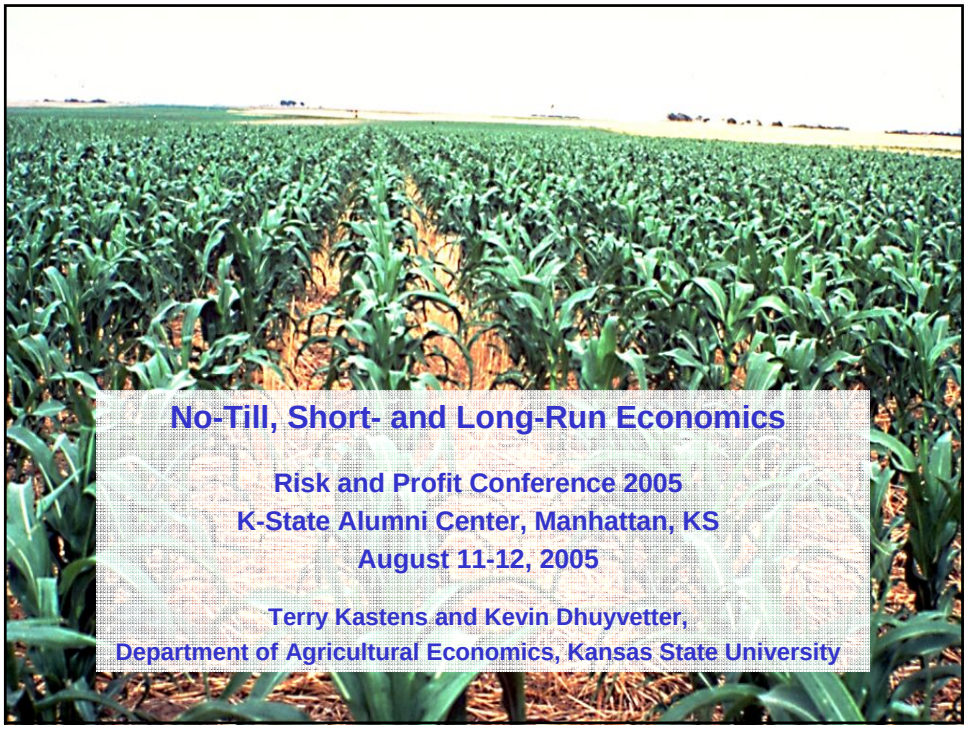


No-Till, Short- and Long-Run Economics

Risk and Profit Conference 2005
K-State Alumni Center, Manhattan, KS
August 11-12, 2005

Terry Kastens and Kevin Dhuyvetter,
Department of Agricultural Economics, Kansas State University

No-till (NT) is a technology to consider

Potential benefits . . .

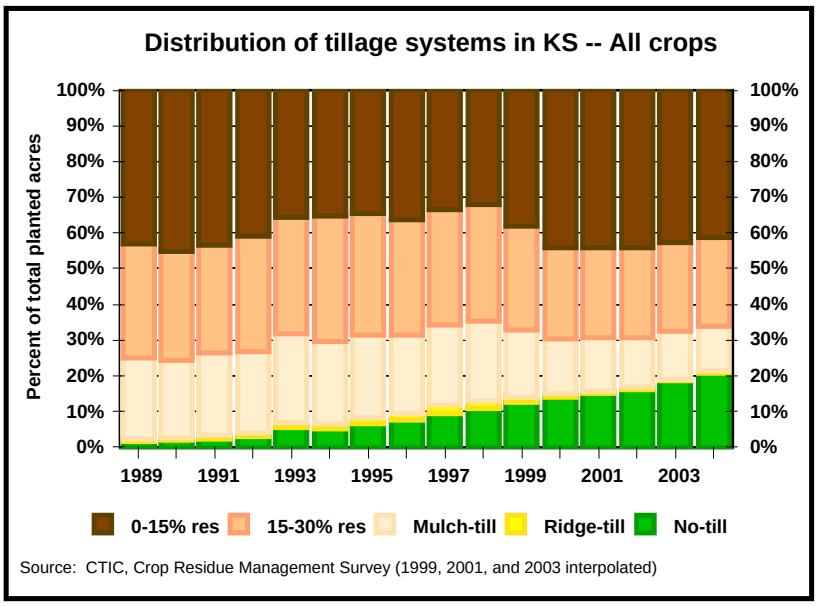
- Machinery cost savings
  - Reduces fuel and labor requirements
- Allows farm expansion
  - Dilutes fixed costs (spread over more land)
- May improve timing
  - Reduces land preparation time
  - Can increase cropping intensity
- Related to water savings
  - Can increase cropping intensity
  - Increases crop yields

Speed of technology adoption depends on

- Size of the expected profit
- Confidence in the outcome
- Investment amount required
- Keep in mind . . .
  - Late adopters adopt for survival
  - Early adopters adopt for profit
  - Speed of adoption is important only relative to your neighbors

Is NT black and white?

- NT is not black and white
  - Moisture savings come from reducing tillage
  - May use NT on one crop and not another in a rotation
- But, years of soil change can be harmed with one year of tillage
- Adopting NT happens in stages for many
  - Later adopters can skip certain stages



Most growth in no-till has come at expense of mulch-till

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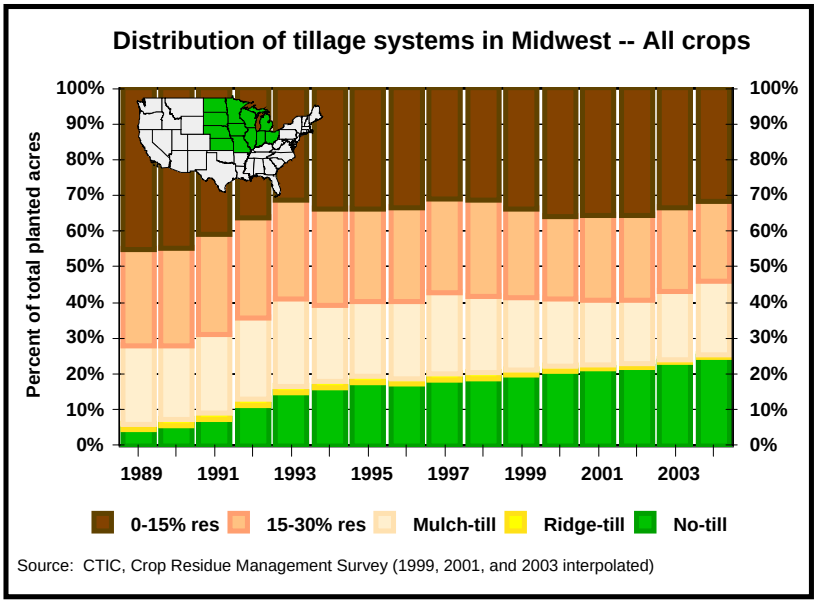
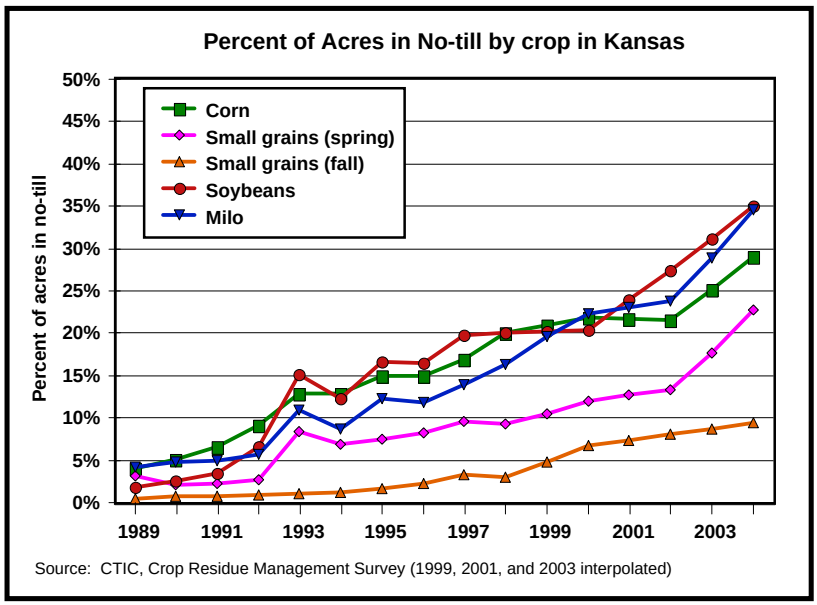


Midwest covers much of Corn Belt (much wetter climate)

6



Source: CTIC, Crop Residue Management Survey (1999, 2001, and 2003 interpolated)

Crops that grow in summer likely respond better to no-till

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)

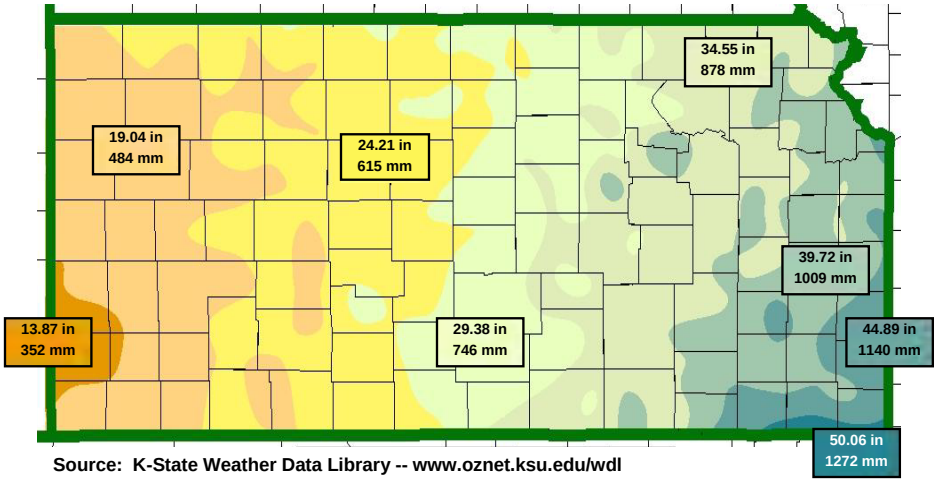
\- Cost (variable and fixed)

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*

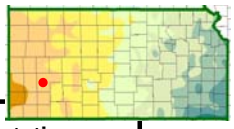
Kansas Annual Precipitation, 1971-2000

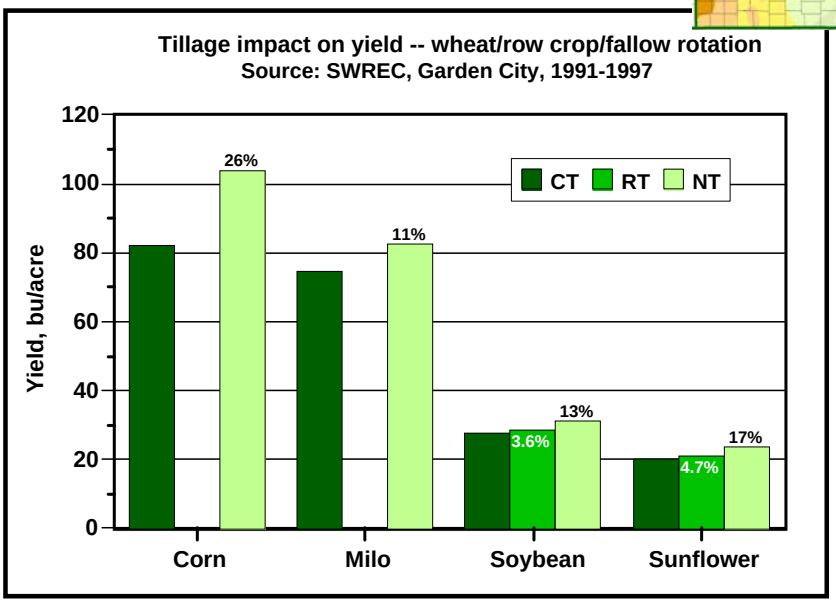


Source: K-State Weather Data Library -- www.oznet.ksu.edu/wdl

K-State research data

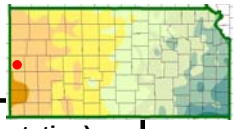
(19.0 in annual precipitation region)

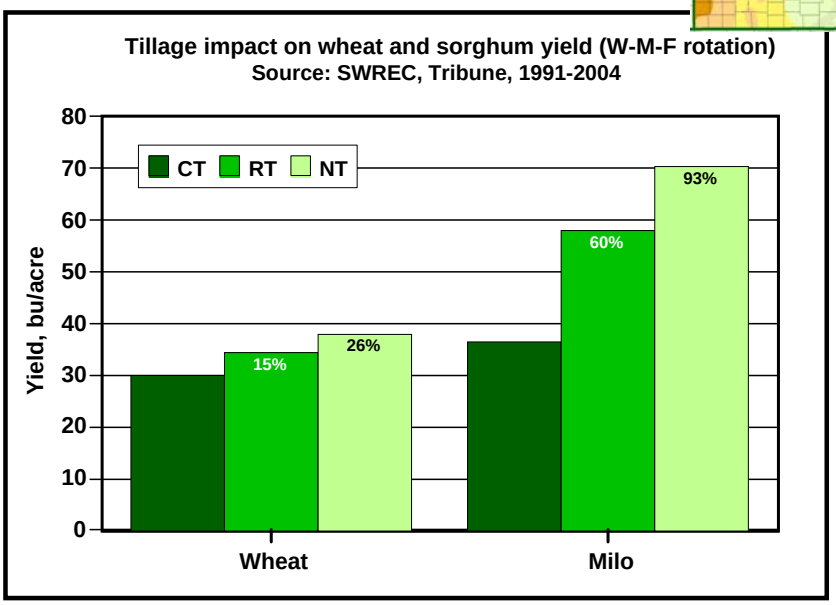




K-State research data

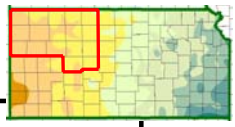
(19.0 in annual precipitation region)

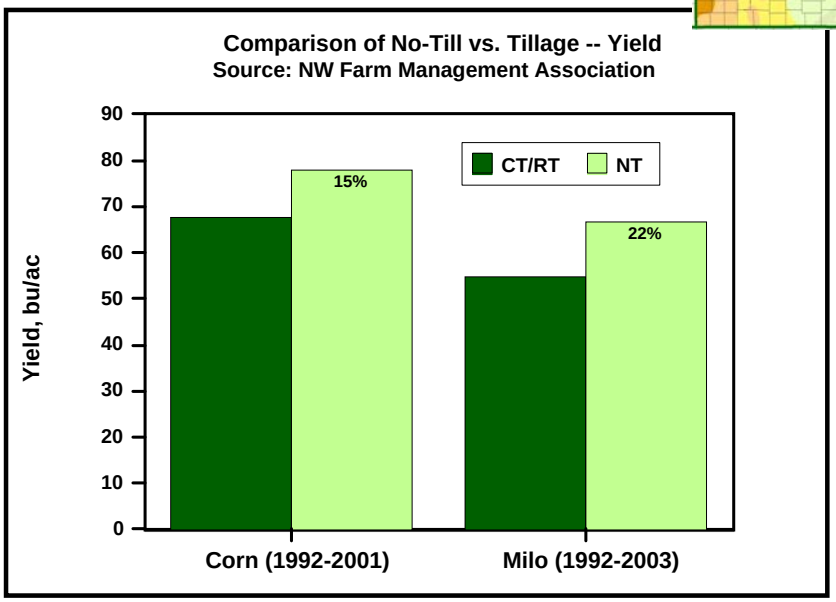




Farm-level data

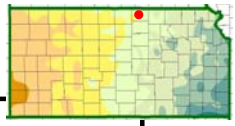
(19.0-24.2 in annual precipitation region)

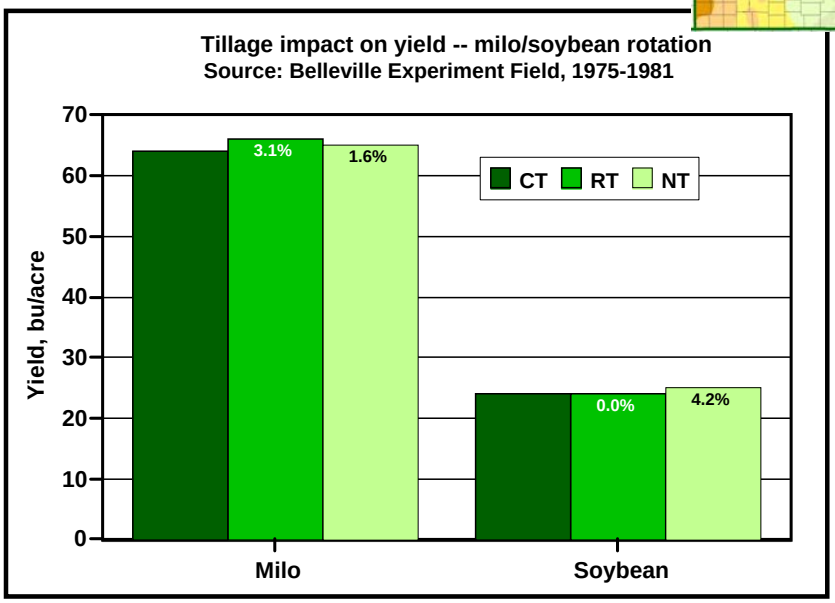




K-State research data

(29.4 in annual precipitation region)





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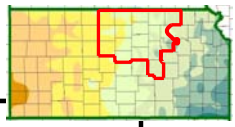
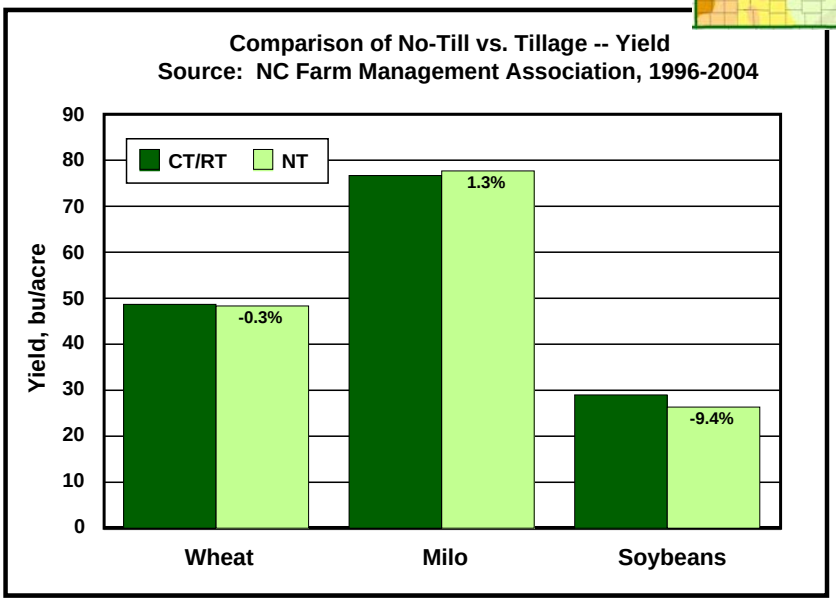
Farm-level data

(24.2-34.6 in annual precipitation region)





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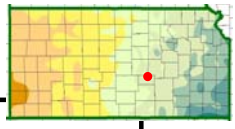
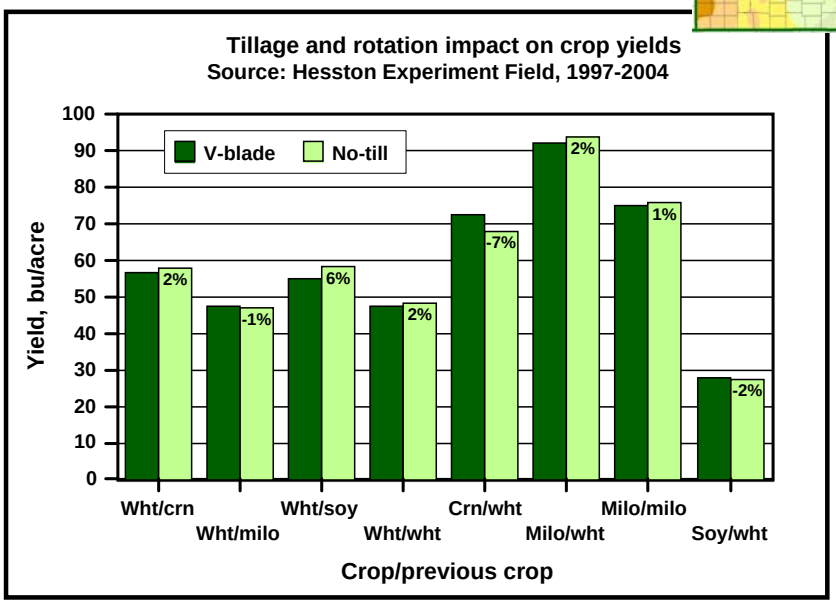
K-State research data

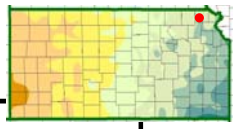
(29.4-34.6 in annual precipitation region)

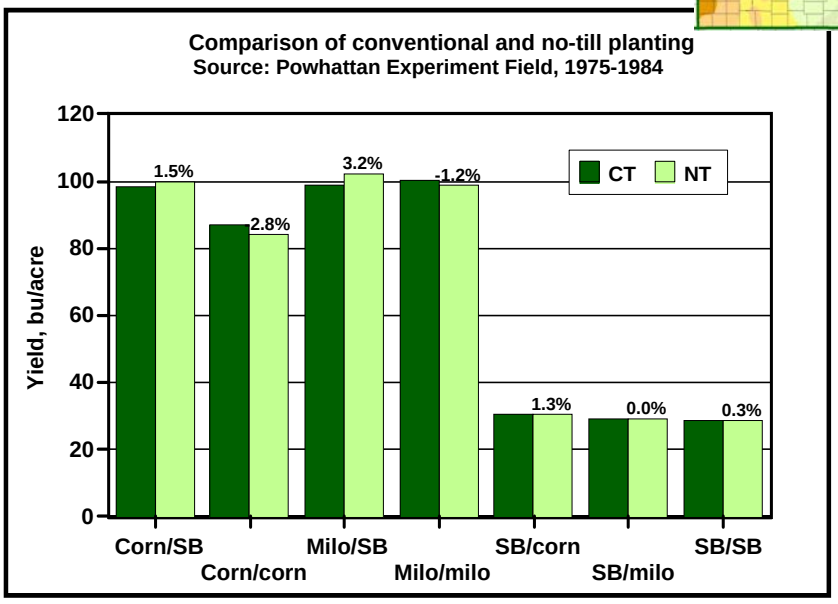




K-State research data

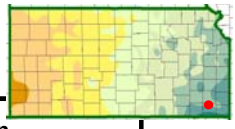
(34.6 in annual precipitation region)

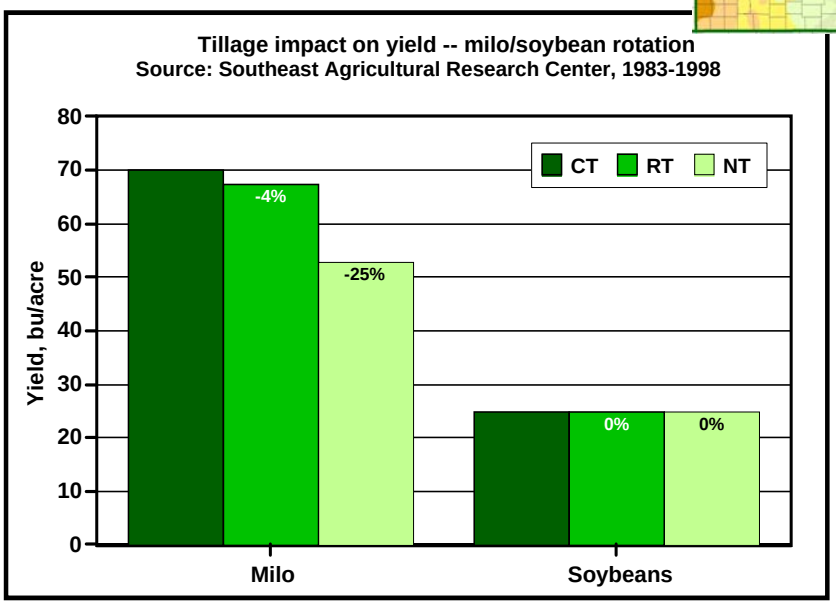




K-State research data

(44.9-50.1 in annual precipitation region)





Effect of tillage on yields?

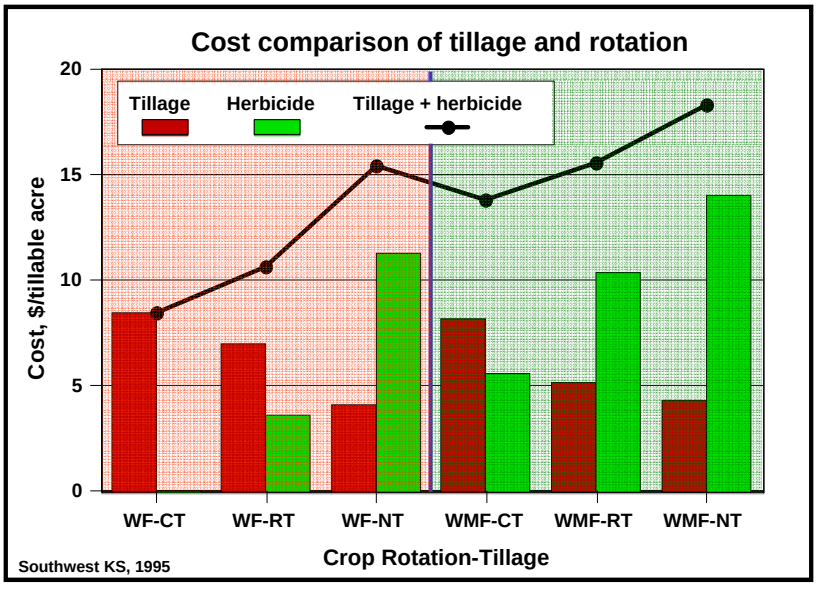
Research in central and eastern Kansas generally has shown little yield difference between tillage systems for wheat, milo, soybeans, and corn => NT cost driven.

Research in western Kansas has shown that yields increase as tillage is reduced, especially for summer crops such as corn and milo => NT revenue driven.

Effect of no-till on *COSTS*

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

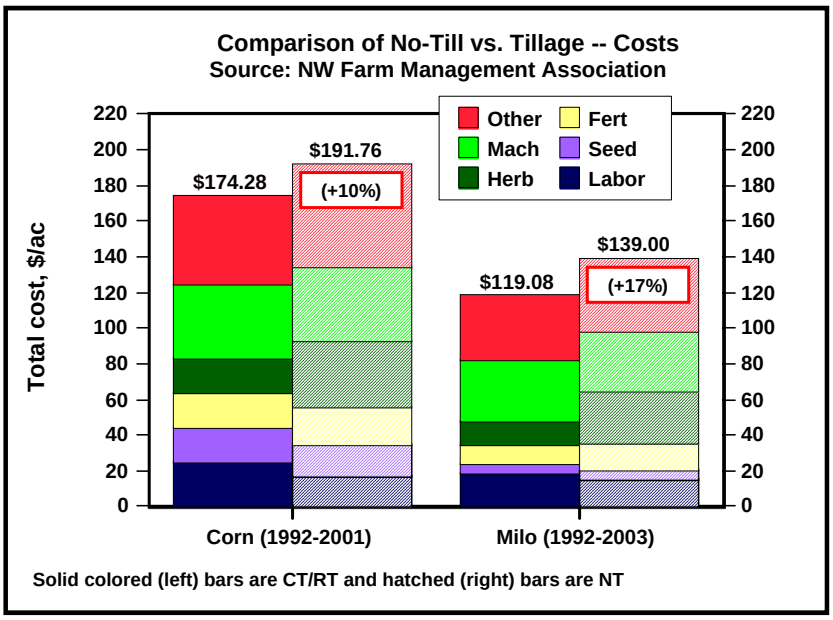
K-State projected budgets



Tradeoff between machinery and herbicide costs, has it changed?

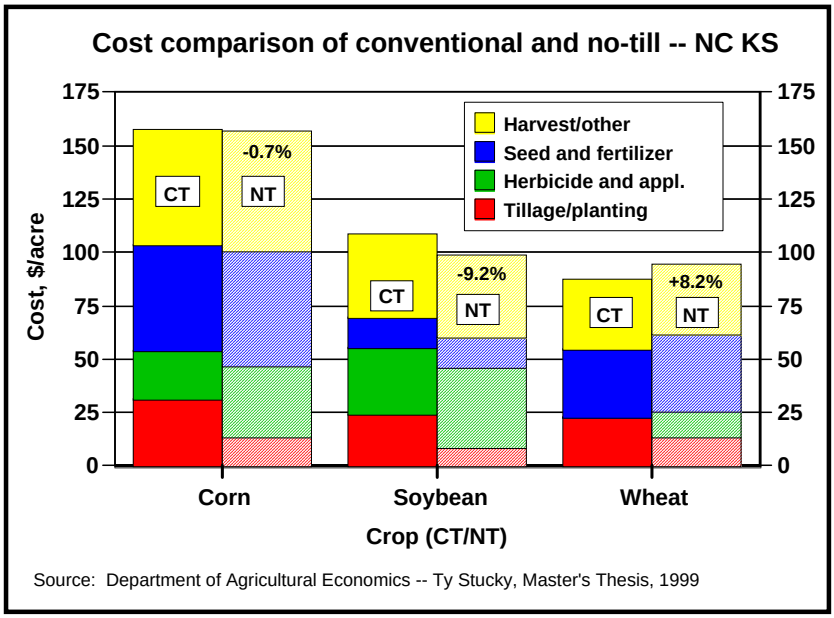
Increased cropping intensity requires additional capital

Actual farm-level data



Higher yields allow adoption of this more costly technology

K-State projected budgets



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

Actual farm-level data

No-Till cost study - NC Farm Management Association, 1996-2004

	$/land acre		$/harvested acre	
EXPENSE ITEM, $/acre	CT/RT	NT	CT/RT	NT
Direct input (seed, fert, chem, etc)	$41.26	$55.41	$42.04	$53.37
Machinery cost	$39.44	$35.60	$40.24	$34.27
Labor	$28.35	$24.42	$28.95	$23.50
Total asset charge	$38.59	$38.03	$39.38	$36.63
Building and conservation	$2.99	$2.09	$3.06	$2.01
Other	$11.94	$9.09	$12.18	$8.75
Total expense	$162.58	$164.63	$165.84	$158.53
Total acres	938	1,212	908	1,256
Harvested acres/land acres	xxxxx	xxxxx	96.8%	103.6%

NT farms are cropping more intensively

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

Western Kansas – higher yields and higher costs

Central / eastern Kansas – similar yields & costs

Profitability complicating factors:

- **Cropping intensity**
- **Farm size**
- **Tillage x rotation interaction**

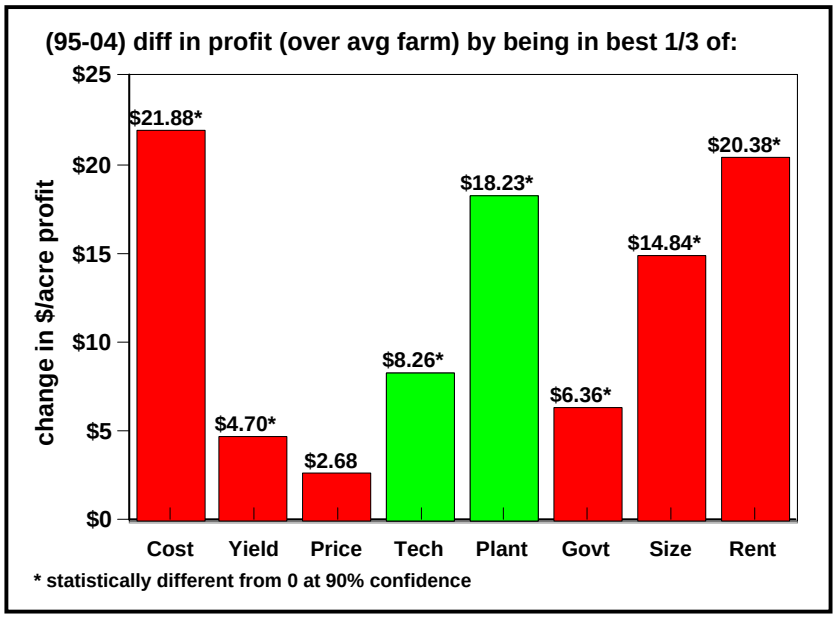
NT adoption is increasing. suggesting profitability

Economic analysis using Kansas Farm Management data

- **Which management factors impact profitability?**
- **10 years of data (1994-03)**
- **Approximately 900 farms**
- **Analysis focuses on crop producers**

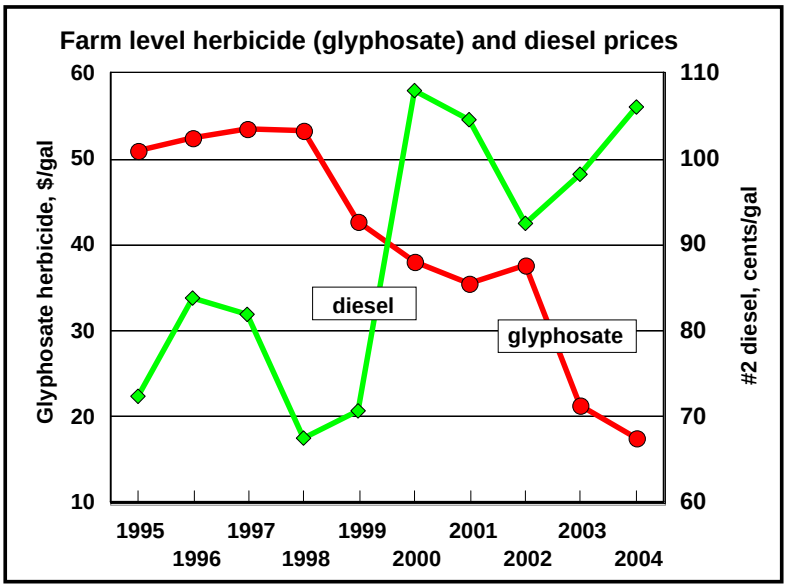
Kansas Farm Management Association
Helping You Put Knowledge To Work

Factors affecting profits …



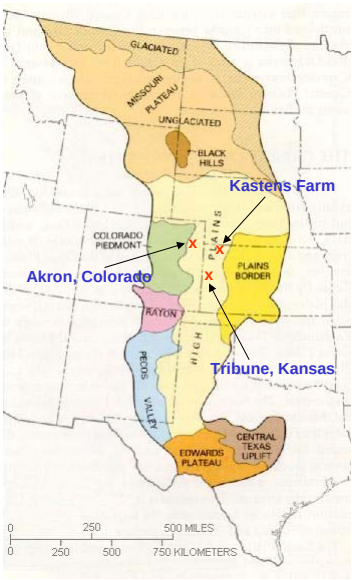
SUMMARY

- **No-till is increasing in all areas of Kansas**
  - -- Cost is the main driver in central and eastern KS (lower cost => higher net returns)
  - -- Revenue is the primary driver in western KS (higher revenue and higher cost)
- **Producers "ahead of their neighbors" at adopting less tillage have had higher profits**
- **Management efforts – focus on being low cost, technology adoption, and production (planting intensity, yield)**



Trends favor herbicides over tillage – increase speed of adoption?

High Plains region of the U.S.



History of High Plains

- Land broke in late 1800s early 1900s
  - Continuous-cropped with wheat, corn, oats
  - Depended on the moldboard plow
- Summerfallow started in 1930s – WF
  - 14-15 months fallow before wheat planting
    - Fallow period includes summer months
  - One-way (1930s-1950s); sweep (1960s-1990s)
  - Water storage increased yields
  - N mineralization exploited organic matter
  - But inefficient water storage (25%)
  - Eventually depleted soils

Moldboard plow (pre-1930)

One-way disk plow (1930-1960)

Undercutter, sweep, v-blade (1960-2000)

Sprayer (2000+)

History of High Plains

- **WMF or WCF started in 1980s-1990s**
  - **Sweeps saved soil & water**
  - **10 months fallow before milo or corn**
  - **11 months fallow before wheat**
  - **NT ahead of milo or corn crop; CT on wheat**
- **In 2000s began to see NT ahead of wheat**
  - **Just starting to be adopted today**

WF (42 months out of 72 fallow)

Wheat (Sep-Jun)	Fallow (Jul-Aug)	Wheat (Sep-Jun)	Fallow (Jul-Aug)	Wheat (Sep-Jun)	Fallow (Jul-Aug)

WCF (42 months out of 72 fallow)

Wheat (Sep-Jun)	Fallow (Jul-Apr)	Corn (May-Sep)	Fallow (Oct-Aug)	Wheat (Sep-Jun)	Fallow (Jul-Apr)	Corn (May-Sep)	Fallow (Oct-Aug)

Water drives NT in the High Plains

- **Water in soil at planting often as important as rainfall during growing season**
- **Questions are now emerging:**
  - **Tillage or chemicals during fallow period before wheat (referred to as chem-fallow)?**
  - **Intensify cropping beyond 2 crops in 3 years?**
  - **Follow a rotation or change crops based on available soil water at planting?**

Continuous-crop long-term NT questions

- How fast does SOM build over time?
  - How deep in the soil are changes observed?
  - Why should I care about SOM?
- Does soil structure change?
- Many crops in rotation or few?
- Will NT rotations in one area work in other areas?

- Do soil changes impact yields, input costs, or profits?

Changes with continued NT

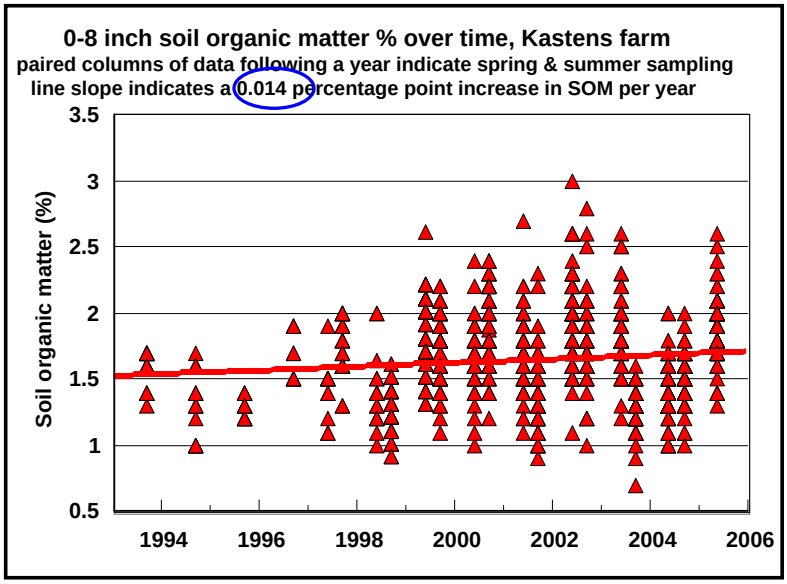
- Fast changes
  - Surface crop residue: improves water infiltration and reduces evaporation
  - Wheat stubble height especially important
- Medium changes
  - Soil structure (pore size) and strength:
    - Holds more water and water travels through faster
    - Surface doesn't seal off as fast during a rainstorm
    - Can support wheel traffic better
- Slow changes
  - SOM:
    - Indicator of positive change
    - Provider of mineralized crop nutrients (N & P)
    - Improves P solubility and availability

Residue: changes near the soil surface

- Get more rain in the soil and keep it there for plants
  - Crop residue improves water infiltration
  - Crop residue reduces evaporation
  - High wheat stubble better than short stubble, especially in low yielding situations
    - Akron field trial:
      - 4 inch (102 mm) stubble: evaporation is 80%
      - 12 inch (305 mm) stubble: evaporation is 50%
      - 20 inch (508 mm) stubble: evaporation is 38%
    - Tribune field trial (2001-2004):
      - Leaving about 13 inches (330 mm) rather than 6.5 inches (165 mm) resulted in 8.2 bu/acre (0.55 Mg/ha) increased yield for the following corn or milo crop

Organic matter: indicator of improvement

- NT induces very slow changes over time
  - Canada (0-15 cm deep):
    - Typical NT rotation, 0.02 percentage points/year
    - If continuous-cropped, perhaps 0.05 points/year
  - Colorado (0-20 cm deep):
    - If <100% cropping intensity then 0.009 points/year
    - If 100% cropping intensity then 0.017 points/year
  - Argentina, 36 in. (914mm) rain; 4% SOM (0-15 cm):
    - 0.07 percentage points/year
  - Kastens Farm (0-20 cm deep):
    - 60% of crops following NT; 40% following CT
    - Cropping intensity went from 60% to 77% during period
    - 0.014 percentage points/year



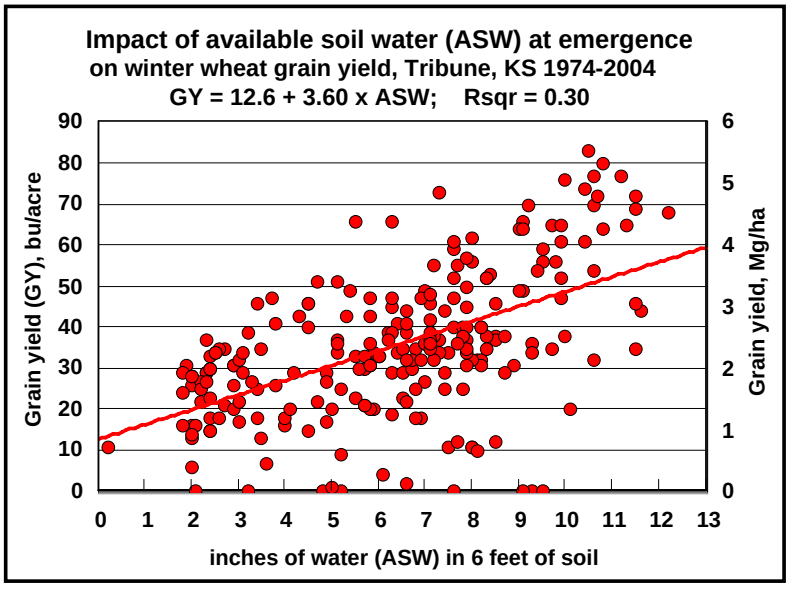
At this rate would take 70 years to build SOM by 1 percentage point!
And, that is at only the 0-8 inch (20 cm) depth.

NT-caused long-term changes in soils

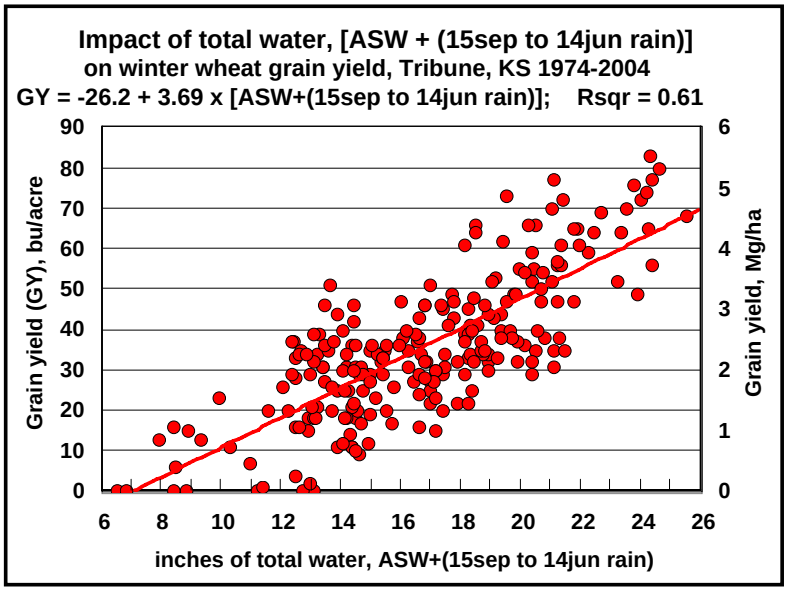
- **Changes will NOT be deep in soil**
  - **Increased capacity of water storage not large**
- **Slow changes in SOM over time**
  - **Savings in fertilizer due to mineralization will eventually matter, but not for a long time and not as important as water savings**
- **But, small changes near the soil surface can be especially important in drier areas**
  - **It's all about getting more water in soil and retaining it**
  - **More water will be observed in NT soils than in CT soils, even through whole rooting zone**

Tribune Kansas Research

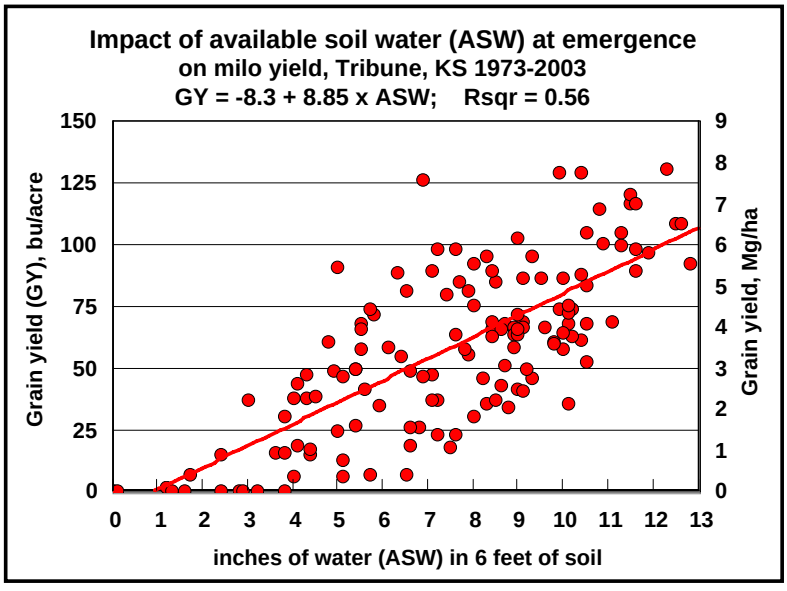
- **Over the last 31 years, differences in available soil water (ASW) & rainfall explain:**
  - **61% of differences in wheat yield**
  - **58% of differences in milo yield**
- **A 14-year wheat-milo-fallow (WMF) study compared CT to NT for:**
  - **available soil water (ASW)**
  - **grain yields**
  - **water use efficiency (WUE)**



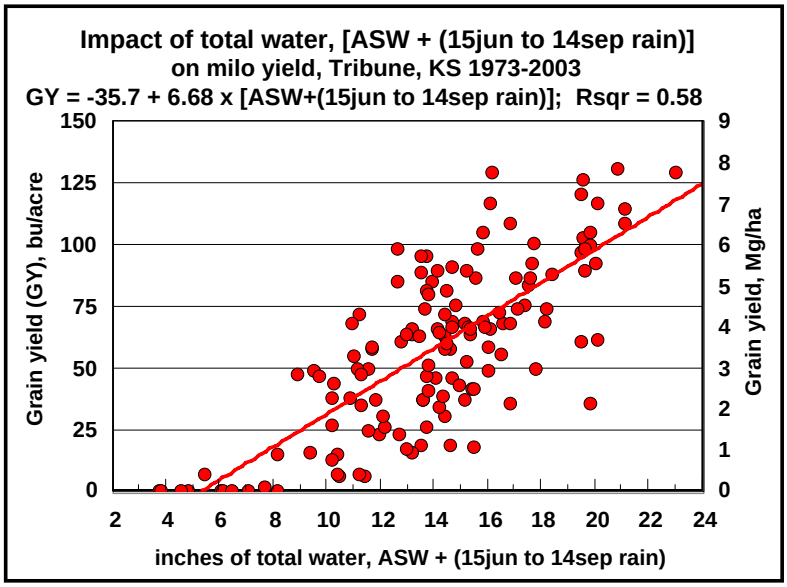
30% of variation in wheat yields explained by ASW alone



61% of variation in wheat yields explained by ASW & rainfall



56% of variation in wheat yields explained by ASW alone



58% of variation in wheat yields explained by ASW & rainfall

Tribune Kansas WMF rotation

- **Wheat**
  - NT has 21% more ASW at planting
  - NT has 26% higher grain yields
  - NT has 22% higher WUE
  - NT ASW grows at 0.29 in (7.5 mm) per year
  - NT WUE grows at 1.34 lb/in (0.24 kg/cm) per year
  - NT yield might grow 1 bu/acre (0.07 Mg/ha) per year
- **Milo**
  - NT has 30% more ASW at planting
  - NT has 93% higher grain yields
  - NT has 97% higher WUE
  - NT ASW grows at 0.15 in (3.7 mm) per year
  - NT WUE grows at 11.41 lb/in (2.04 kg/cm) per year
  - NT yield might grow 4 bu/acre (0.25 Mg/ha) per year

A computer-based decision tool is next

- Historical farm-level data come too late to greatly benefit the early adopter
- Must rely on more basic research, such as the results shown from Tribune
- High Plains farmers gain the most if consider NT to be mainly about water management
  - Collecting, storing, using rainfall more efficiently
- Early version of decision tool:
  - Use NT even on wheat crop in WMF or WCF
  - Consider cropping more intensively than 67%

Questions ???

Terry L. Kastens
785-532-5866
tkastens@ksu.edu

Kevin C. Dhuyvetter
785-532-3527
kcd@ksu.edu

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