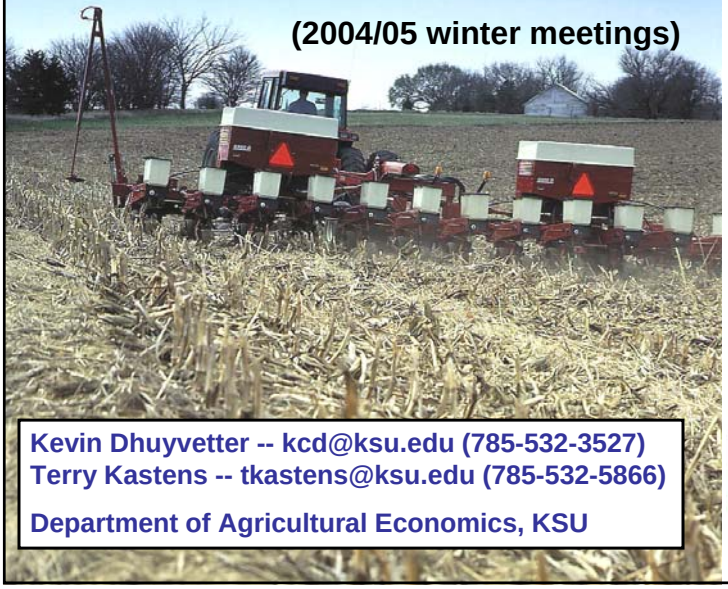
Economics of No-Till

No-till in Kansas: Where Does it Fit?

(2004/05 winter meetings)



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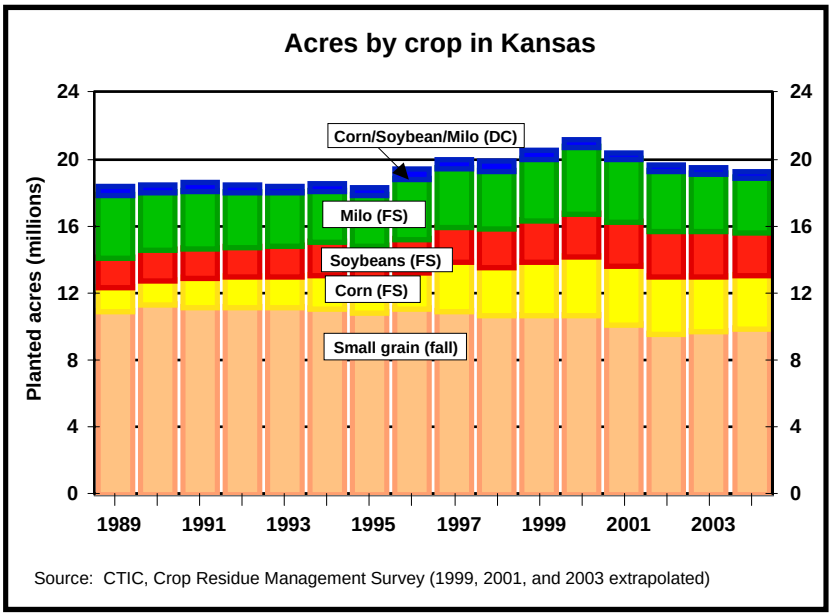
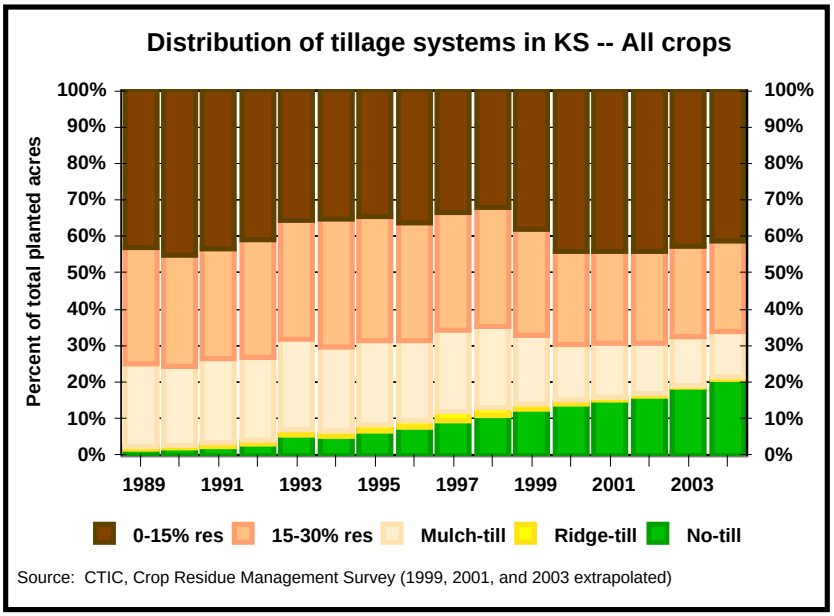
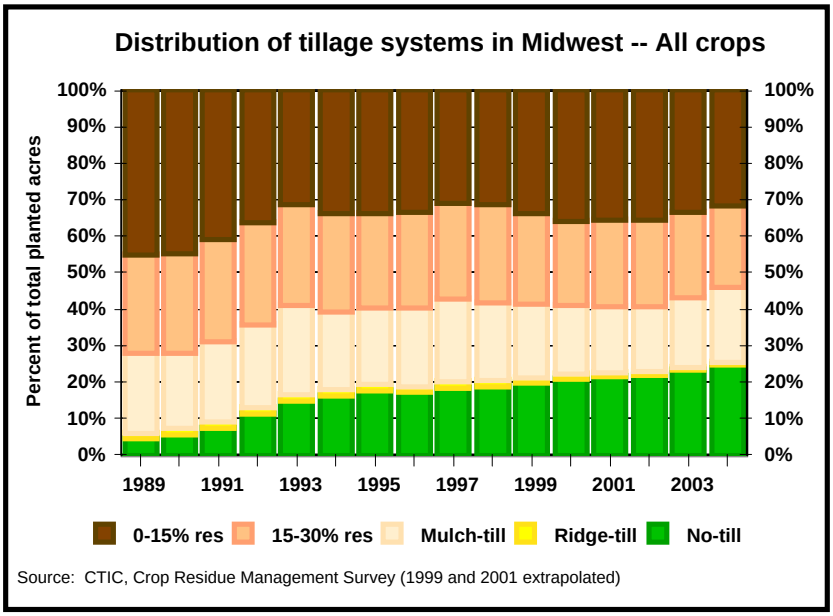
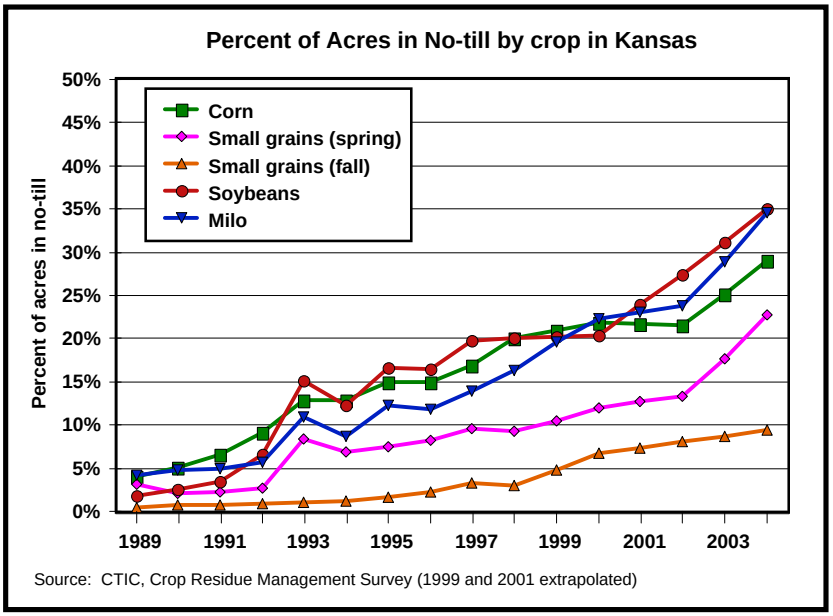
What I'm going to talk about ...

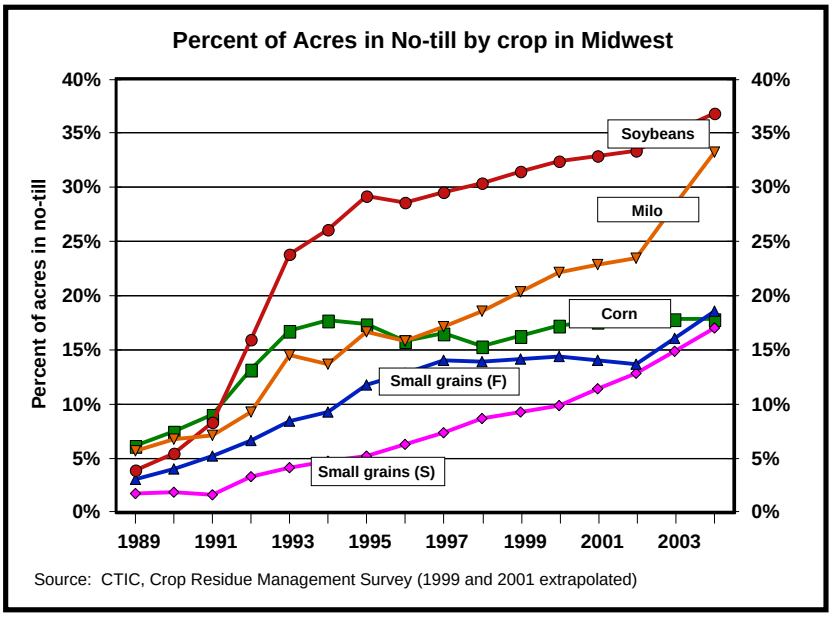
- ✓ **Trends in no-till acreage in Kansas**
- ✓ **Impact of tillage on yields**
- ✓ **Impact of tillage on costs**
- ✓ **Economic analysis using KFMA data**
- ✓ **Impact of NT on equitable crop share leases**


Acres by crop in Kansas
Planted acres (millions)
24
20
16
12
8
4
0
Corn/Soybean/Milo (DC)
Milo (FS)
Soybeans (FS)
Corn (FS)
Small grain (fall)
1989
1991
1993
1995
1997
1999
2001
2003
Source: CTIC, Crop Residue Management Survey (1999, 2001, and 2003 extrapolated)

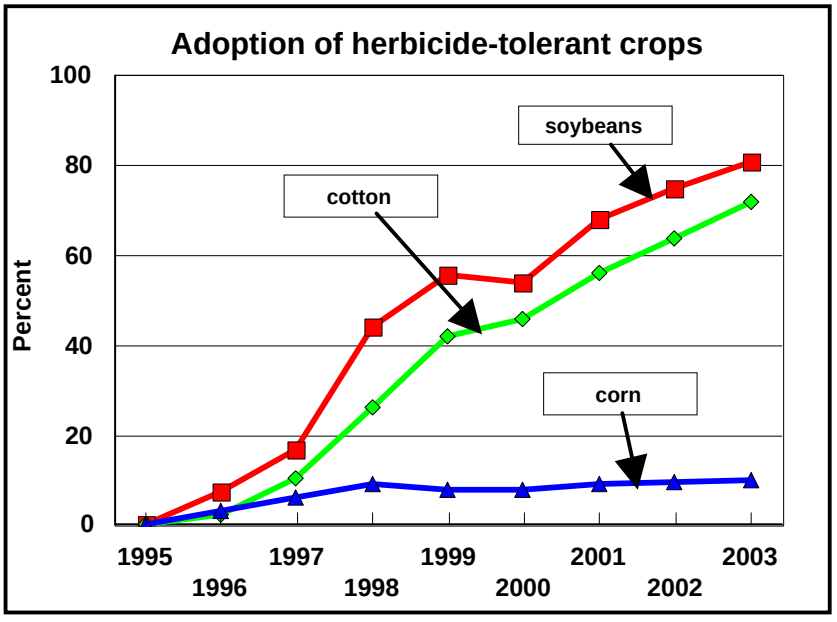

Distribution of tillage systems in KS -- All crops
Percent of total planted acres
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1989
1991
1993
1995
1997
1999
2001
2003
0-15% res
15-30% res
Mulch-till
Ridge-till
No-till
Source: CTIC, Crop Residue Management Survey (1999, 2001, and 2003 extrapolated)


Distribution of tillage systems in Midwest -- All crops
Percent of total planted acres
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1989
1991
1993
1995
1997
1999
2001
2003
0-15% res
15-30% res
Mulch-till
Ridge-till
No-till
Source: CTIC, Crop Residue Management Survey (1999 and 2001 extrapolated)


Percent of Acres in No-till by crop in Kansas
Percent of acres in no-till
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
1989
1991
1993
1995
1997
1999
2001
2003
Corn
Small grains (spring)
Small grains (fall)
Soybeans
Milo
Source: CTIC, Crop Residue Management Survey (1999 and 2001 extrapolated)



Source: CTIC, Crop Residue Management Survey (1999 and 2001 extrapolated)



Through 2002 from USDA/ERS; 2002-03 soybeans from Soybean Digest; 2002-03 corn and cotton are a KSU extrapolation

Possible reasons for switching to reduced or no-till ...

- ✓ Increase profitability
- ✓ Reduce labor requirements
- ✓ Reduce machinery cost/acre
- ✓ Increase acres farmed
- ✓ Reduce moisture stress/increase yield
- ✓ Conservation compliance/soil erosion
- ✓ Other (e.g., wildlife, carbon sequestration)

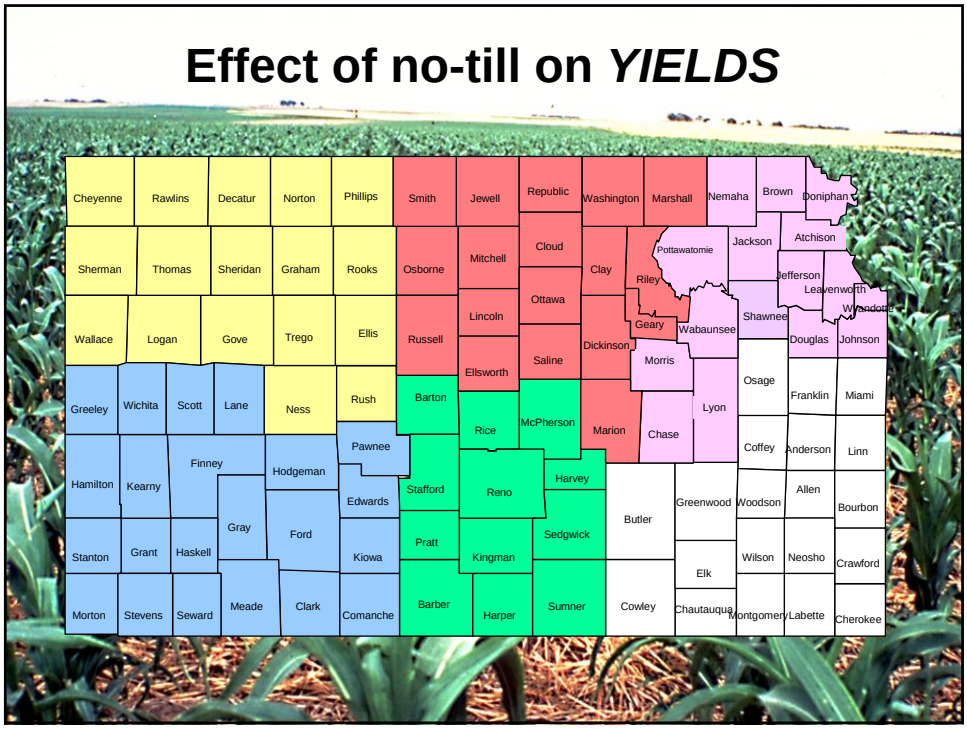
Profitability ...

Revenue (yield x price)
- Cost (variable and fixed)

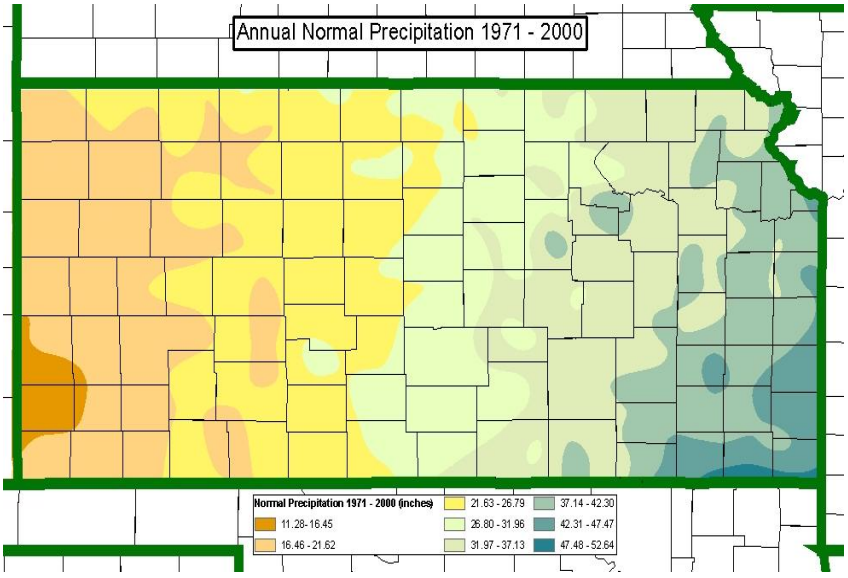
Profit or net returns

Tillage won't impact price, thus profitability will depend on how yields and costs are affected by reducing tillage.

Effect of no-till on *YIELDS*

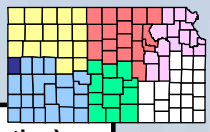


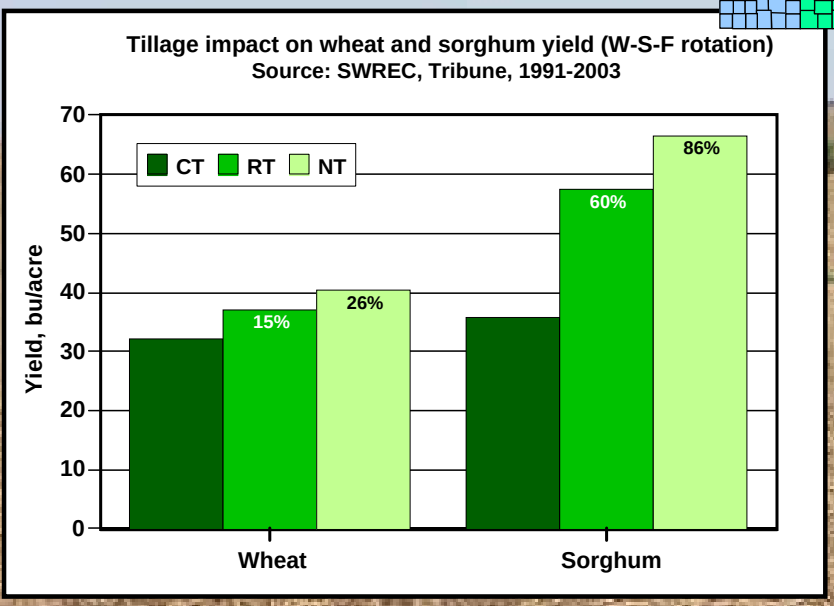
Kansas Annual Precipitation, 1971-2000



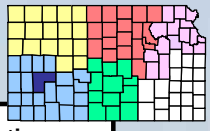
Source: K-State Weather Data Library -- www.oznet.ksu.edu/wdl

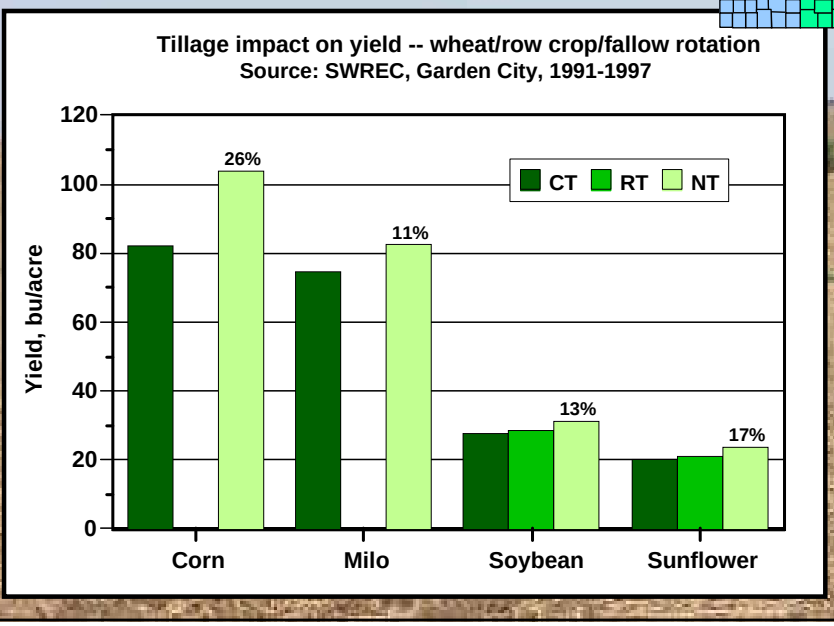
K-State research data



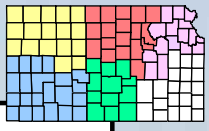


K-State research data

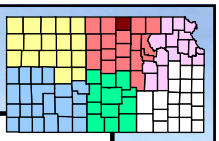




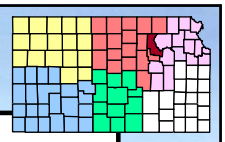
Farm-level data

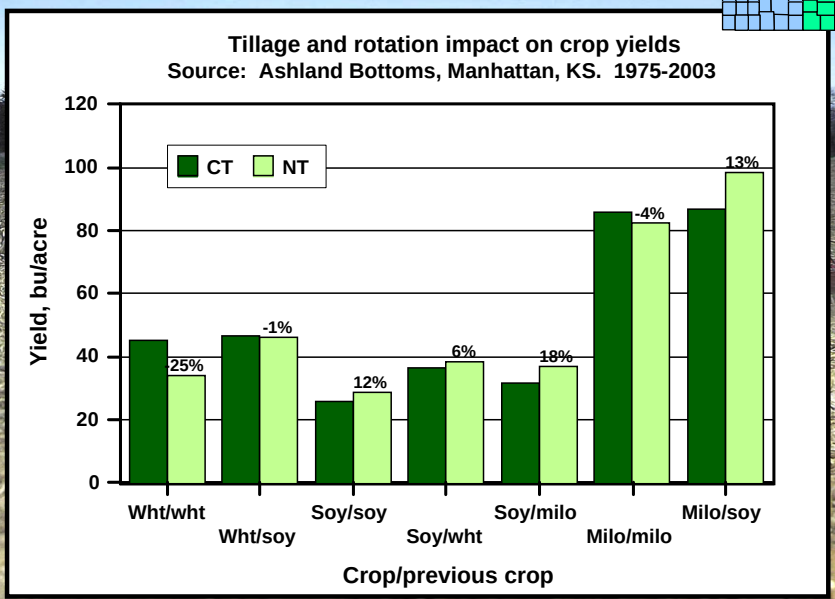


K-State research data

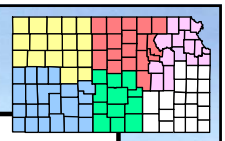


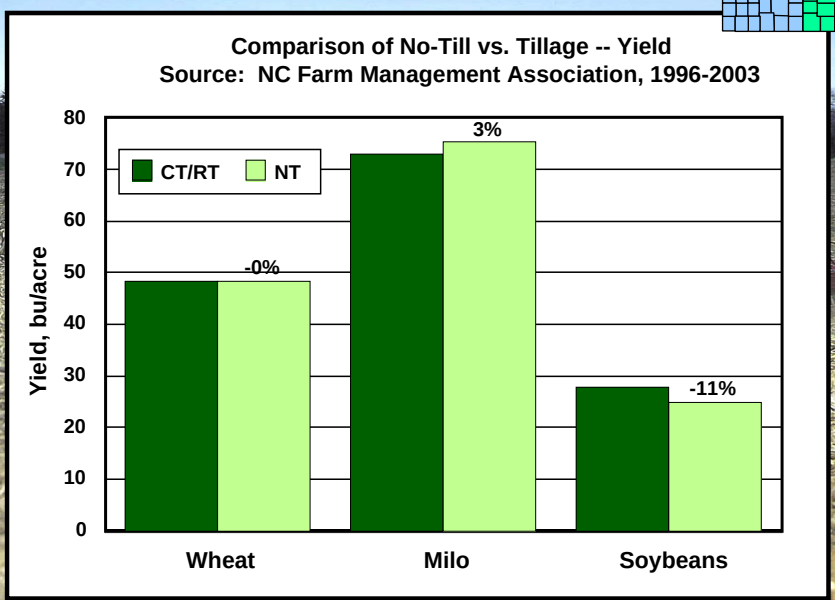
K-State research data

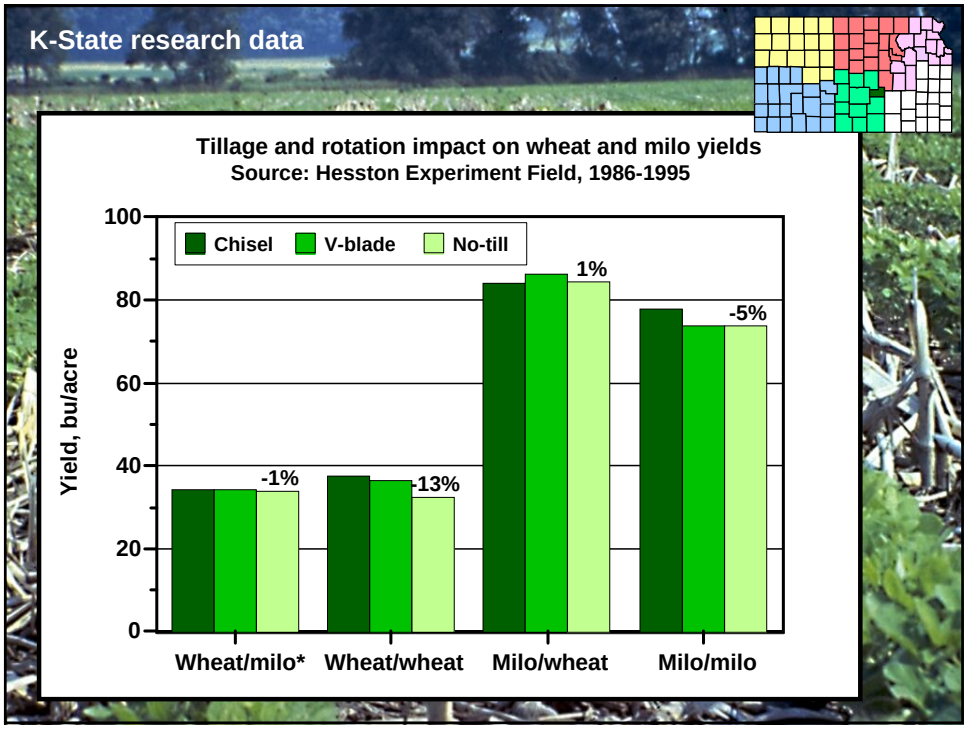


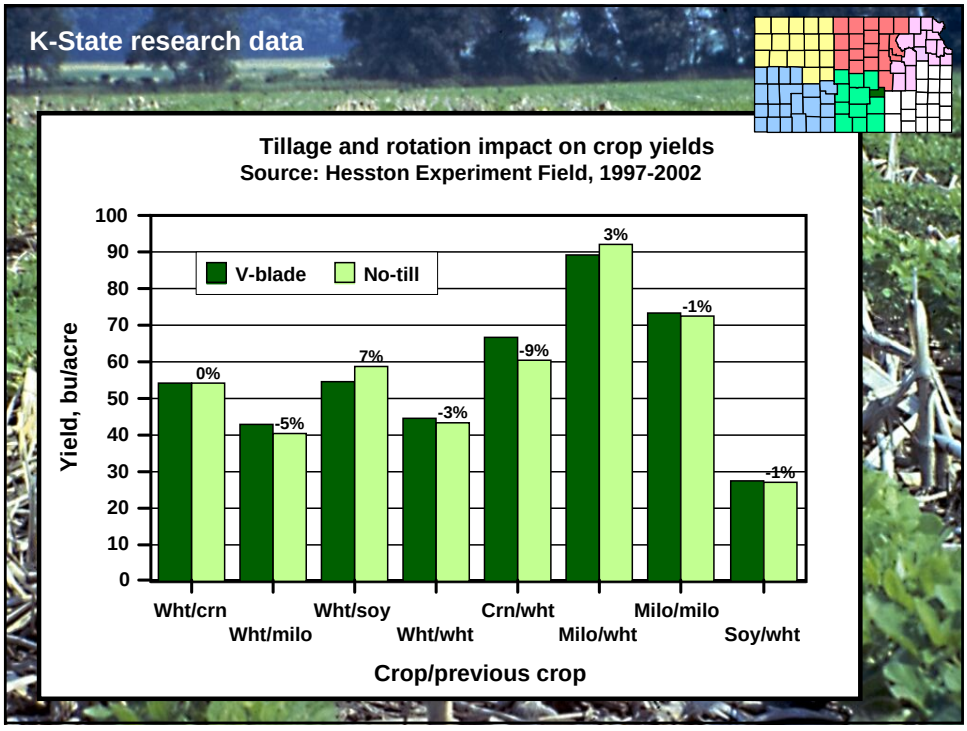


Farm-level data

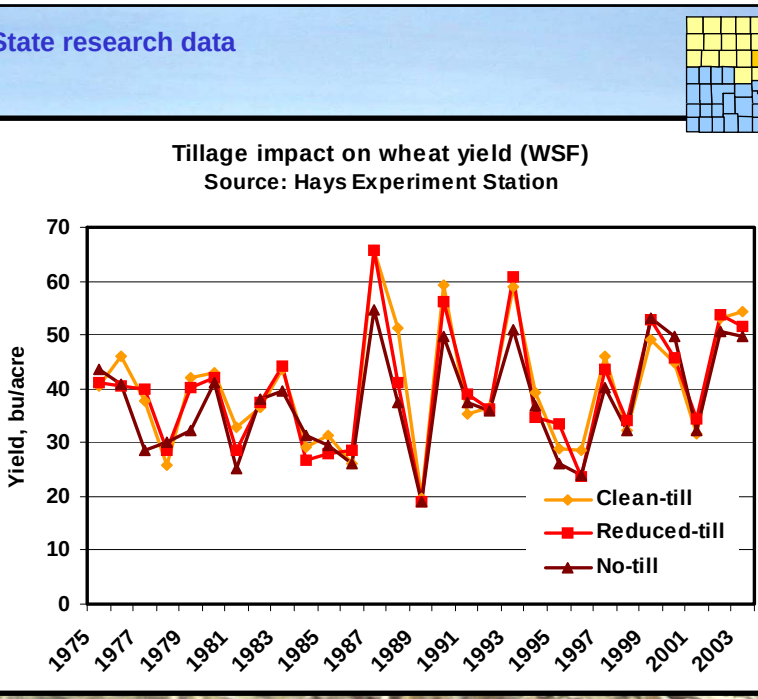





K-State research data
Tillage and rotation impact on wheat and milo yields
Source: Hesston Experiment Field, 1986-1995
Chisel
V-blade
No-till
Yield, bu/acre
100
80
60
40
20
0
-1%
-13%
1%
-5%
Wheat/milo*
Wheat/wheat
Milo/wheat
Milo/milo


K-State research data
Tillage and rotation impact on crop yields
Source: Hesston Experiment Field, 1997-2002
V-blade
No-till
Yield, bu/acre
100
90
80
70
60
50
40
30
20
10
0
0%
-5%
7%
-3%
-9%
3%
-1%
-1%
Wht/crn
Wht/milo
Wht/soy
Wht/wht
Crn/wht
Milo/wht
Milo/milo
Soy/wht
Crop/previous crop

K-State research data



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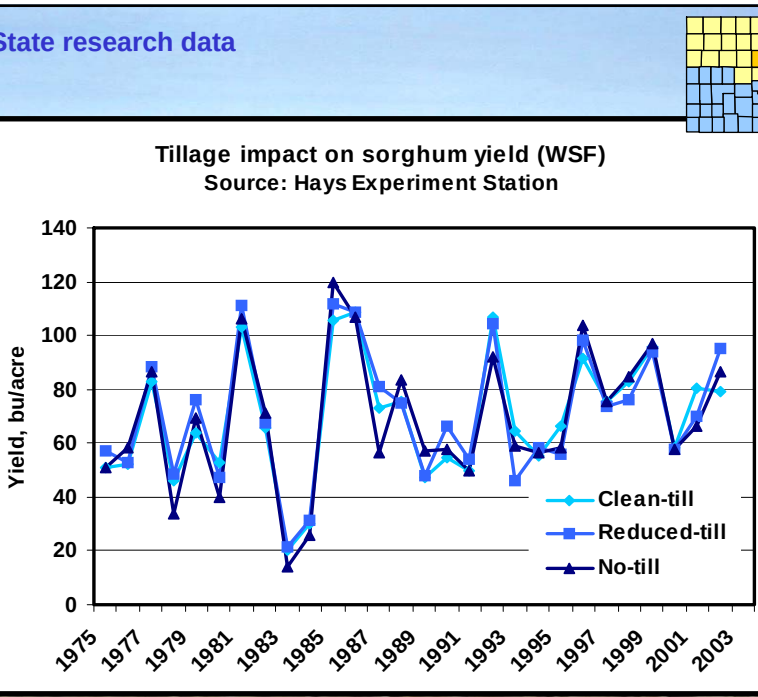
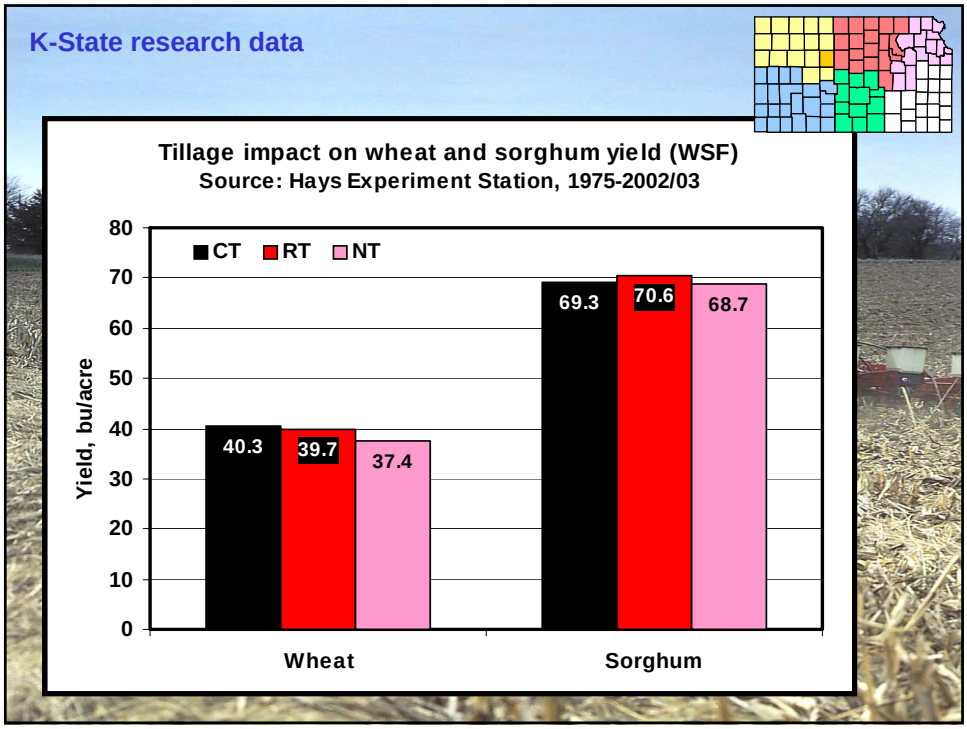
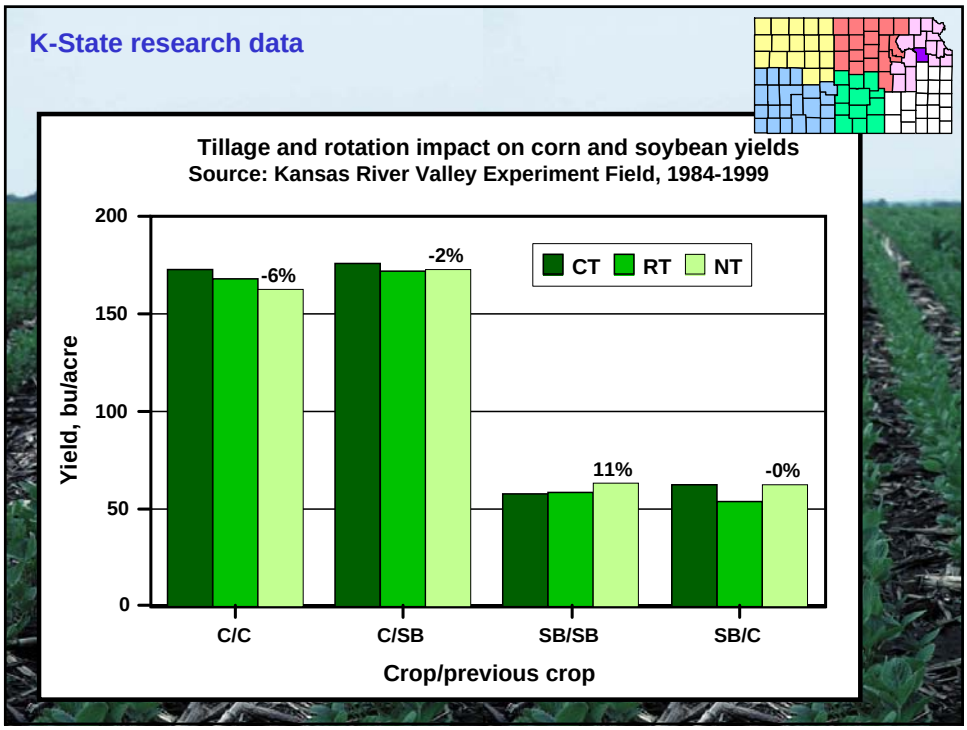
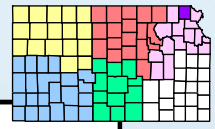
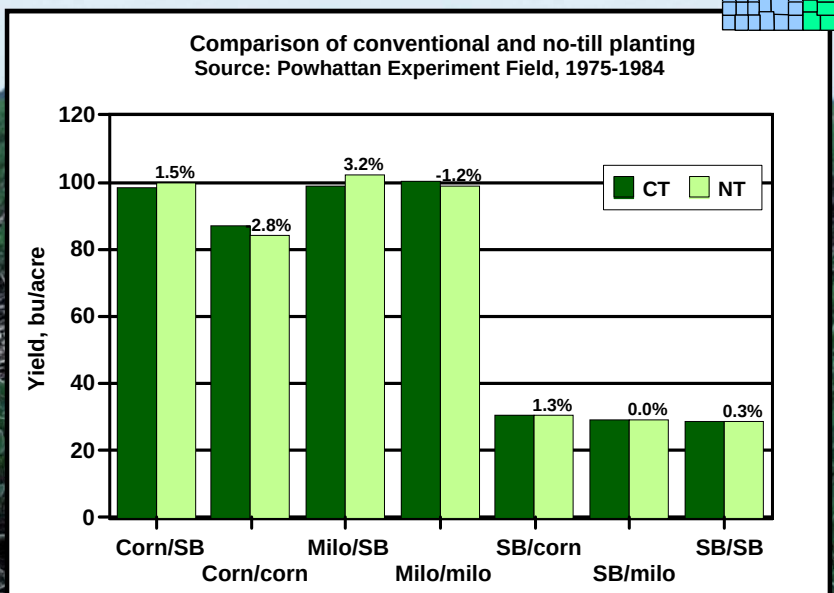



K-State research data
Tillage impact on wheat and sorghum yield (WSF)
Source: Hays Experiment Station, 1975-2002/03
CT
RT
NT
Yield, bu/acre
80
70
60
50
40
30
20
10
0
40.3
39.7
37.4
69.3
70.6
68.7
Wheat
Sorghum

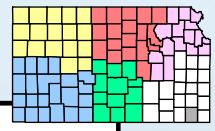

K-State research data
Tillage and rotation impact on corn and soybean yields
Source: Kansas River Valley Experiment Field, 1984-1999
CT
RT
NT
Yield, bu/acre
200
150
100
50
0
-6%
-2%
11%
-0%
C/C
C/SB
SB/SB
SB/C
Crop/previous crop

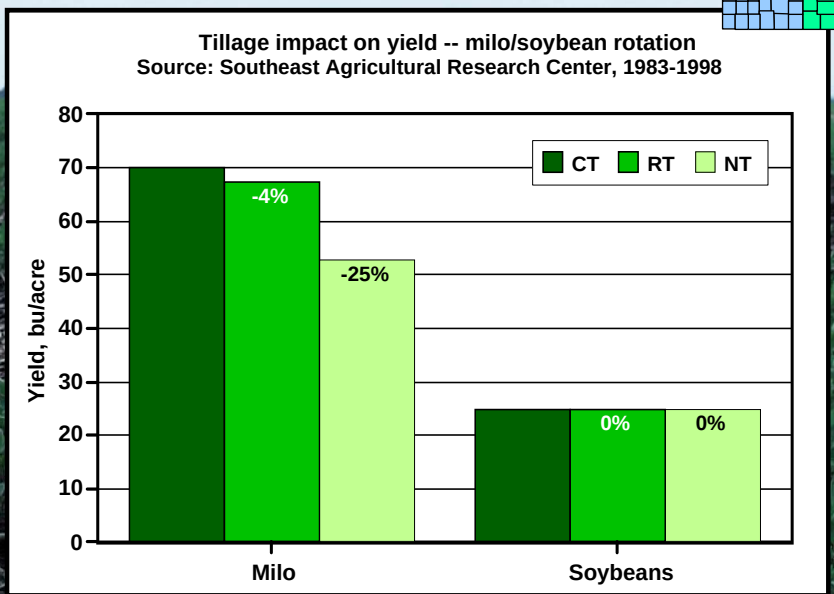
K-State research data





K-State research data





Effect of tillage on yields?

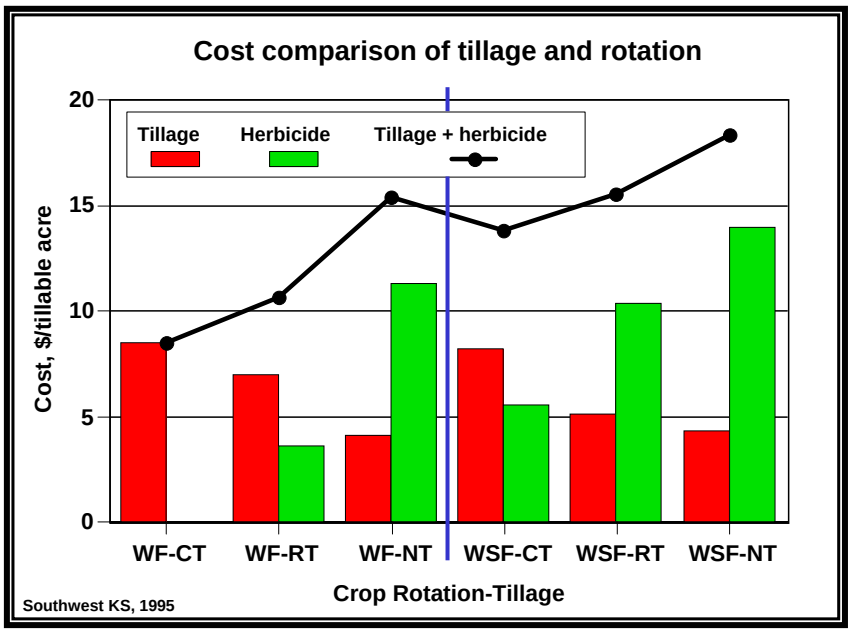
KSU research in central and eastern Kansas has generally shown little yield difference between tillage systems for wheat, sorghum, soybeans, and corn => NT cost driven.

Research in western Kansas has shown that yields of crops such as milo and corn grown in rotation with wheat increase as tillage is reduced => NT revenue driven.

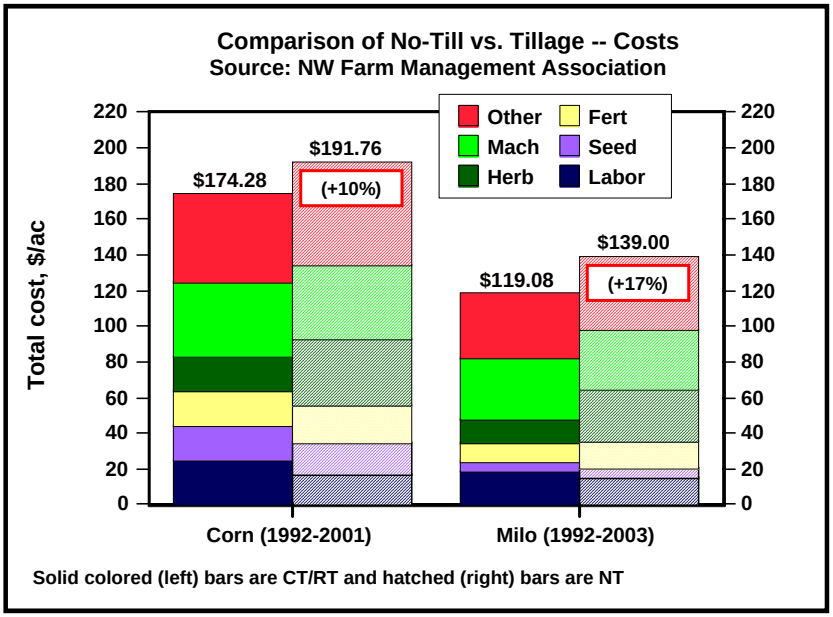
Effect of no-till on *COSTS*

- **Projected/simulated budgets**
- **Actual farm-level data**

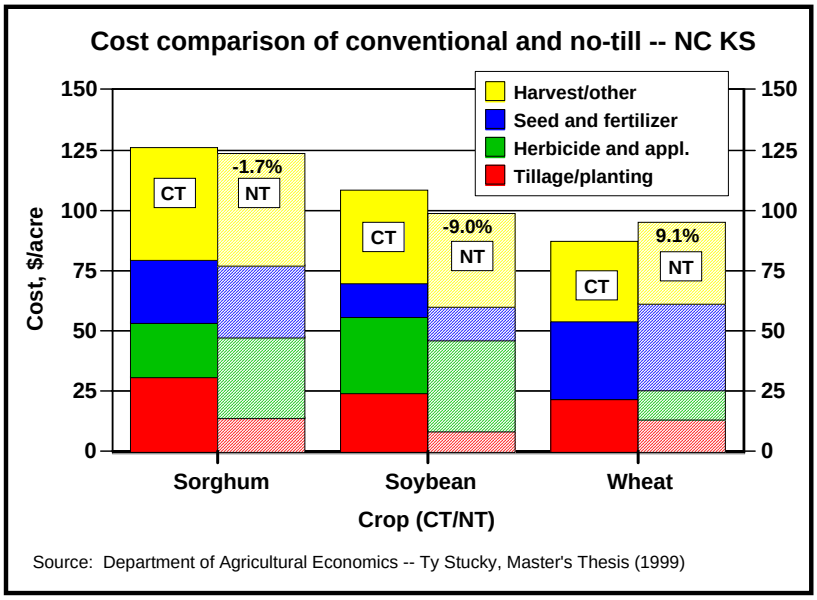
K-State projected data



Farm level data



Projected budgets



Source: Department of Agricultural Economics -- Ty Stucky, Master's Thesis (1999)

Actual farm-level budgets

No-Till cost study - NC Farm Management Association, 1996-2003

	$/tillable acre		$/harvested acre	
EXPENSE ITEM, $/acre	CT/RT	NT	CT/RT	NT
Direct input (seed, fert, chem, etc)	$39.95	$55.08	$40.88	$53.07
Machinery cost	$38.73	$35.21	$39.68	$33.91
Labor	$28.20	$24.26	$28.91	$23.36
Total asset charge	$38.13	$37.79	$39.06	$36.41
Building and conservation	$3.01	$2.06	$3.08	$1.98
Other	$11.71	$8.83	$11.99	$8.50
Total expense	$159.72	$163.23	$163.60	$157.24
Total acres	938	1,212	908	1,256
Harvested acres/tillable acres	xxxxx	xxxxx	96.8%	103.6%

Effect of no-till on costs

- **Central and eastern KS data indicate slight decrease to little change in total costs if acreage is held constant. Western KS data suggest costs increase with NT compared to CT.**
- **Changes cost "structure" --- i.e., herbicide is substituted for tillage-related expenses.**
- **Fixed costs (land, machinery, management, etc.) will depend on acreage and thus will vary between producers.**

Profitability ...

Revenue (yield x price)

- Cost (variable and fixed)

Profit or net returns

Yield and cost data suggest reducing tillage may be profitable in western Kansas but more of a breakeven proposition in central and eastern Kansas. However, tillage x rotation interaction and farm size complicate things considerably.

Economic analysis using KFMA data

- 10 years of data (1994-03)
- Approximately 900 farms
- Analysis focuses on crop producers

Economic analysis using KMAR data

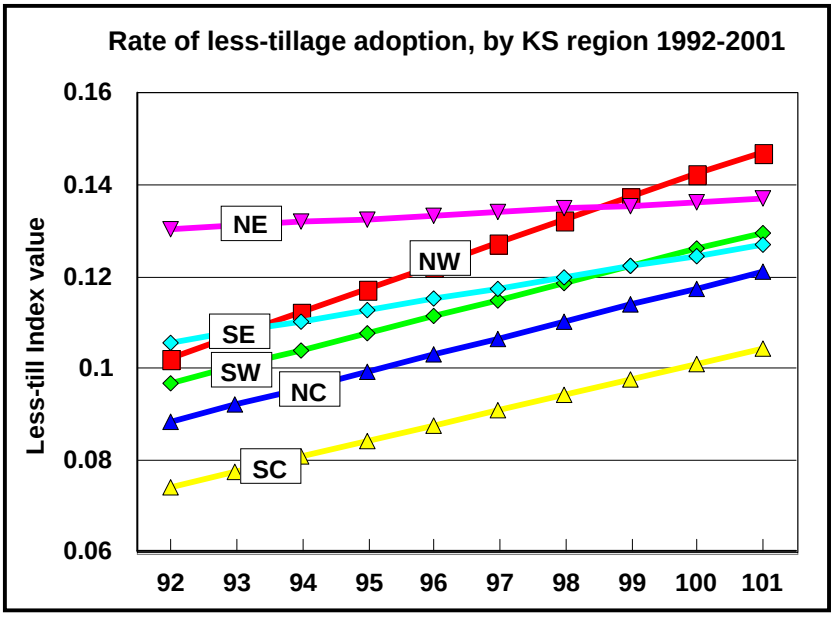
- "Different from neighbors"
- Management traits:
  - -- profit, yield, cost, price, tech, intensity
  - -- acres, govt, risk
- Persistence of management traits

Technology adoption variable

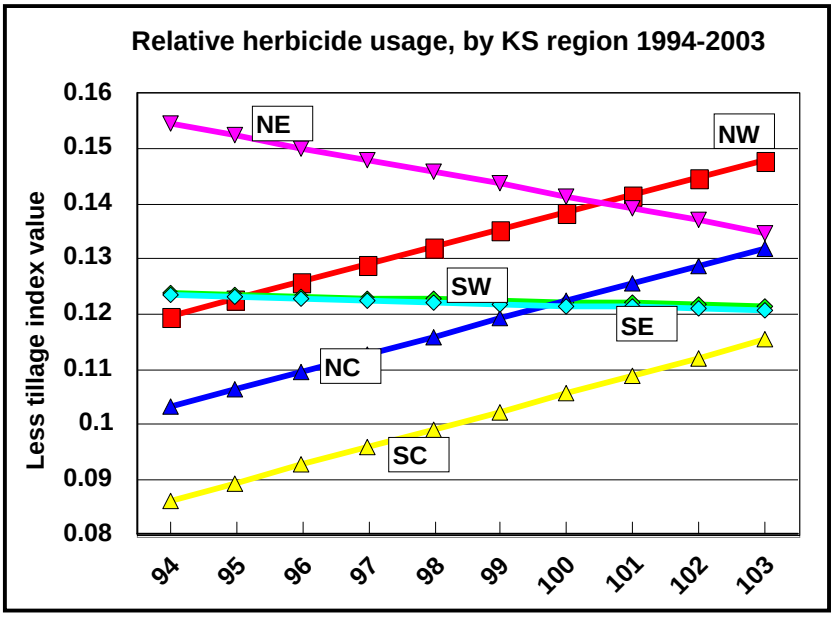
Less tillage index =

$$\frac{\$herbicide}{\$herbicide + (\$crop\ labor\ and\ \$crop\ mach\ operation)}$$

Technology adoption …



Technology adoption …



What's happening in NE Kansas?

"Different from neighbors" variables for …

- Profit
- Yield
- Cost
- Price
- Planting intensity
- Less-tillage adoption
- Government payments/acre
- Farm size
- Rent

~ 900 farms with 10 observations each

Statistical Significance

	farm A	farm B
Year 1	-$80	-$ 5
Year 2	$200	$30
Year 3	-$50	$20
Year 4	-$270	$25
Year 5	$300	$30
Average	$20	$20

Expected value vs. confidence in expectations.

H_0: Mean = 0;

H_A: Mean > or < 0;

***p*-value = 0.85 (A)** ***p*–value = 0.02 (B)**

Persistence …

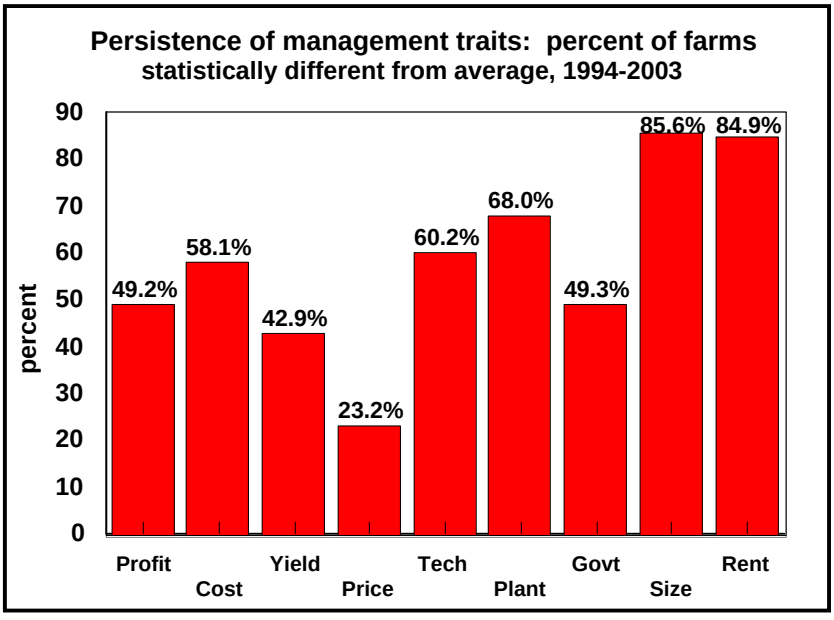


Table 2. Variability of Management Measures: Standard Deviation (1994-03)

Measure	Std dev
Profit ($/acre profit difference than neighbors)	77.3
Cost (% difference in cost/acre than neighbors)	26.7
Yield (% difference in yield/acre than neighbors)	15.0
Price (% difference in crop value than neighbors)	8.3
Tech (% difference in less-tillage adoption)	50.6
Plant (% difference in planting intensity than neighbors)	22.5
Rent (% difference in acres rented than neighbors)	44.8
Govt (% difference in govt pymts/acre than neighbors)	65.1
Size (% difference in crop acres than neighbors)	77.5
Risk (% difference in across-years income variability)	65.9

Economic analysis using KMAR data

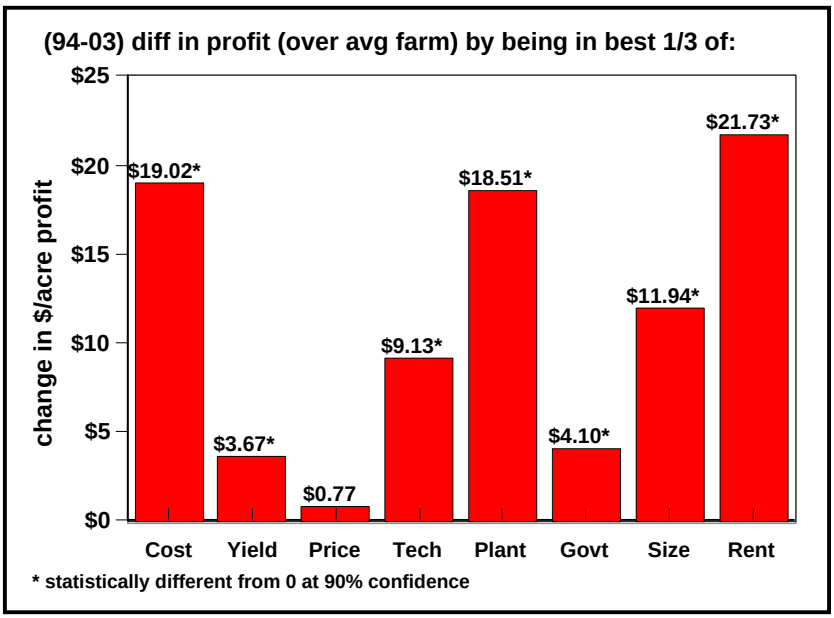
Profit = *f* (management factors)

Use regression analysis to quantify the relationship between profit and the various management factors.

Regression analysis ...

- **... "isolates" the impact of an individual trait.**
- **... results are additive across all traits.**
- **... 1-std change in variables represents an equal likelihood chance of occurring.**

Factors affecting profits …



Results compared to other studies …

1. **Large number of operations should be representative => reliable for inferences.**
2. **Implicitly accounts for crop rotation and less-till transition costs.**
3. **Covers relatively long time period.**
4. **Other management factors have been accounted for when considering impact of less-till.**

A good crop share lease should follow five basic principles …

1. **Yield increasing inputs should be shared**
2. **Share arrangements should be adjusted as technology changes**
3. **Total returns divided in same proportion as resources contributed**

---

4. **Compensation for unused long-term investments at termination**
5. **Good landlord/tenant communications**

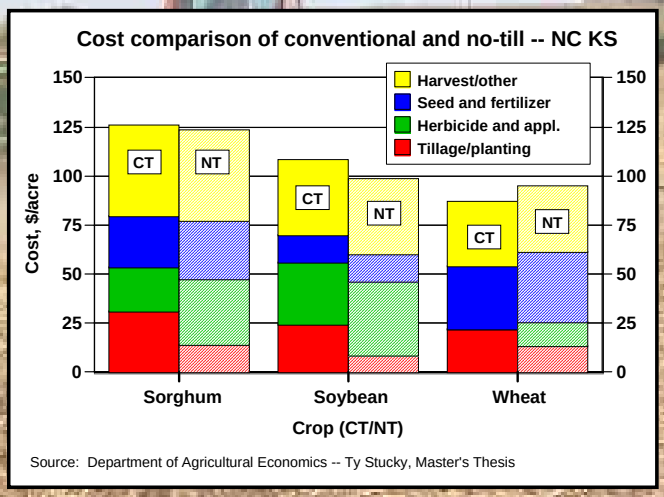
Technology adoption EXAMPLE:

Impact switching to no-till has on equitable lease arrangements

Lease examples of CT vs. NT for NC Kansas

-- Corn, soybean, wheat rotation projected budgets

-- Average land values



Conventional (CT) vs. No-tillage (NT) Effect on Equitable Shares

(Rotation = 50% W, 25% C, 25% S)

Tillage system	Farm #1		Farm #2	
	CT	NT	CT	NT
Contribution	Contributor		Contributor	
Land	Landlord	Landlord	Landlord	Landlord
Machinery	Tenant	Tenant	Tenant	Tenant
Fertilizer/insect.	Shared	Shared	Shared	Shared
Herbicde	Tenant	Tenant	Shared	Shared
Herbicide appl.	Tenant	Tenant	Shared	Shared
Other	Tenant	Tenant	Tenant	Tenant
Contributions	32.5/67.5	33.1/66.9	36.3/63.7	40.6/59.4

If you were previously sharing herbicides ...

- **Rather than change the crop share splits, many producers/landowners continue to share "non-burndown" herbicides and the tenant pays 100% of the burndown herbicides.**
- **Is this equitable?**
- **Is there a problem with this arrangement?**

Conventional (CT) vs. No-tillage (NT) Effect on Equitable Shares

(Rotation = 50% W, 25% C, 25% S)

Tillage system	Farm #1		Farm #2	
	CT	NT	CT	NT
Contribution	Contributor		Contributor	
Land	Landlord	Landlord	Landlord	Landlord
Machinery	Tenant	Tenant	Tenant	Tenant
Fertilizer/insect.	Shared	Shared	Shared	Shared
Herbicde	Tenant	Tenant	Shared	Shared
Herbicide appl.	Tenant	Tenant	Shared	Shared
Burndown herbicde	Tenant	Tenant	Tenant	Tenant
Burndown appl.	Tenant	Tenant	Tenant	Tenant
Other	Tenant	Tenant	Tenant	Tenant
Contributions	32.5/67.5	33.1/66.9	36.3/63.7	36.7/63.3

Technology adoption EXAMPLE:

Impact of adding double crop soybeans to equitable lease

Equitable Crop Shares with W-M (NT) vs. W-M-DC B (NT) in NC Kansas[1]
(Costs are based on 2003 FM Guides)

	Alternative Arrangements for Sharing Various Inputs[2]					
	Wheat-Milo			Wheat-Milo-DC Beans		
Contribution	A1	B1	C1	A2	B2	C2
Land	L	L	L	L	L	L
Machinery	T	T	T	T	T	T
Fertilizer (N-P-K)	S	S	S	S	S	S
Lime	L	L	S	L	L	S
Herbicide	S	S	S	S	S	S
Fertilizer application	T	S	S	T	S	S
Herbicide application	T	S	S	T	S	S
Other	T	T	T	T	T	T
Contributions (L/T)	33.4/66.6	36.7/63.3	33.9/66.1	25.0/75.0	27.6/72.4	25.3/74.7

[1] Land value is held constant across rotations (100% of wheat acres planted to DC beans)

[2] L=Landlord, T=Tenant, S=Shared (equitably)

Percent of acres planted to dc beans matters ...

Equitable Crop Shares with W-M (NT) vs. W-M-DC B (NT) in NC Kansas[1]
(Costs are based on 2003 FM Guides)

	Alternative Arrangements for Sharing Various Inputs[2]					
	Wheat-Milo			Wheat-Milo-DC Beans		
Contribution	A1	B1	C1	A2	B2	C2
Land	L	L	L	L	L	L
Machinery	T	T	T	T	T	T
Fertilizer (N-P-K)	S	S	S	S	S	S
Lime	L	L	S	L	L	S
Herbicide	S	S	S	S	S	S
Fertilizer application	T	S	S	T	S	S
Herbicide application	T	S	S	T	S	S
Other	T	T	T	T	T	T
Contributions (L/T)	33.4/66.6	36.7/63.3	33.9/66.1	28.6/71.4	31.5/68.5	29.0/71.0

[1] Land value is held constant across rotations (50% of wheat acres planted to DC beans

[2] L=Landlord, T=Tenant, S=Shared (equitably)

Adoption of new technologies …

… tends to cause problems because traditional arrangements or rules-of-thumb are often not appropriate.

… should not be a problem if we follow basic principles of a good lease.

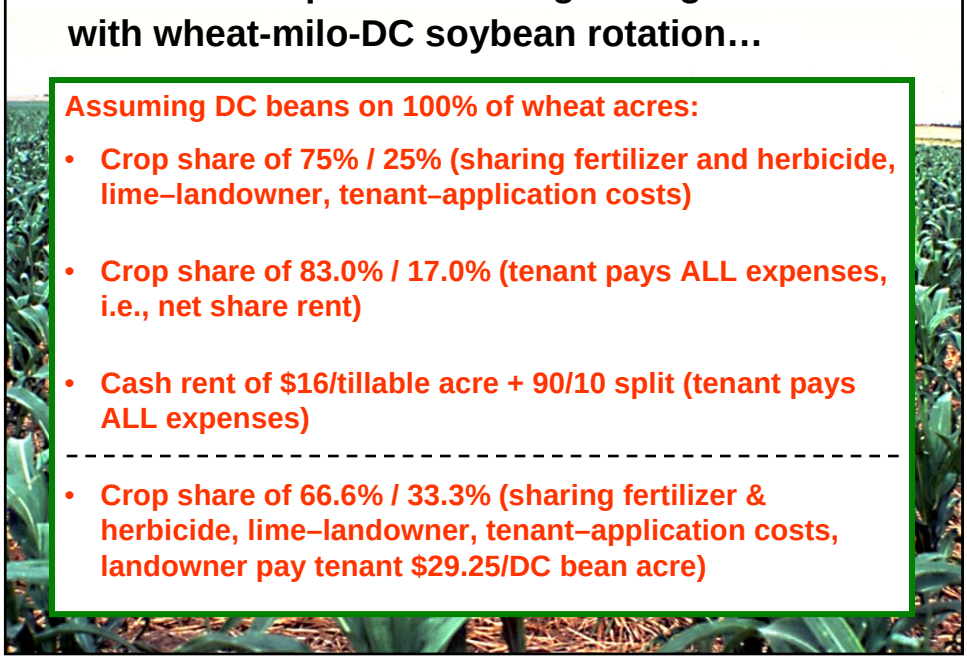
… if problems persist as to what is equitable, can lead to alternative leasing arrangements (e.g., cash lease).

If the goal is to have an "equitable" lease …

… then crops should be divided in the same proportion that inputs are provided, regardless of how any particular inputs (e.g., herbicides) are shared.

What is most important is *communication*.

Alternative equitable leasing arrangements with wheat-milo-DC soybean rotation…



Assuming DC beans on 100% of wheat acres:

- **Crop share of 75% / 25% (sharing fertilizer and herbicide, lime–landowner, tenant–application costs)**
- **Crop share of 83.0% / 17.0% (tenant pays ALL expenses, i.e., net share rent)**
- **Cash rent of $16/tillable acre + 90/10 split (tenant pays ALL expenses)**

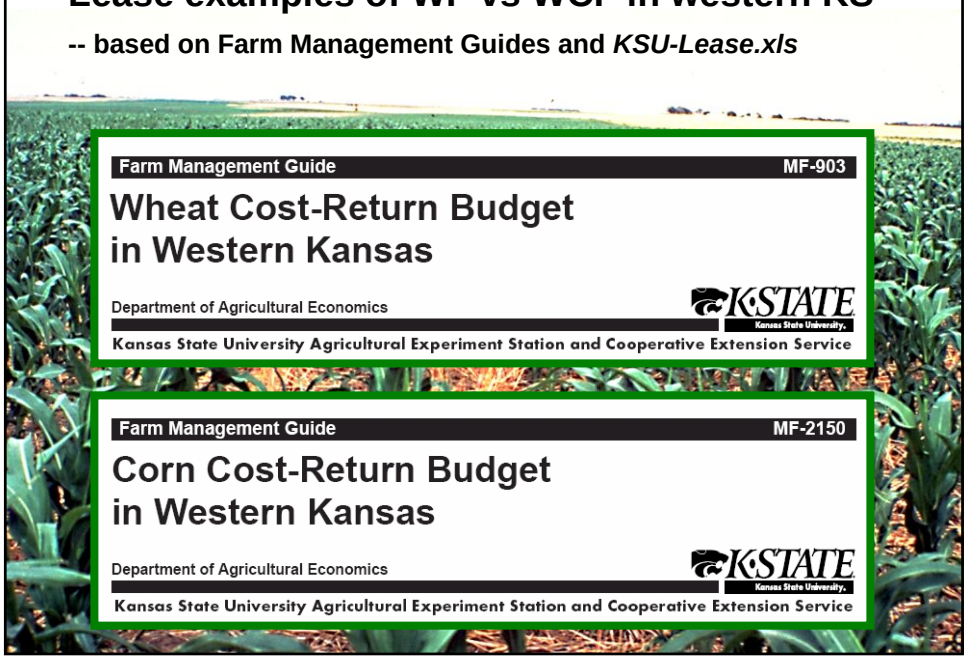
- **Crop share of 66.6% / 33.3% (sharing fertilizer & herbicide, lime–landowner, tenant–application costs, landowner pay tenant $29.25/DC bean acre)**

Technology adoption example:

Impact increasing cropping intensity has on equitable lease arrangements

Lease examples of WF vs WCF in western KS

-- based on Farm Management Guides and *KSU-Lease.xls*



Impact of increasing cropping intensity …

Equitable Crop Shares with Wheat-Fallow vs. Wheat-Corn-Fallow Rotations
(based on 2004 Farm Management Guides -- machinery costs adjusted)

Contributor --- (L=Landlord, T=Tenant, and S=Shared (equitably))

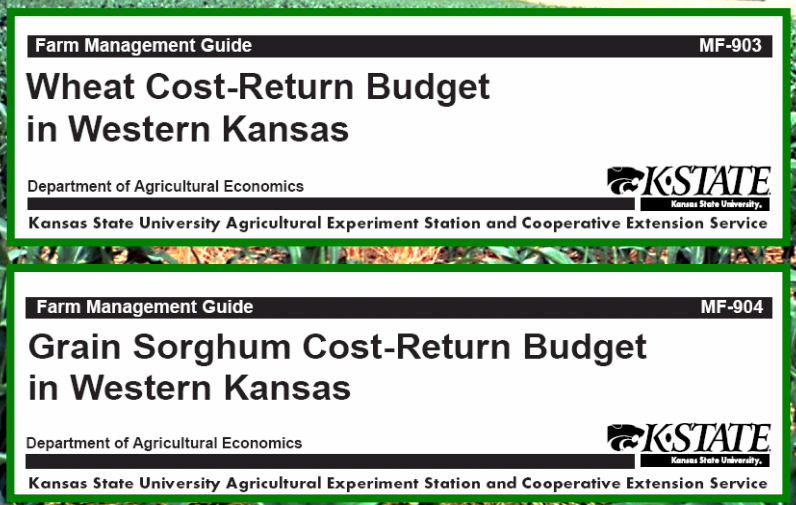
Alternative Arrangements for Sharing Various Inputs

Crop rotation	Wheat-Fallow			Wheat-Corn-Fallow			
Land	L	L	L	L	L	L	L
Machinery	T	T	T	T	T	T	T
Fertilizer[1]	S	S	T	S	S	S	T
Herbicide (wheat)[1]	T	S	T	T	T	S	T
Herbicide (corn)[1]	---	---	---	T	S	S	T
Other	T	T	T	T	T	T	T
Contributions (L/T)	37.1/62.9	39.8/60.2	32.8/67.2	29.7/70.3	33.5/66.5	34.9/65.1	24.6/75.4
Net return, $/ac	-$18.10	-$18.10	-$18.10	-$2.10	-$2.10	-$2.10	-$2.10

[1] Product only; application cost is included in machinery category and is covered by tenant.

Lease examples of WF vs WSF in western KS

-- based on Farm Management Guides and *KSU-Lease.xls*



Impact of increasing cropping intensity …

Equitable Crop Shares with Wheat-Fallow vs. Wheat-Milo-Fallow Rotations
(based on 2004 Farm Management Guides -- machinery costs adjusted)

Contributor --- (L=Landlord, T=Tenant, and S=Shared (equitably))

Alternative Arrangements for Sharing Various Inputs

Crop rotation	Wheat-Fallow			Wheat-Milo-Fallow			
Land	L	L	L	L	L	L	L
Machinery	T	T	T	T	T	T	T
Fertilizer[1]	S	S	T	S	S	S	T
Herbicide (wheat)[1]	T	S	T	T	T	S	T
Herbicide (milo)[1]	---	---	---	T	S	S	T
Other	T	T	T	T	T	T	T
Contributions (L/T)	37.1/62.9	39.8/60.2	32.8/67.2	32.1/67.9	36.7/63.3	38.4/61.6	26.6/73.4
Net return, $/ac	-$18.10	-$18.10	-$18.10	-$4.03	-$4.03	-$4.03	-$4.03

[1] Product only; application cost is included in machinery category and is covered by tenant.

Alternative equitable leasing arrangements with wheat-corn/milo-fallow rotation…

- Crop share of 70.6% / 29.4% (sharing fertilizer & application)
- Crop share of 66.1% / 33.9% (sharing fertilizer & application and herbicides on corn/milo)
- Cash rent of $6.40/acre + 75/25 split (sharing fertilizer & appl.)
- Cash rent of $13.60/acre + 80/20 split (sharing fertilizer & appl.)
- Cash rent of $16.50/acre + 85/15 (nothing shared)

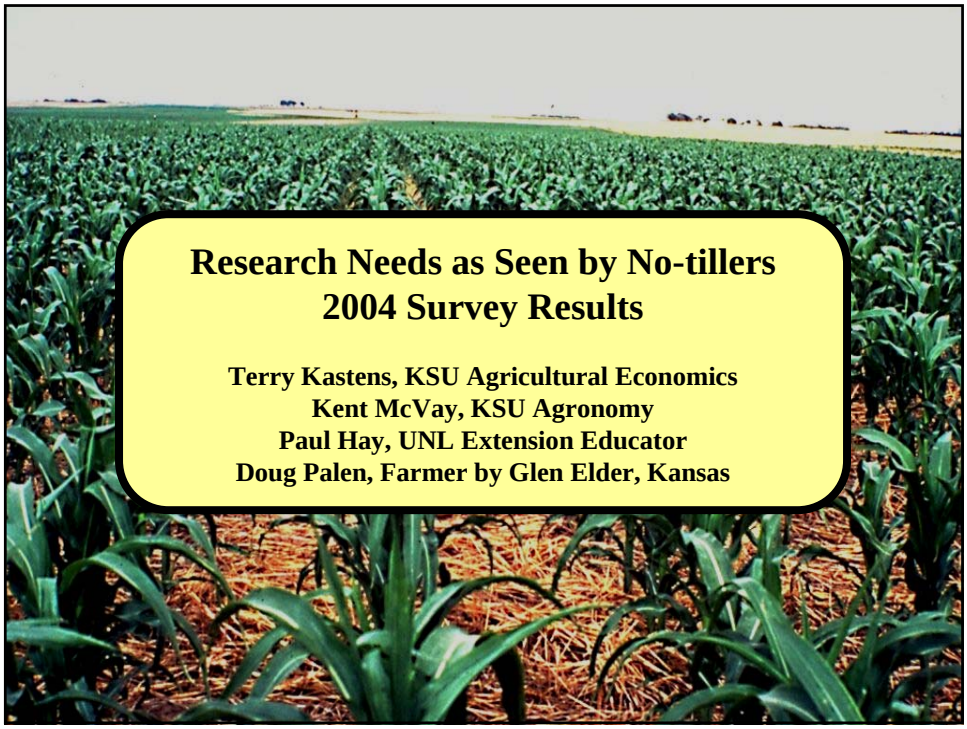
All five of these lease arrangements are “equitable”

Does no-till impact rents (land values) . . .

- What are the long-term impacts of NT on soil quality?
  - -- organic matter (fertilizer provider)
  - -- soil structure (water holding capacity)
  - -- reduced erosion
- Market rents early vs. late (extra N needed early?)
- Will tenants be compensated for improvements at lease termination?

SUMMARY

- No-till is increasing in all areas of Kansas
  - -- Cost is the main driver in central and eastern KS (lower cost => higher returns)
  - -- Revenue is the primary driver in western KS
- Producers “ahead of their neighbors” at adopting less tillage have had higher profits
- Management efforts – focus on being low cost, technology adoption, and production (yield, planting intensity)
- Changing cropping system can impact the equitable crop share arrangement

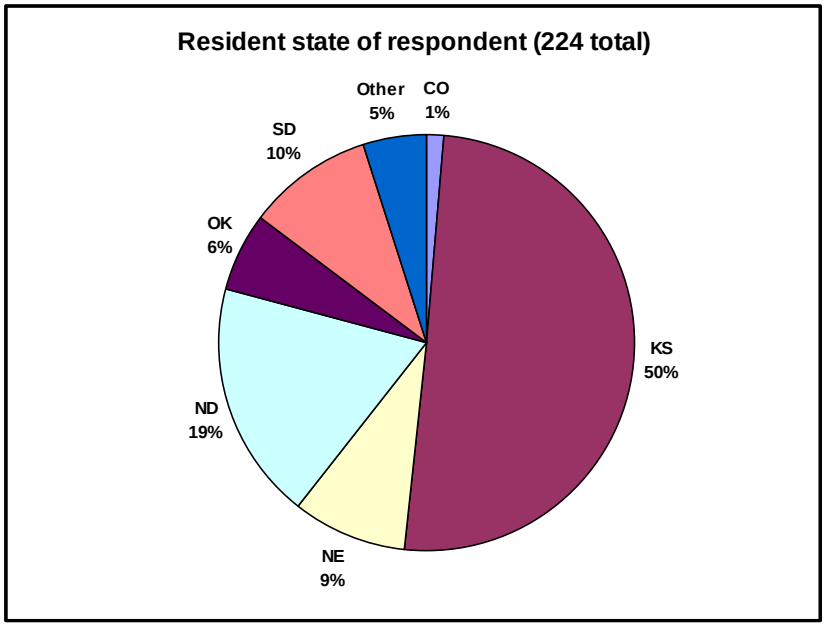


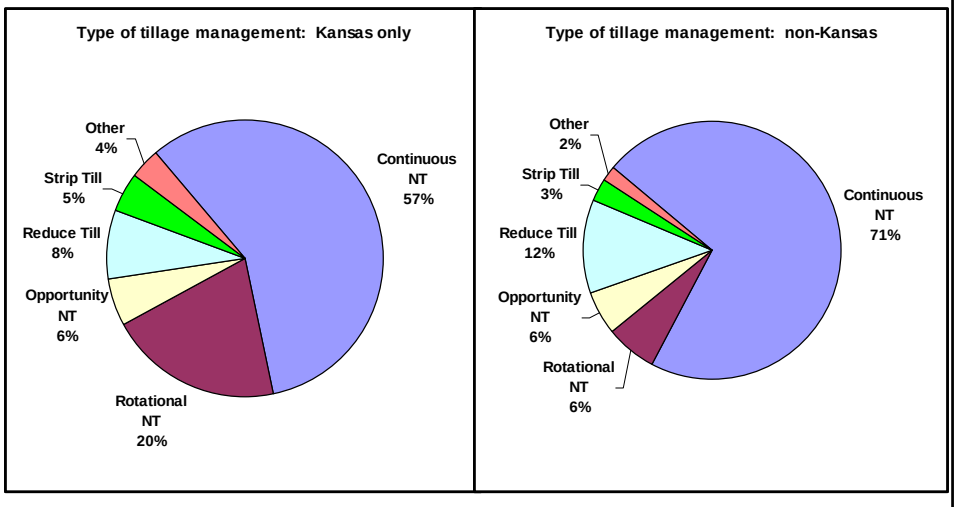
Research Needs as Seen by No-tillers
2004 Survey Results

Terry Kastens, KSU Agricultural Economics
Kent McVay, KSU Agronomy
Paul Hay, UNL Extension Educator
Doug Palen, Farmer by Glen Elder, Kansas

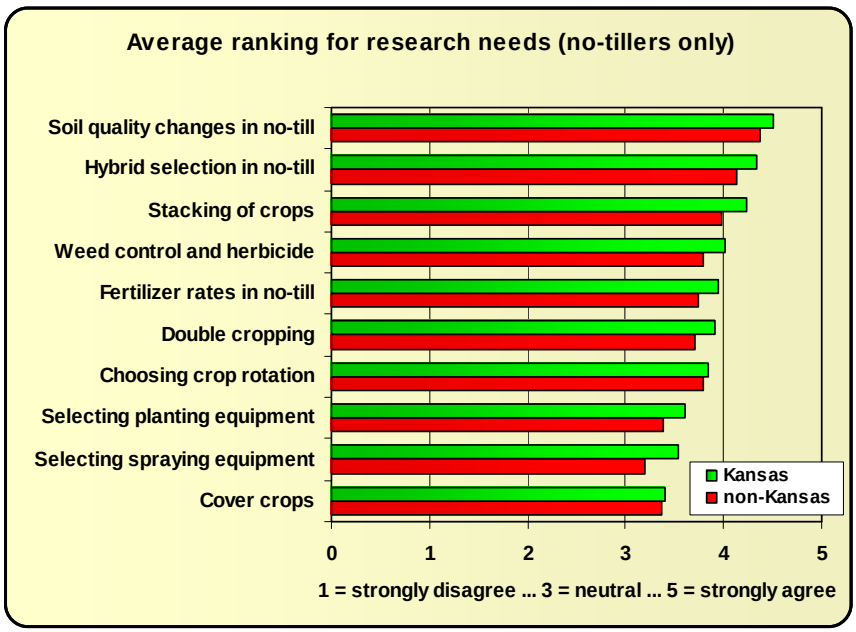
Background

- a NTOP group delivered to KSU Agronomy a wish list of research in February 2004
- an AIM (Agriculture's Innovative Minds) task force:
  - Leon Atwell, John Griebel, Paul Hay, Terry Kastens, Tony Kodesh, Kent McVay, Doug Palen, Alan Schlegel, Ray Ward
  - Link researchers to no-tillers
  - Blend university research with cooperator plots
  - Influence research direction
- a web-based non-randomized survey of no-tillers
  - Hoped to narrow down wish list
  - improve credibility of research funding requests

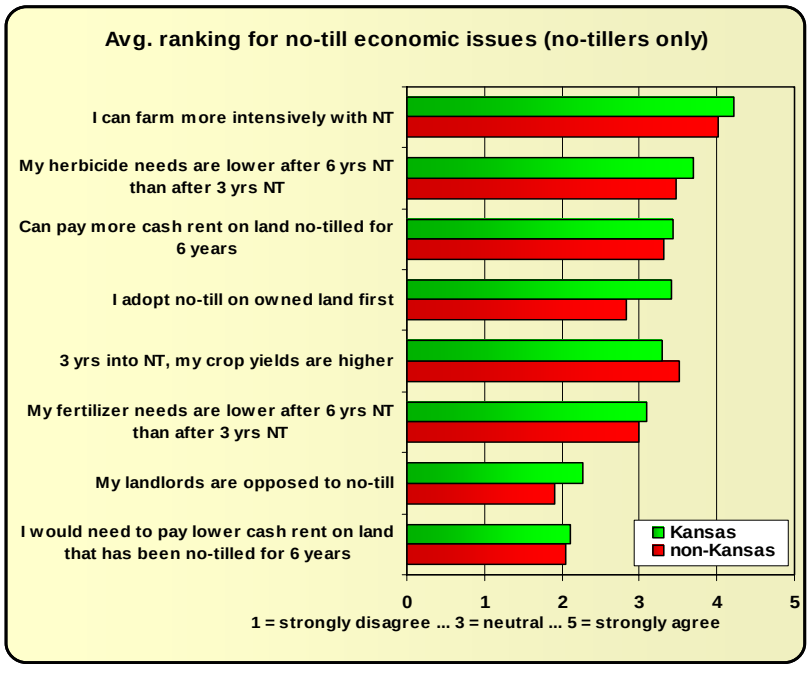


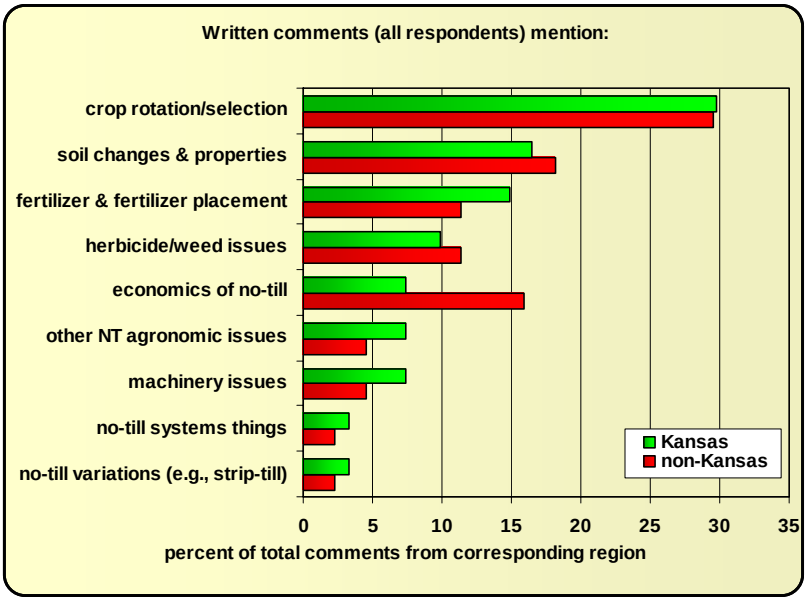


Heading to more continuous no-till in 5 years and less of everything else



Everything needs research; KS similar to non-KS; all statistically above 3





Key Points

- **No-tillers desire research in every area asked about**
- **Profitability of no-till is about:**
  - **Economies of size for machinery & labor (likely well known)**
  - **Changes in future income wrought by changes in the soil (less understood) – really needs research**
- **Plan to dig just a little deeper:**
  - **future questionnaires to help learn more**

Soil sampling and no-till

- OM increases with no-till
  - Perhaps to 85%-100% of it's native value
  - Takes perhaps 30 years in western Kansas?
- %C = 0.5809 x %OM
- 10 lb/a of C translates to 1 lb/a organic N
- KSU assumes 2% of organic N mineralizes to useful forms (nitrate & ammonium) each year
  - Some work in KS by Rice suggests 3% (we use 2%)
  - Saves fertilizer N
- Starting at OM=1.6, ending at OM=3.0 in 30 yrs:
  - Results in an amortized advantage of $4.24/ac/year
  - Above usual yield increases due to better water efficiency

Questions ???

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