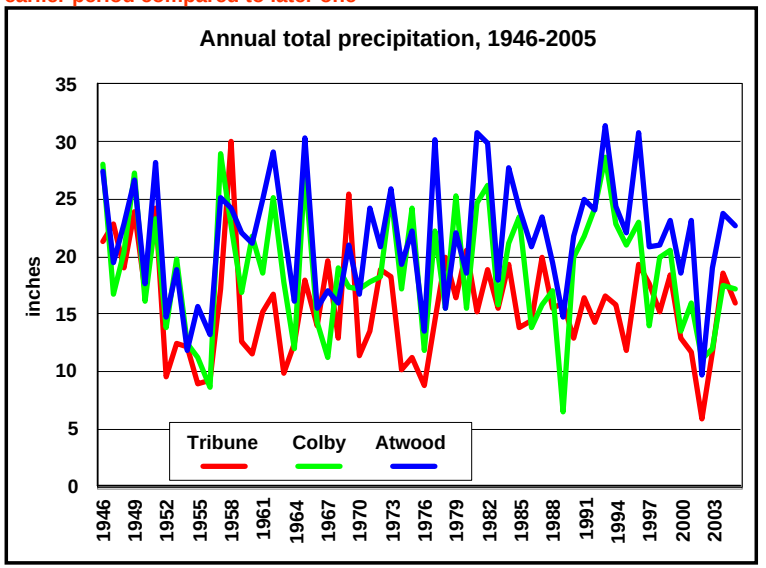
- **What historical weather will best represent the future?**



We settled on selecting two 30-year weather normals, hence 1946-2005.

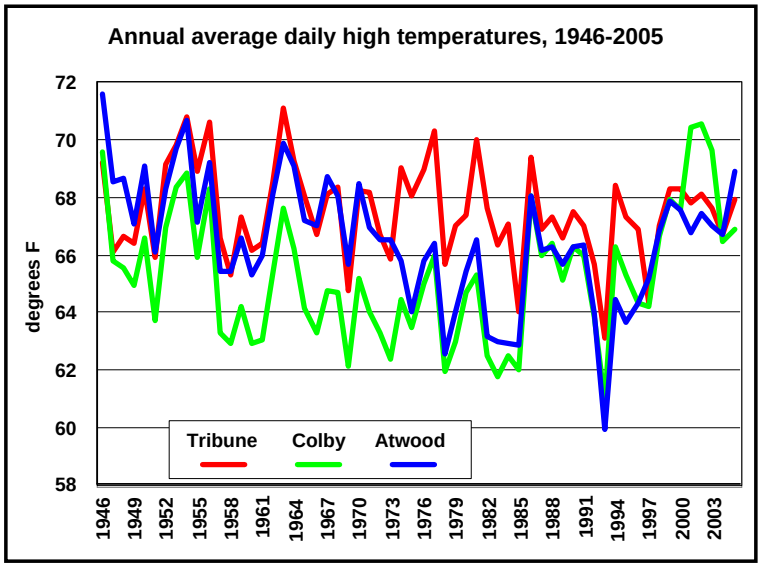
The time period determined only the group of data from which we randomly picked values (didn't actually say that some year had to re-occur). Rather, we randomly constructed a sequence of 150,000 possible years (weather renditions) into the future.

Weather wasn't the same in the past as it was in the 1991-2005 period. Atwood 5.6% less rain 1946-1990 than 1991-2005; Tribune 8.1% more in earlier period compared to later one



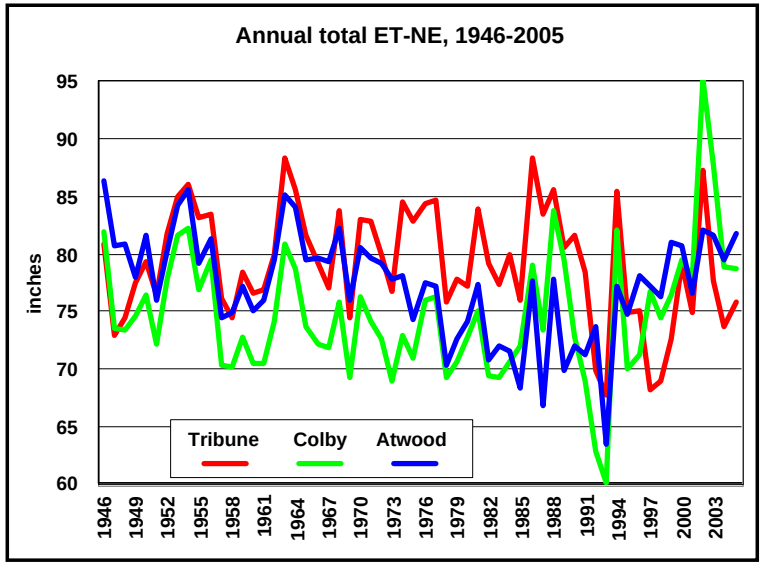
Avg. rain Tribune 15.73, Colby 18.82, Atwood 21.70

Weather wasn't the same in the past as it was in the 1991-2005 period



Avg. high temps Tribune 67.52, Colby 65.26, Atwood 66.49

Weather wasn't the same in the past as it was in the 1991-2005 period



It shouldn't be surprising if we find some less-than-intuitive results

Rotations examined

- WMF wheat-milo-fallow
- WCF wheat-corn-fallow
- WCMF wheat-corn-milo-fallow
- Opp based on ASW_{plant} opportunity
- WF wheat-fallow
- WW wheat-wheat
- MM milo-milo
- CC corn-corn
- CM corn-milo

Opp considered here

- Following wheat
  - Wheat planted back that fall if ASW>5 then
    - Else corn next spring if ASW>6 then
      - Else milo next spring if ASW>4 then
        - Else plant wheat next fall
- Following corn
  - Wheat planted into stalks if ASW>3 then
    - Else corn next spring if ASW>5 then
      - Else milo next spring if ASW>4 then
        - Else plant wheat next fall
- Following milo
  - Plant corn next spring if ASW>5 then
    - Else milo next spring if ASW>4 then
      - Else plant wheat next fall

Could have considered many more – this one had around 85%-90% intensity

Crops with different expected yields

- WaF wheat after long fallow (as in WF)
- WaM wheat after milo (as in WMF)
- WaC wheat after corn
- WaW wheat after wheat (as in WW)
- WaS wheat planted into corn stalks
- MaW milo after wheat (as in WMF)
- MaM milo after milo
- MaC milo after corn
- CaW corn after wheat (as in WCF)
- CaM corn after milo
- CaC corn after corn

Economic assumptions

- Cash prices (expected 3-year avg at Colby)
  - Wheat $4.43, Corn $3.29, Milo $2.86
  - No variation in simulations
- Liquid fertilizer applied at crop removal rates
  - N at $0.33/lb N; P at $0.30/lb P_2O_5
- Harvest at 2005 custom rates + 5%
- Plant $12.50/acre; apply chemicals $4.35/acre
- Herbicide cost from Kastens Farm
- Assume a 65% actuarially fair crop insurance
- Rent is $35/acre in all locations (govt $12)
- Risk: standard deviation and worst6

Table A5. Cost of herbicide and application, fertilizer application, seed, and planting.

crop[a]	herbicide $/crop acre	no. of herbicide applications per crop acre @ $4.35 per applied acre	no. of fertilizer applications per crop acre @ $7.00 per applied acre	seed $/crop acre[b]	total non-fertilizer costs $/crop acre
WaF	19.95	5.25	1	7.00	69.29
WaM	13.30	3.5	1	7.00	55.03
WaC	13.30	3.5	1	7.00	55.03
WaW	10.60	3	1	7.00	50.15
WaS	0.00	0	1	10.50	30.00
MaW	28.34	3.75	0	5.00	62.15
MaM	25.53	2	0	5.00	51.73
MaC	25.53	2	0	5.00	51.73
CaW	26.44	2.75	0	25.00	75.90
CaM	19.79	1	0	21.05	57.69
CaC	19.79	1	0	21.05	57.69

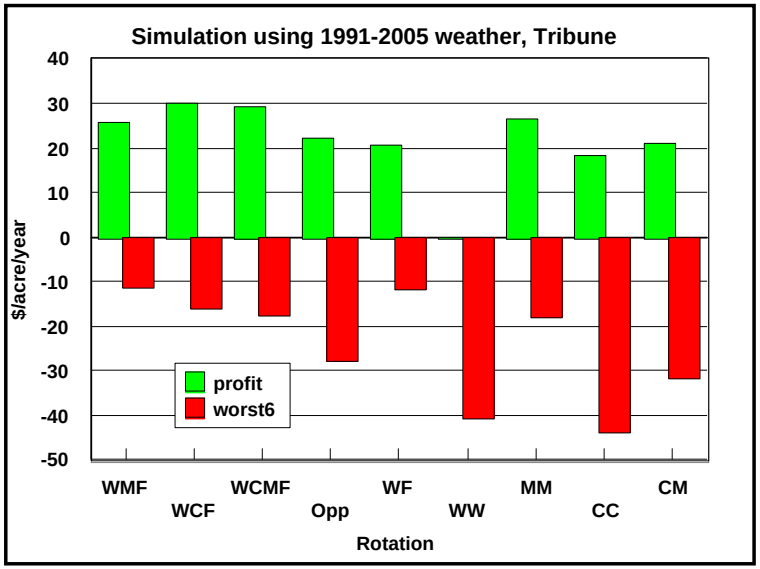
[a] WaF is wheat after long-fallow, as in a wheat-fallow rotation, WaW is continuous wheat, WaM, WaC, MaW, CaW depict the typical crops in a wheat-milo-fallow or wheat-corn-fallow rotation. WaS is wheat after a spring crop, as in wheat planted immediately following corn harvest (into corn stalks). MaM, MaC, CaM, CaC represent milo-milo rotations, milo-corn, corn-milo, and corn-corn.
[b] All crops are assigned a planting charge of $12.50/acre (included in the totals in right column).

Management matters: MaW has about $1/acre/year more herbicide than CaW

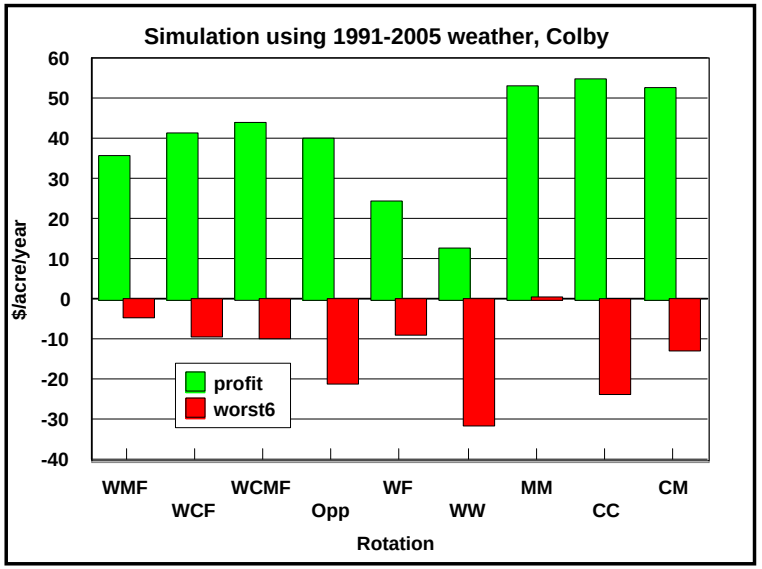
Before we look at long-run 1946-2005 . . .

- Permanent NT targeted yields suggested
  - Tribune: milo 69.7 bu/acre, corn 67.8 bu/acre
  - Colby: milo 78.7 bu/acre, corn 71.1 bu/acre
  - Atwood: milo 75.7 bu/acre, corn 77.4 bu/acre
  - Wheat: Tribune 37.9, Colby 42.5, Atwood 46.0
- Wheat especially good in Atwood
- Corn better than milo in Atwood
- Milo better than corn in Colby

- Remember, these are permanent NT yields
  - Bumps both wheat and row crop yields



If had 15-year intuition with permanent NT, this might be what you'd think



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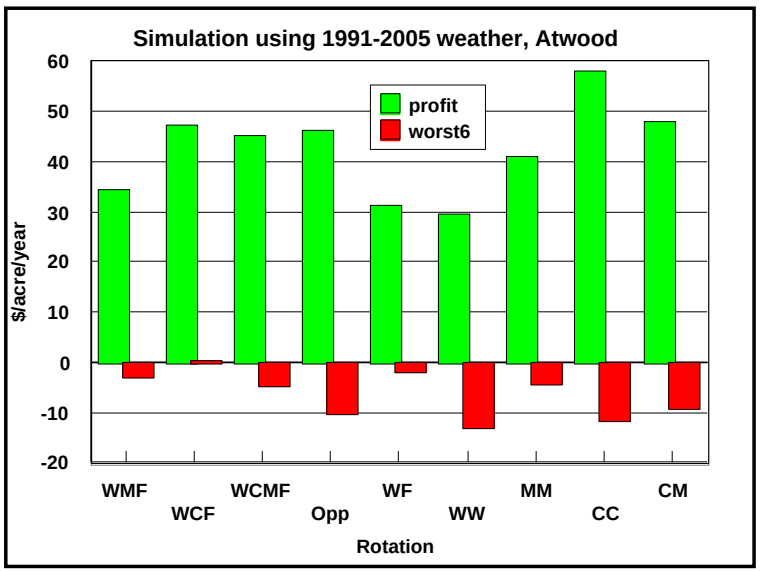
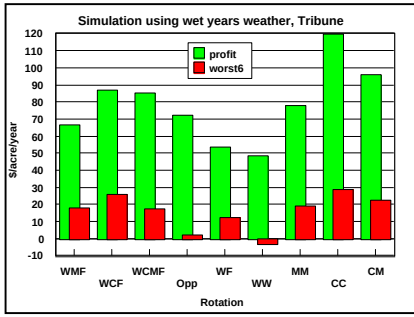
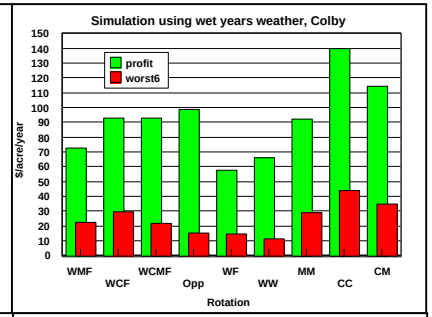


If had 15-year intuition with permanent NT, this might be what you'd think

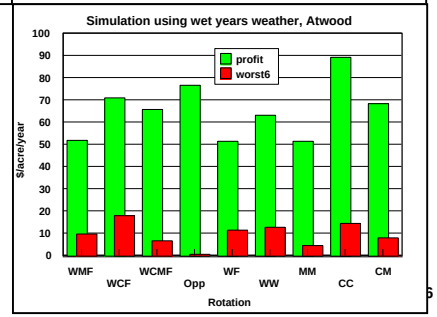
Looking at wet years first (the 37 of 74 total 1932-2005) across all locations



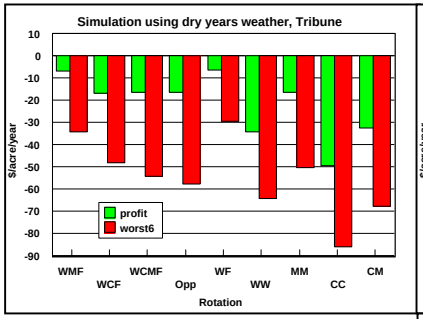


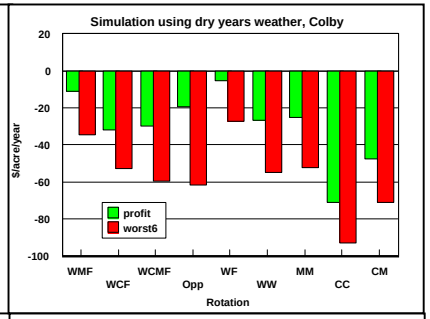
Added annual rainfall together for the 3 locations, then picked out the wettest 37 of the 74 years

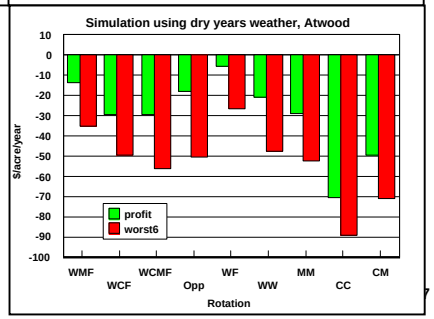
Grow corn



dry years (the 37 of 74 total 1932-2005) across all locations

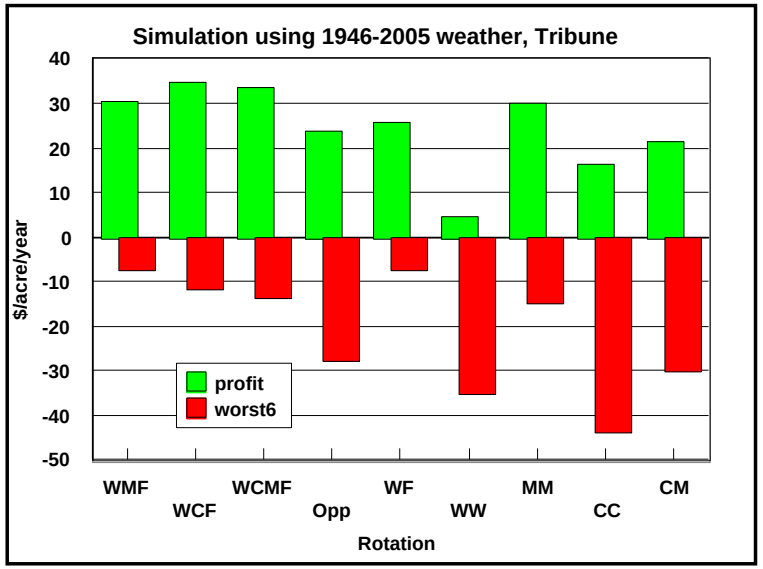




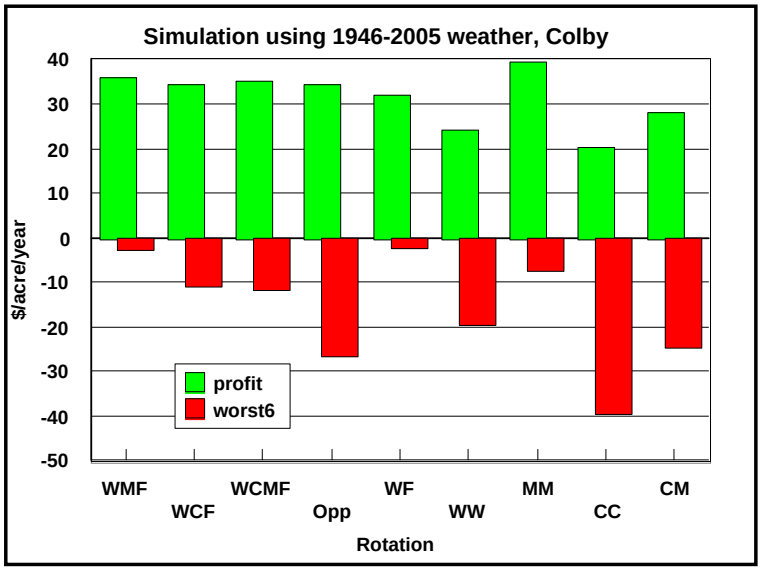


Grow summerfallow wheat

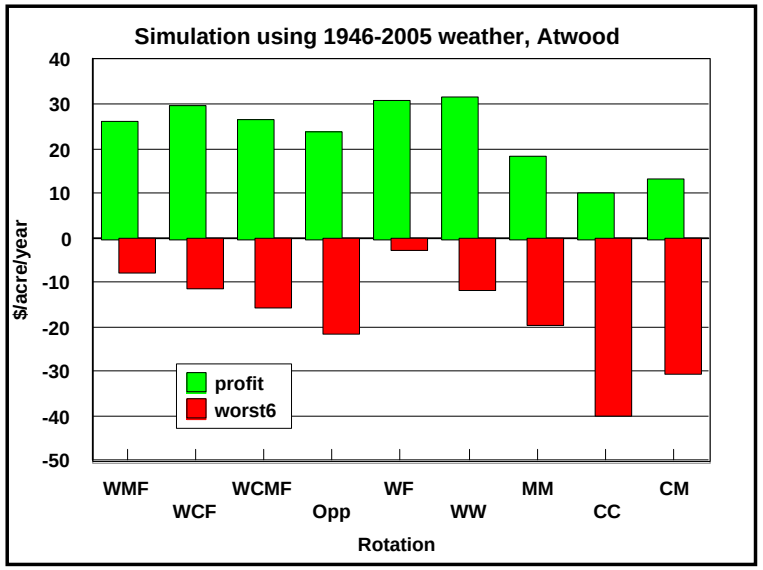
But, WMF not a bad low-risk alternative



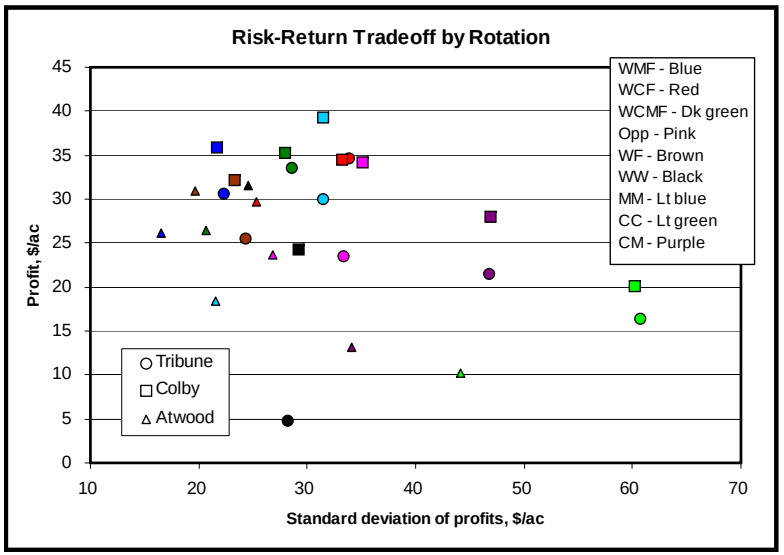
Think about very little WW, more row crops, more intensity?



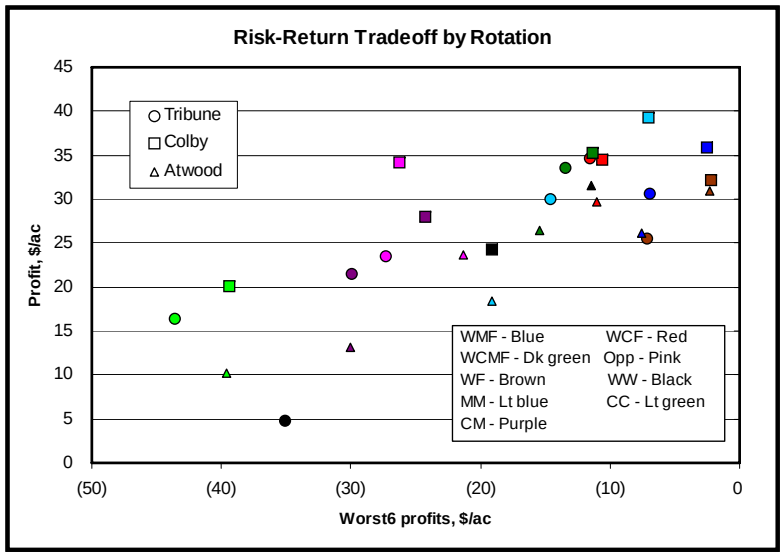
Think about more row crops, more intensity, maybe more MM?



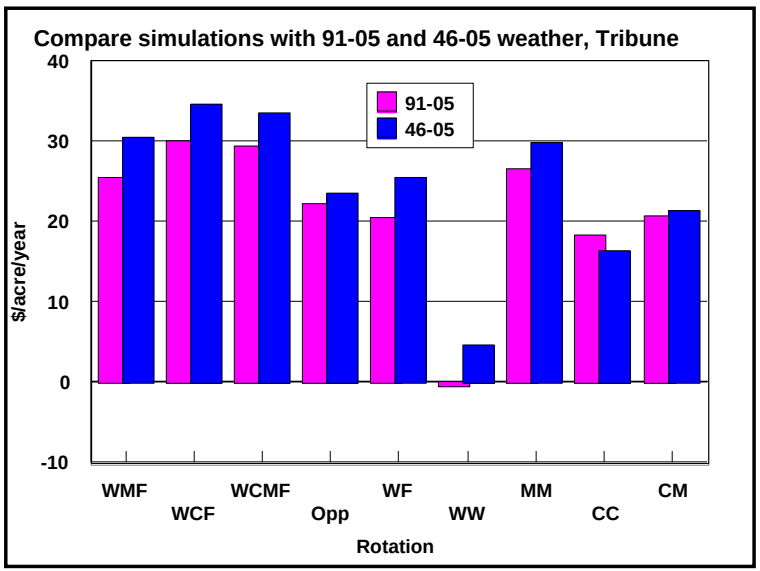
Think about more wheat?



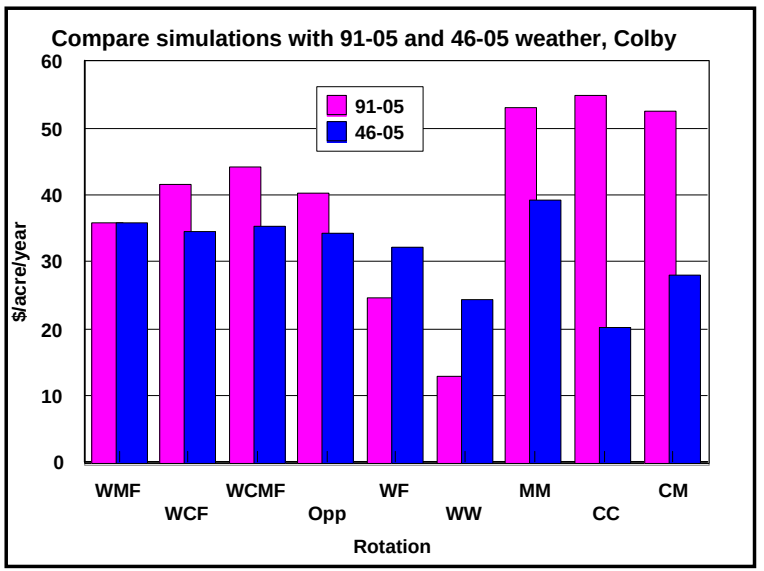
Not much relationship between profit and risk across rotations



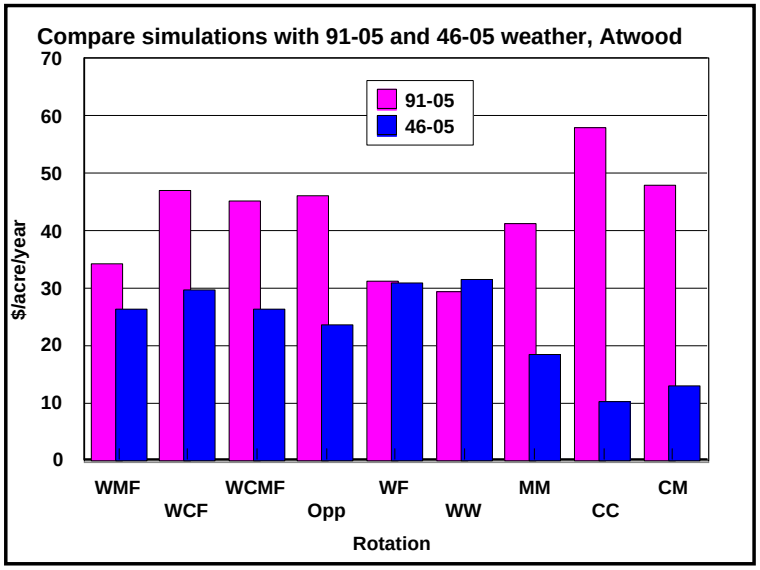
Risk-reward relationship is opposite of what you might expect



1991-2005 intuition may serve you well in the future



1991-2005 intuition not terrible but likely would over-rate intensity some



1991-2005 intuition may not serve you very well in the future

Caveats

- No consideration of
  - Crops like sunflowers and soybeans
  - "New" crops like canola or peas
- Ignored idea that permanent no-till improves yields over time, perhaps disproportionately
- Reflects relative technology in 1991-2005
  - Corn benefits more from technology
  - Adequate account of biofuel craze?
- Continuous crops did not consider disease & weeds
- Increased global warming or cooling would negate our efforts

Summary

- Adding more years of weather as a predictor for the future can negate our intuition
- No holy grail
- WMF & WCF likely around for awhile
- Surprises
  - Opp not particularly great
  - WW bad in Tribune, good in Atwood
  - WF still holding its own
- Recommendations
  - Focus main effort on more important tasks, for example machinery management
  - Then focus on tweaking crop rotations

Questions ???

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