No-till Oklahoma

Farm-level economic impact of no-till farming in Western Oklahoma

by

E. Osei[1], D. Moriasi[2], J. L. Steiner[2], P. J. Starks[2], and A. Saleh[1]

[1]Texas Institute for Applied Environmental Research (TIAER)

[2]USDA-ARS, El Reno, Oklahoma

No-till Oklahoma

Acknowledgements

- Funding support for this project was provided by USDA-ARS
- Authors also acknowledge useful input from other USDA-ARS and TIAER staff

Introduction

- Tillage practices can impact water quality
- Conservation tillage reduces sediment loss
- Reduced and conservation tillage can increase soluble nutrient concentrations
- Overall, conservation tillage, particularly no-till helps improve water quality

Introduction (Contd.)

- Farm profits also depend on tillage method used
- Conservation tillage – increased yield variability
- Conservation tillage yields:
  - Usually higher in dryer years
  - Often lower in wetter years
- Yield impacts of no-till are inconclusive
  - Some studies show that no-till yields increase over time relative to other tillage practices

Introduction (Contd.)

- Conservation tillage – lower crop operating costs:
  - Fewer field operations
  - Lower fuel/energy costs
  - Lower machinery ownership & maintenance costs
- Conservation tillage – generally higher pesticide costs
  - Greater need to control herbicides with chemicals

Introduction (Contd.)

- Overall, conservation tillage competitive with conventional tillage
- Relative profit on a specific farm depends primarily on yields
- Profit depends also on fuel prices
- Recent technology advances help no-till:
  - Better equipment for conservation tillage
  - Pesticide-ready seed varieties

Introduction (contd.)

- Water quality impacts of no-till quite certain
- However, economic impacts inconclusive
  - Partly due to lack of sufficient data/analysis
    - E.g. impact of no-till on grain and forage yields
  - Can hinder producer decisions
- Purpose of this study is to use Farm-level Economic Model (FEM) to determine no-till profits relative to conventional tillage or mix of current tillage practices in Western Oklahoma.
  - Based on data collected in Fort Cobb Reservoir watershed.
  - Applicable to other areas in Western Oklahoma

What we will talk about today

- Tillage systems overview:
  - Types
  - Trends
- What computer model or software we used
- How we ensured that the model estimates are reliable
- What kinds of data we used and where we got them from
- How we performed the analysis
- Results
- Recommendations
- Conclusions

Types of tillage systems

- Conventional tillage:

Leaves less than 15% residue cover

  - With moldboard plow
  - Without moldboard plow

- Reduced tillage:

Leaves 15-30% residue cover

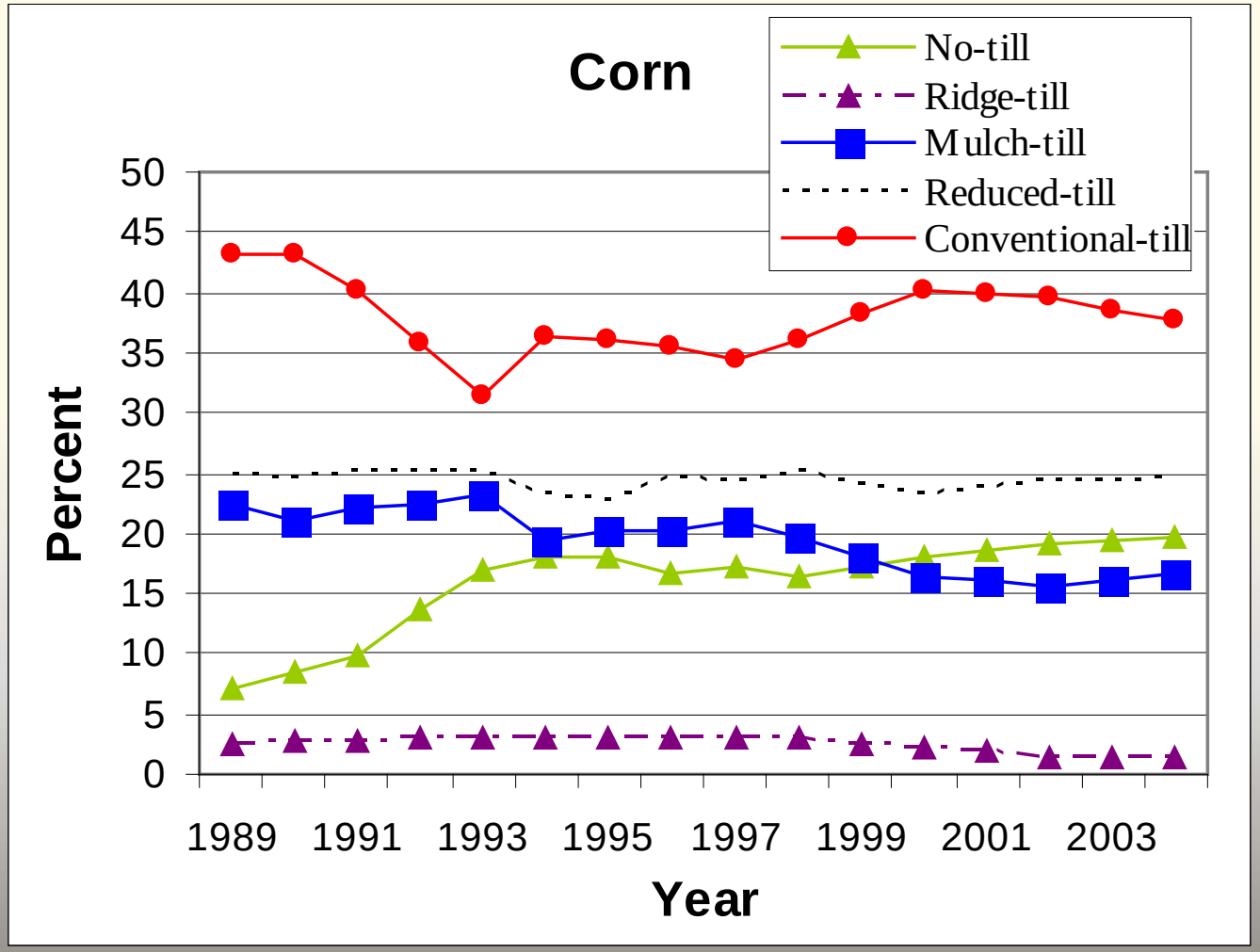
Types of tillage systems (Contd.)

- Conservation tillage:

Leaves at least 30% residue cover

  - Mulch till
  - Ridge-till
  - No-till

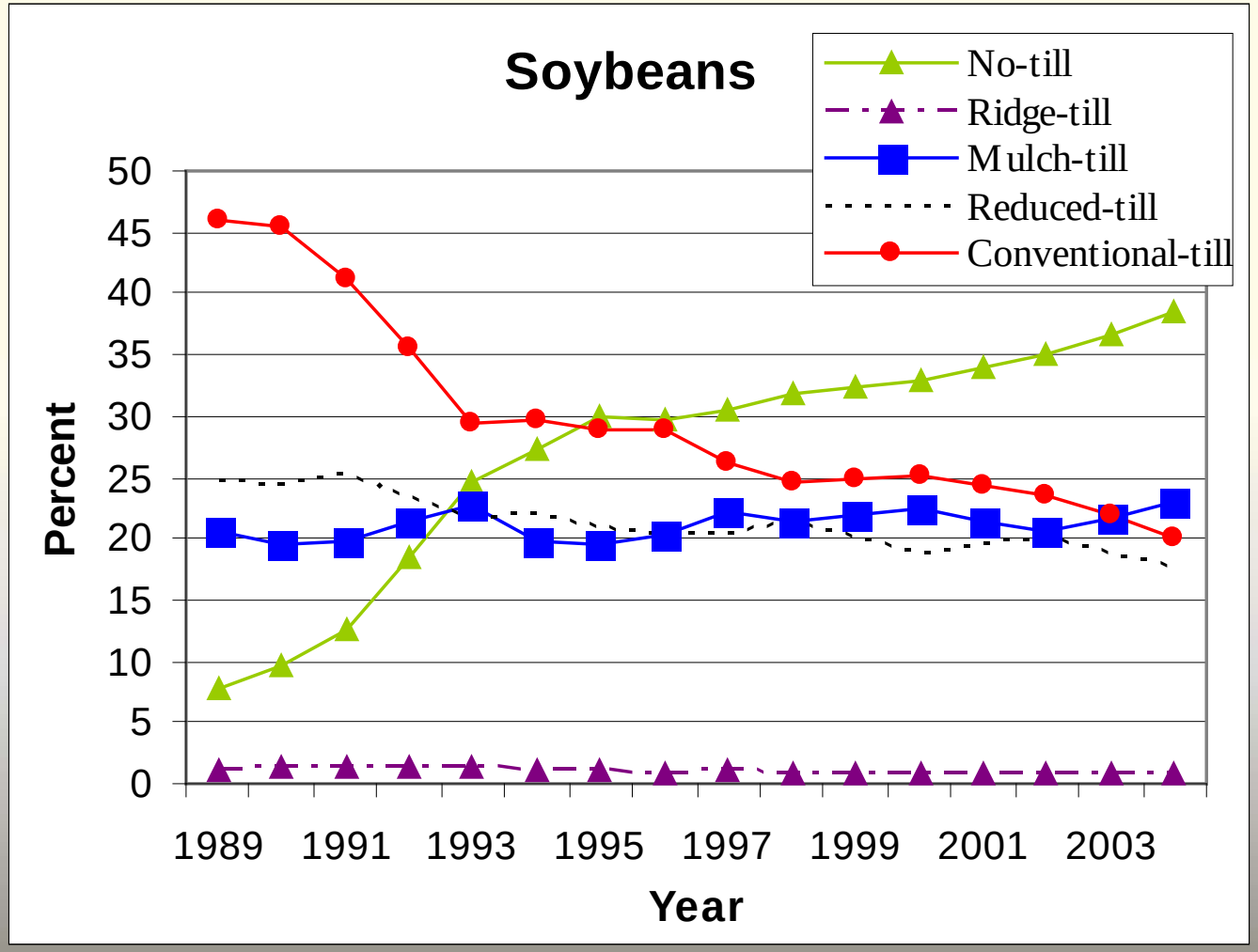
Trends in tillage system use in the U.S.



No-till Oklahoma

Trends in tillage system use in the U.S.

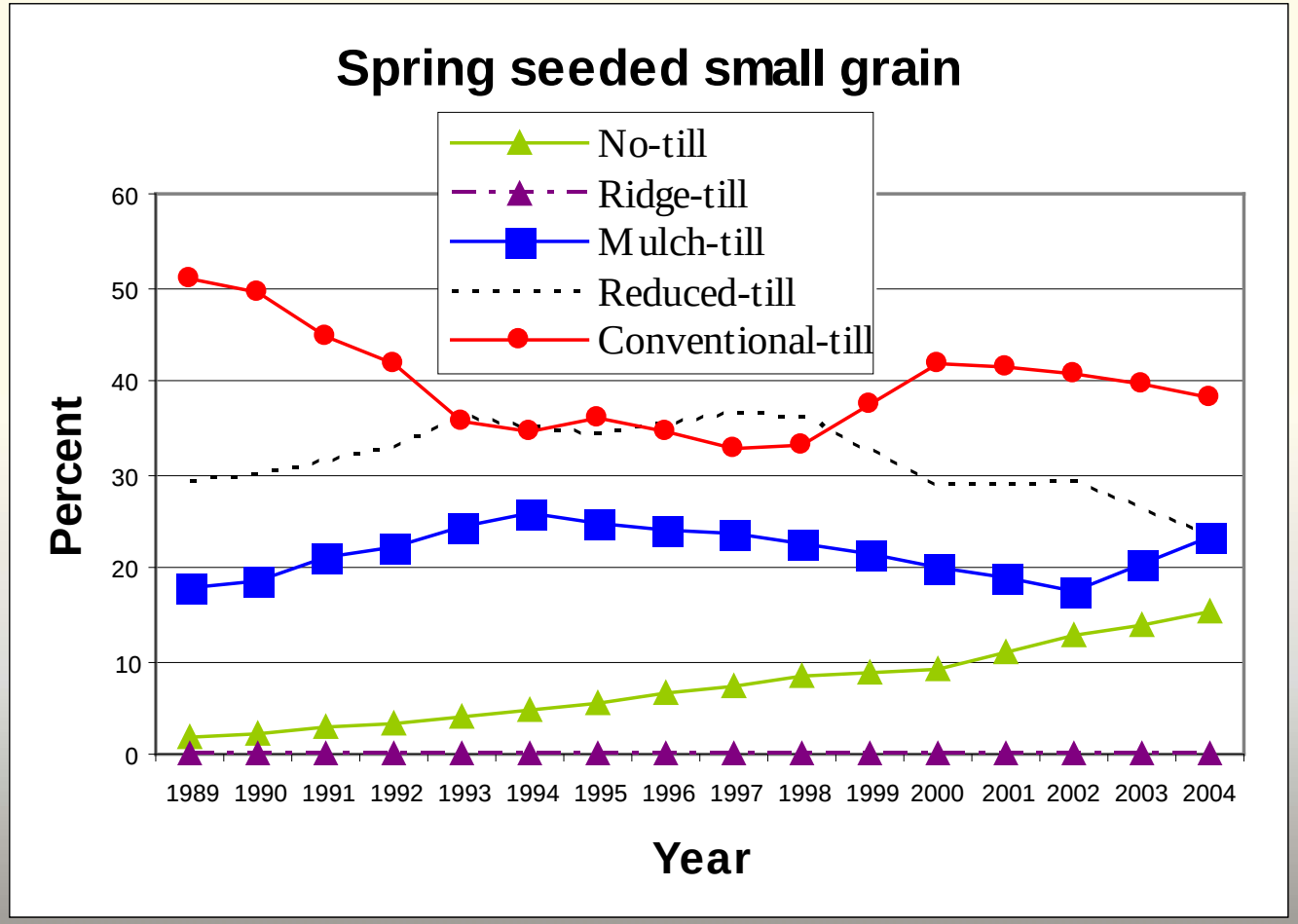
(Contd.)



No-till Oklahoma

Trends in tillage system use in the U.S.

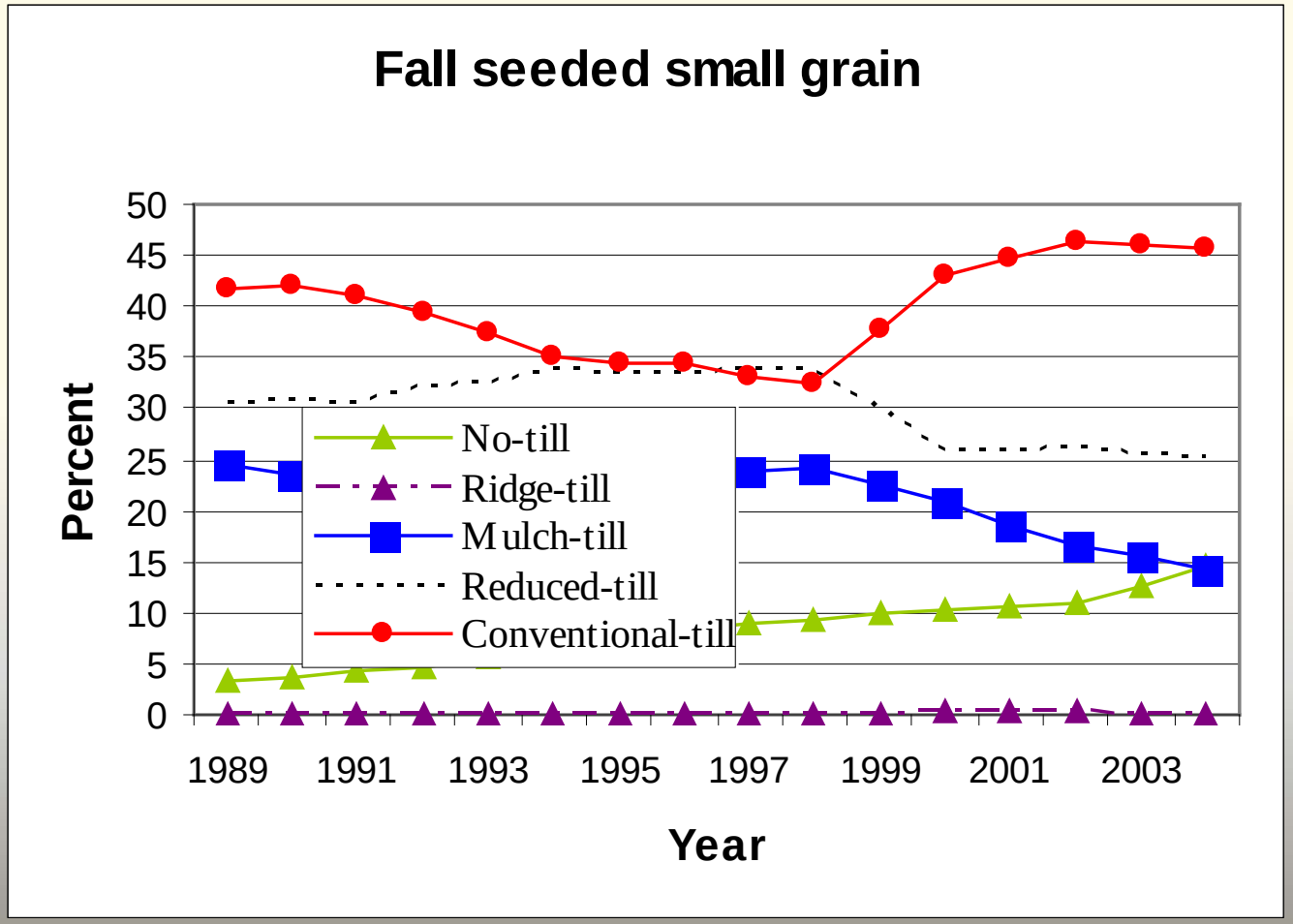
(Contd.)



No-till Oklahoma

Trends in tillage system use in the U.S.

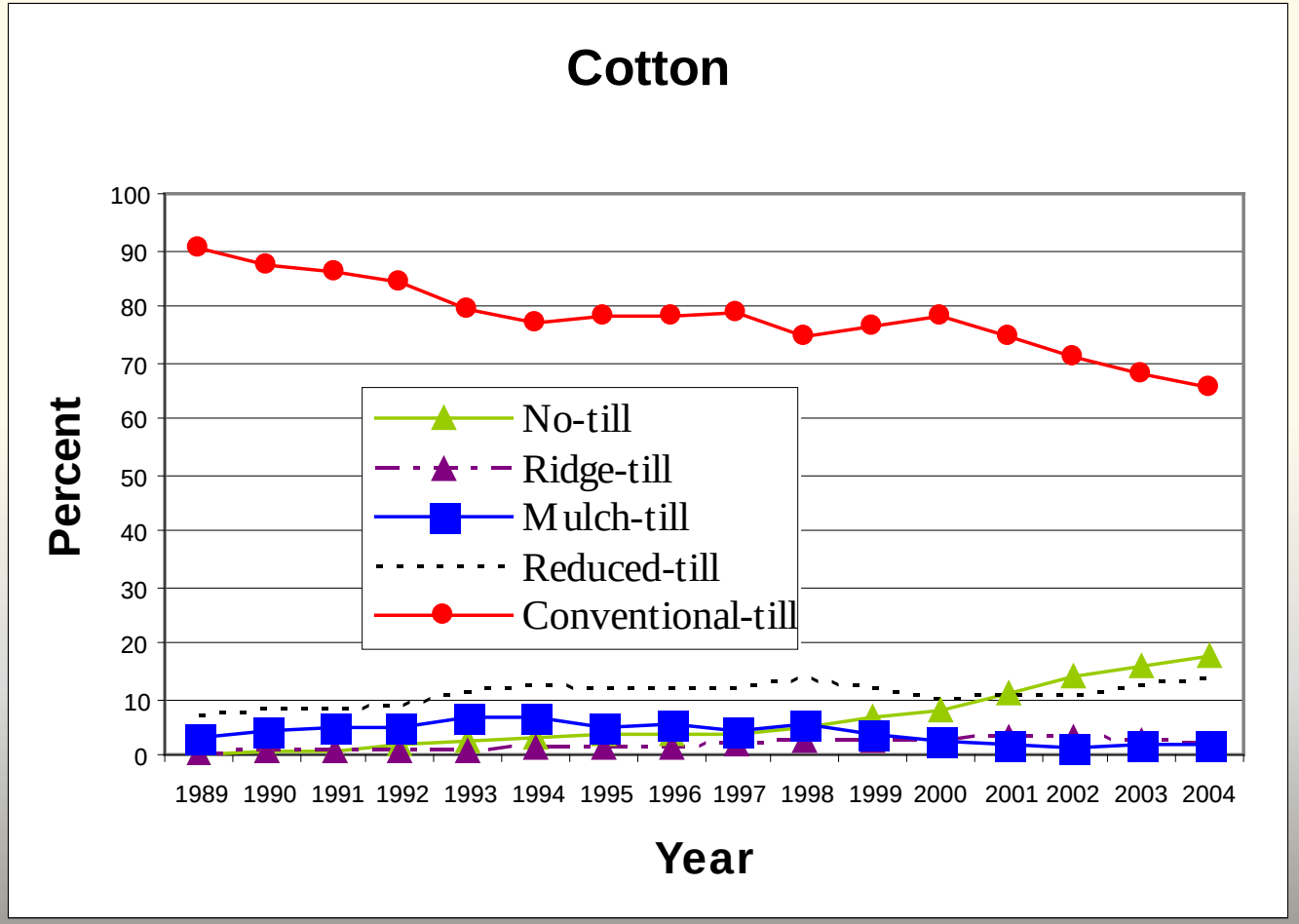
(Contd.)



No-till Oklahoma

Trends in tillage system use in the U.S.

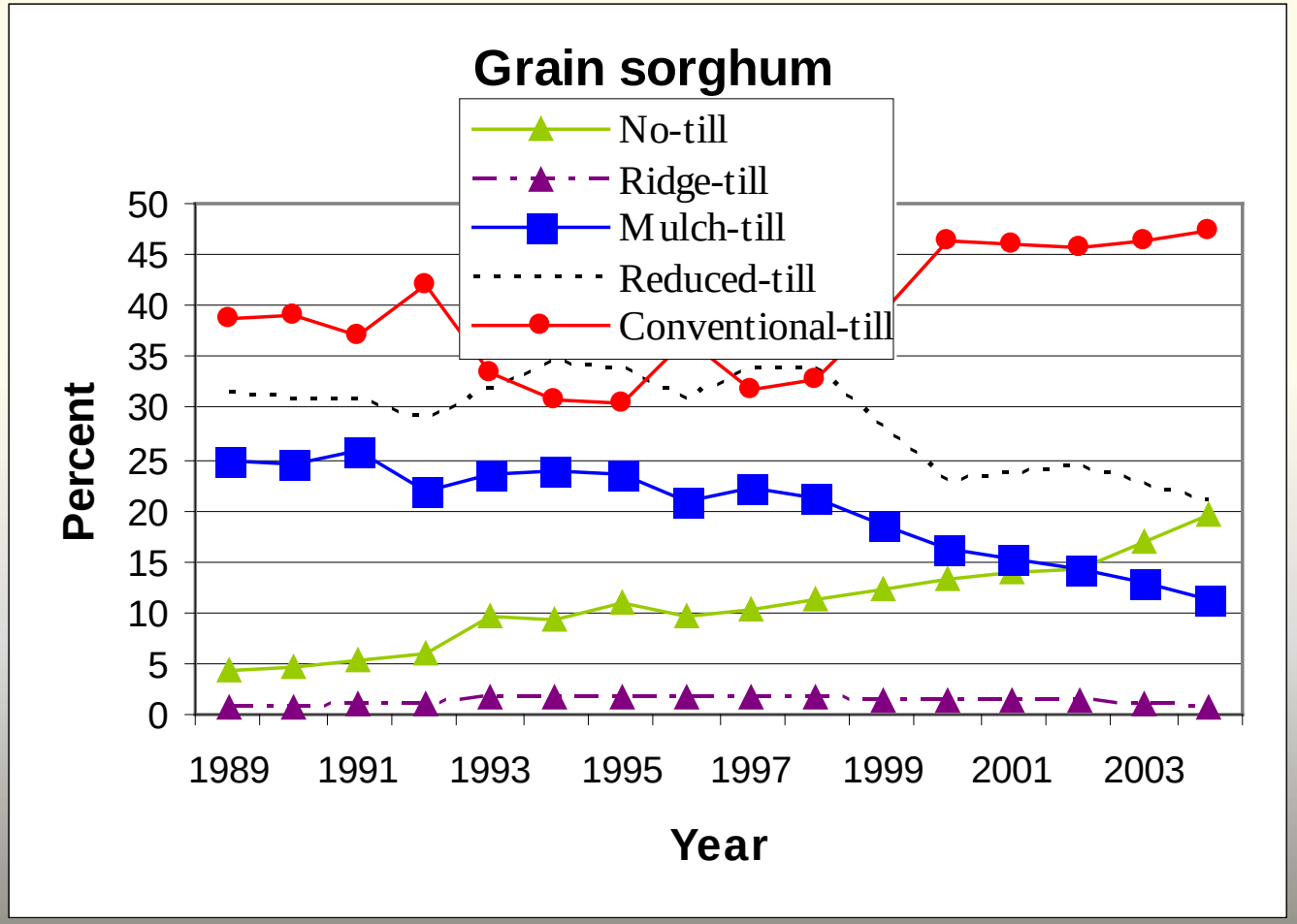
(Contd.)



No-till Oklahoma

Trends in tillage system use in the U.S.

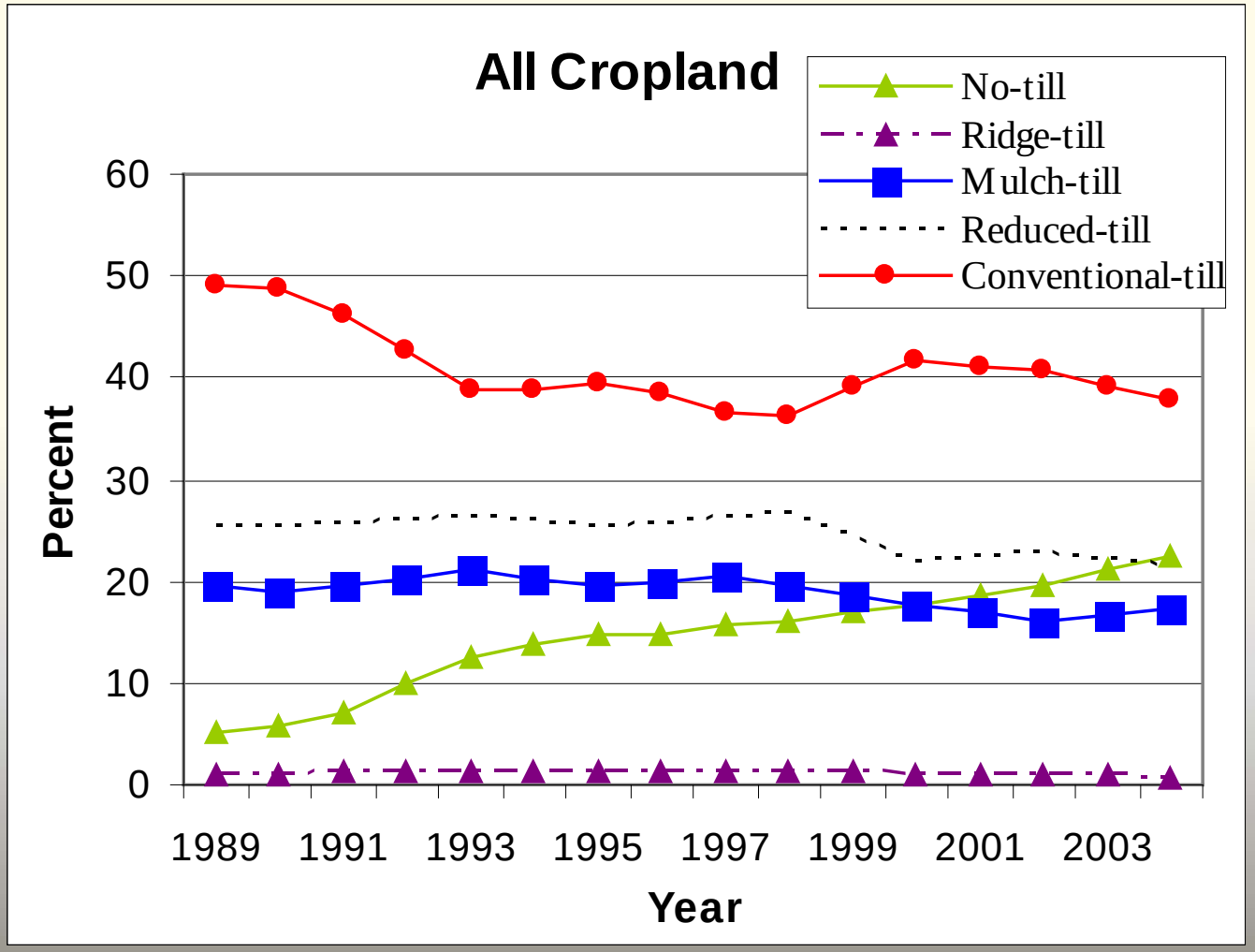
(Contd.)



No-till Oklahoma

Trends in tillage system use in the U.S.

(Contd.)



No-till Oklahoma

Computer model used – FEM

Brief overview

- A whole-farm annual economic model
- Simulates economic impacts of a wide range of scenarios on farms
- For each application, model is calibrated with extensive data on farm practices, budgets and other watershed information
- Includes a number of simulation and optimization routines

No-till Oklahoma

Major components of FEM

- Cropping Systems
- Livestock systems/husbandry
- Manure handling/management
- Land areas and uses
- Machinery and Equipment
- Structures and facilities
- Exogenous factors

How we made sure FEM works well for Western Oklahoma

- We calibrated the model
  - We adjusted model parameters and input data to reflect study area
  - For this study we compared FEM estimates to enterprise budgets and custom rate surveys
- Machinery coefficients adjusted include:
  - Prices
  - Hours of effective use
  - Field efficiency
  - Width
  - Speed

Comparison of field operation costs: calibrated FEM estimates versus Oklahoma custom rate survey data

Field Operation	FEM Model Estimate			Current Custom Rate		
	Total	Fixed	Variable	Average	Low	High
Moldboard plow	15.10	5.66	9.44	13.00	9.00	16.00
Chisel plow	9.96	5.00	4.96	9.32	7.00	12.00
Spring-tooth harrow	5.38	2.04	3.34	5.90	2.50	10.00
Tandem disk	8.50	5.01	3.49	NA	NA	NA
No-till drill	12.96	6.47	6.49	11.11	5.70	15.00
Drill, regular	10.19	6.71	3.48	8.55	4.40	15.00
Cultivator	8.55	4.75	3.80	8.67	6.00	12.00
Packer, pulverize	12.53	4.09	8.44	NA	NA	NA
Spray herbicide/pesticide	3.99	2.41	1.58	4.61	2.00	12.00
Fertilizer spreading: bulk	4.74	2.36	2.38	3.71	1.10	10.00

*NA: Not available in Oklahoma customs rate survey.

Data used and data sources

Prices

- Input prices – USDA-NASS, feed & chemical dealers, etc.
- Output prices – USDA-NASS

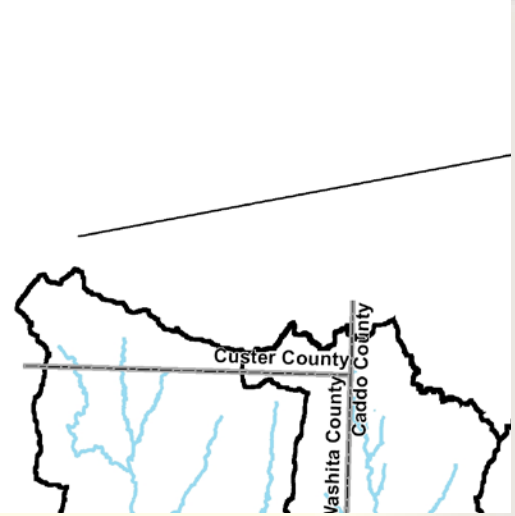
Crop yields

- Grain yields – Fort Cobb reservoir watershed, USDA-NASS
- Forage yields – Fort Cobb reservoir watershed

Cultural practices/field operations

- Current practices – Farm survey sites – Ft. Cobb reservoir watershed
- No-till/conventional tillage practices – Farm survey sites – Ft. Cobb reservoir watershed

Location of the Ft. Cobb reservoir watershed in Southwestern Oklahoma



After 9” rain – field that was conventional tilled

Photo credit: Larry Wright, USDA NRCS

No-till Oklahoma

After 9” rain – adjacent field that was no-tilled

Photo credit: Larry Wright, USDA NRCS

No-till Oklahoma

Summary of tillage practices

from farm survey sites in Ft. Cobb reservoir watershed

Crop	Conventional	No-till	Minimum till	Row-till	Row-till/ No-till	Totals
Corn	4	0	2	0	0	6
Cotton	2	5	3	0	2	12
Peanuts	7	0	0	2	0	9
Rye	0	2	7	0	0	9
Sorghum	3	0	0	0	0	3
Soybeans	0	1	0	0	0	1
Wheat	10	10	12	0	0	32
Totals	26	18	24	2	2	72

No-till Oklahoma

Simulation Procedure

Scenario input file created for 189 iterations for each of the 40 farms:

- Diesel prices changed from $1.00 to $7.00/gallon in seven steps (7 iterations)
- No-till yield changed from -20% to +20% relative to conventional tillage yields, in 5% increments (9 iterations)
- Simulated baseline, conventional tillage and no-till for each farm (3 iterations) using FEM

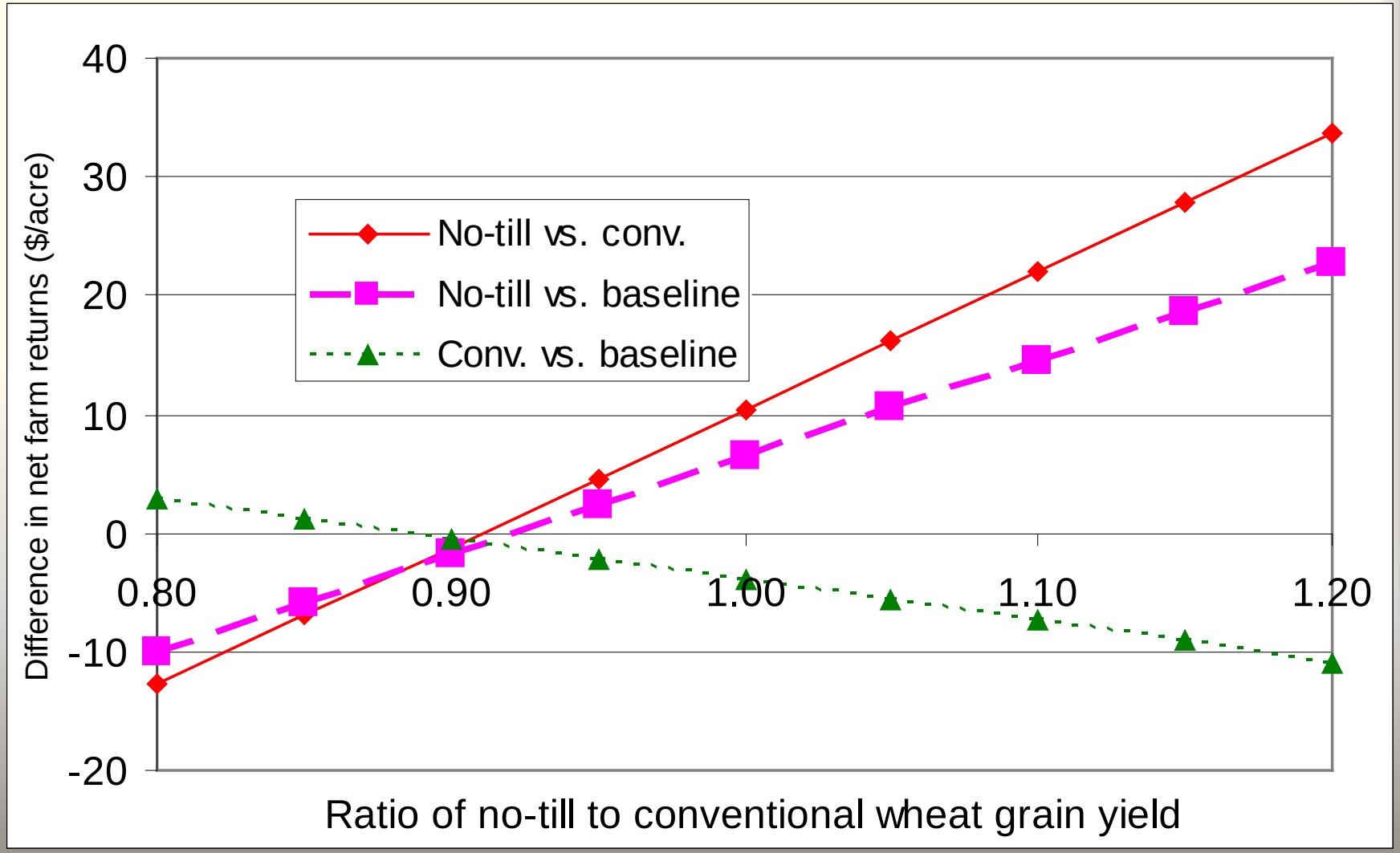
Results

- Results shown here for 30-year time horizon
- Following charts show difference between farm profits for:
  - No-till versus conventional tillage
  - No-till versus baseline
    - Baseline is current mix of tillage practices
  - Conventional tillage versus baseline
- Results are annual averages across all 30 years and across:
  - All farms
  - All farms that grow only winter wheat

No-till Oklahoma

Results (contd.)

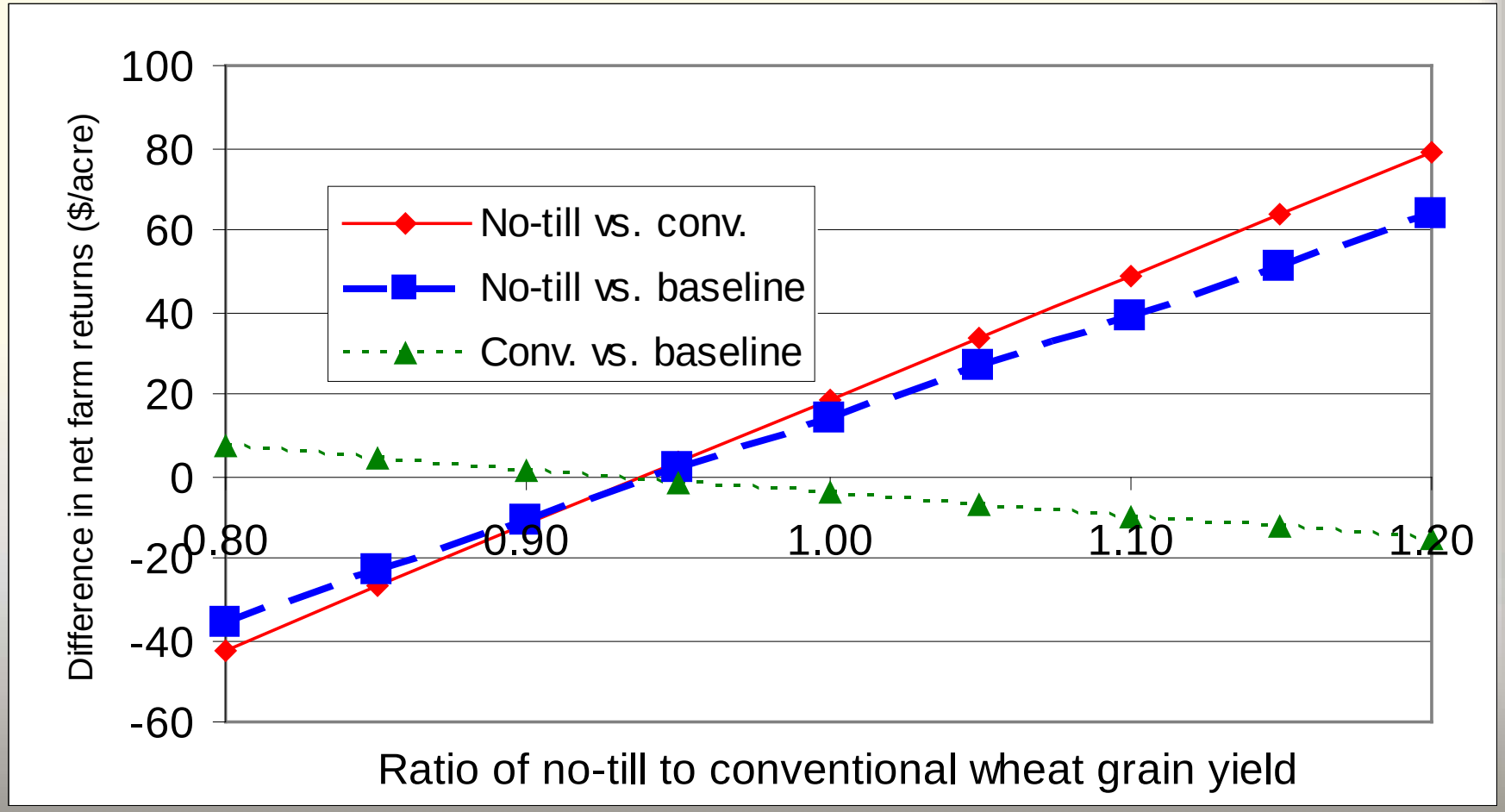
Impact of wheat yields when diesel is $4/gallon – all farms



No-till Oklahoma

Results (contd.)

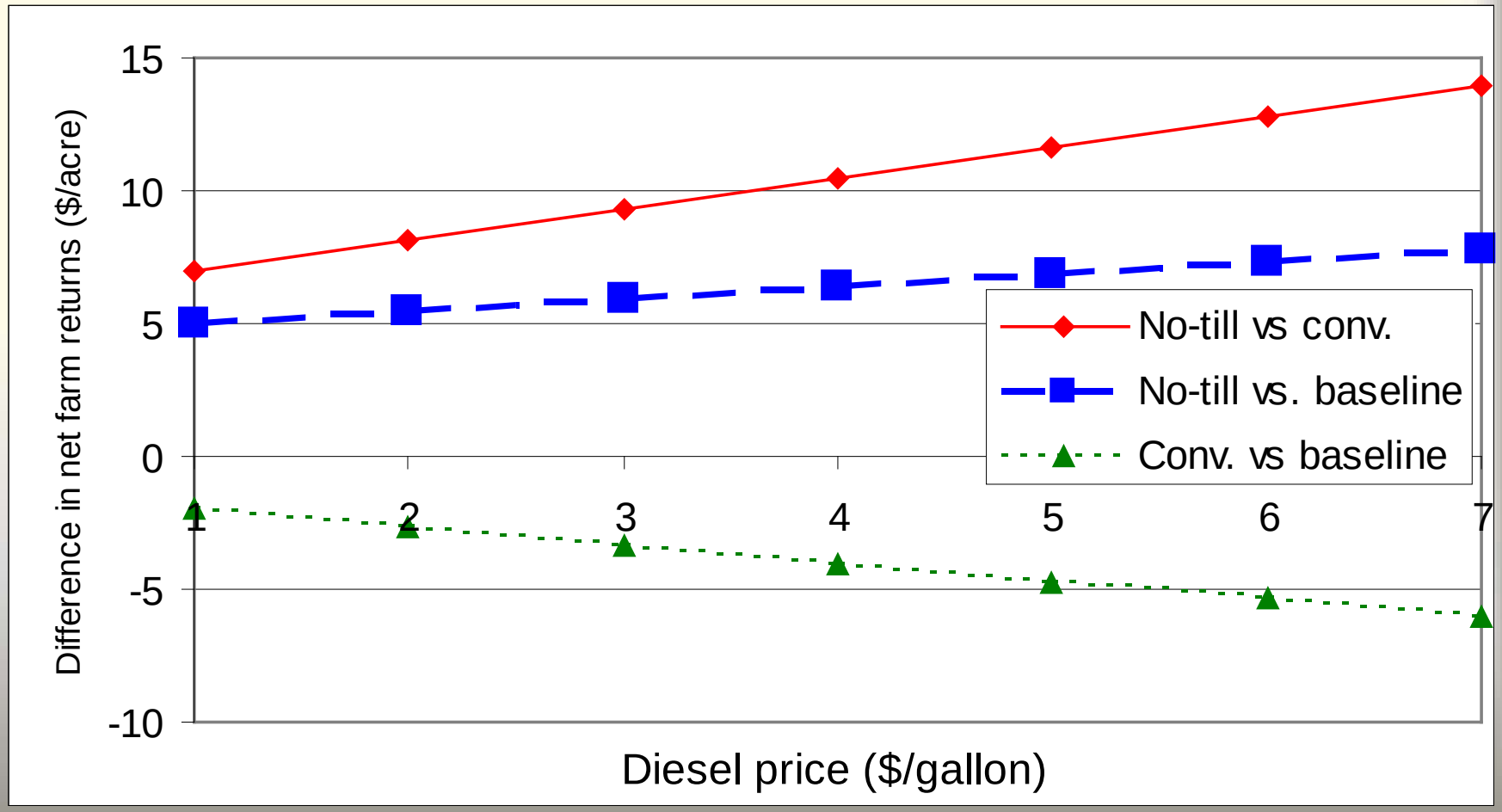
Impact of wheat yields when diesel is $4/gallon – wheat-only farms



No-till Oklahoma

Results (contd.)

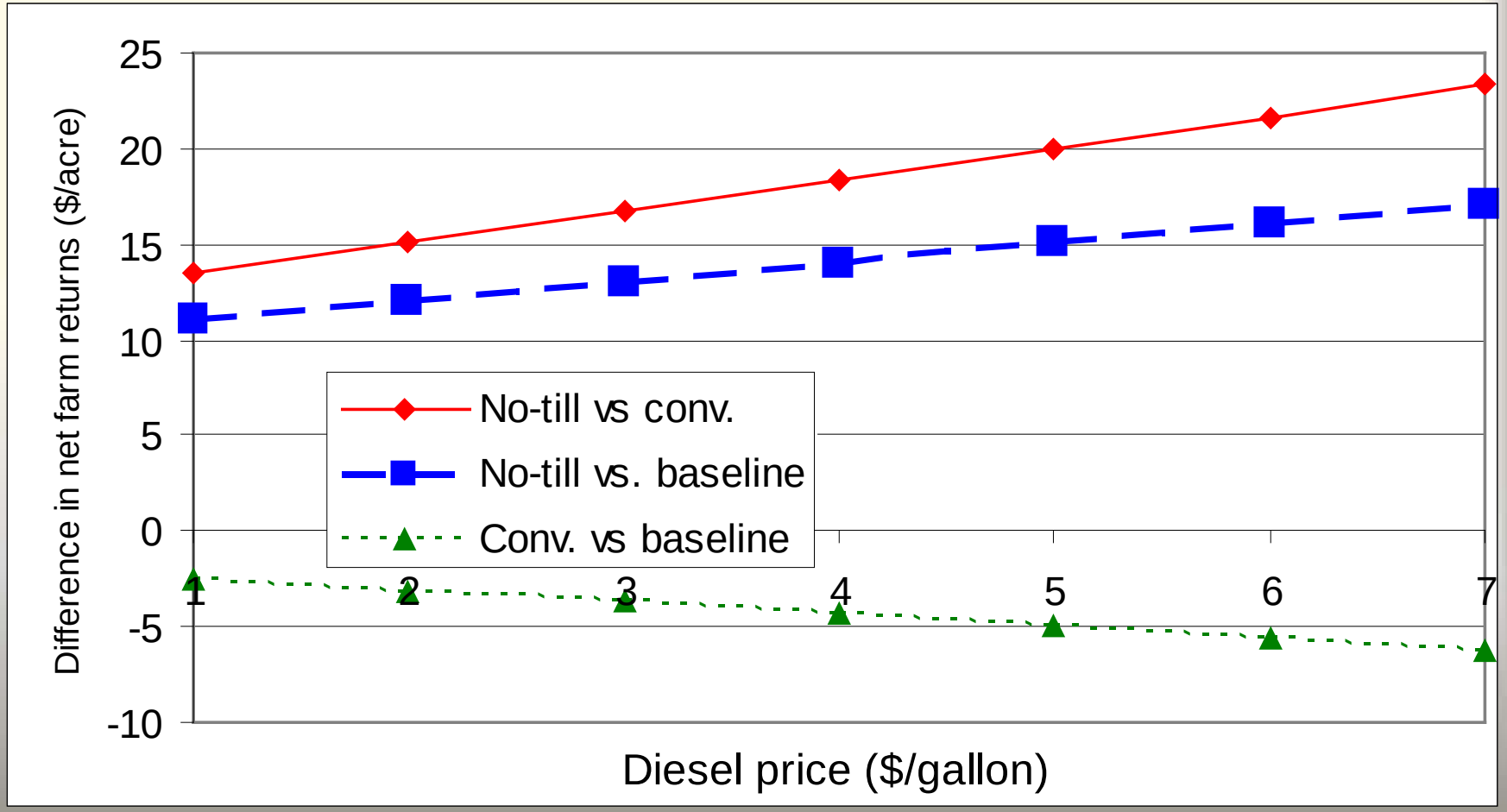
Impact of diesel price when wheat yields are the same – all farms



No-till Oklahoma

Results (contd.)

Impact of diesel price when wheat yields are the same – wheat-only farms



No-till Oklahoma

Results (Contd.)

- Next set of results show cross-tabulations
- Can be used to estimate no-till impact for a wide range of fuel and yield effects:
  - Diesel price from $1 to $7/gallon
  - Relative no-till yield -20% to +20%
- Simply interpolate between prices and yields closest to what you are looking for
- Examples:
- For $3.50 and -5% look between $3 and $4 in the -5% column
- For $2.50 and +2% look between numbers corresponding to $2 and 0%, and $3 and 5%

Results (contd.)

Cross-tabulations of profit impacts:

No-till versus conventional tillage – all farms

		Percentage difference between no-till and conventional wheat grain yield								
		-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Diesel price ($/gallon)	$1.00	-16.26	-10.45	-4.64	1.16	6.97	12.78	18.58	24.39	30.20
	$2.00	-15.10	-9.30	-3.49	2.32	8.12	13.93	19.74	25.54	31.35
	$3.00	-13.95	-8.14	-2.33	3.47	9.28	15.09	20.89	26.70	32.51
	$4.00	-12.79	-6.99	-1.18	4.63	10.43	16.24	22.05	27.85	33.66
	$5.00	-11.64	-5.83	-0.03	5.78	11.59	17.39	23.20	29.01	34.81
	$6.00	-10.48	-4.68	1.13	6.94	12.74	18.55	24.36	30.16	35.97
	$7.00	-9.33	-3.52	2.28	8.09	13.90	19.70	25.51	31.32	37.12

Examples:

$3.50 and -5%: Answer is $4.05

$2.50 and +2%: Answer is $11.02

Results (contd.)

Cross-tabulations of profit impacts:

No-till versus baseline – all farms

		Percentage difference between no-till and conventional wheat grain yield								
		-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Diesel price ($/gallon)	$1.00	-11.40	-7.31	-3.22	0.87	4.97	9.06	13.15	17.24	21.33
	$2.00	-10.92	-6.83	-2.74	1.35	5.44	9.54	13.63	17.72	21.81
	$3.00	-10.44	-6.35	-2.26	1.83	5.92	10.01	14.10	18.20	22.29
	$4.00	-9.97	-5.88	-1.78	2.31	6.40	10.49	14.58	18.67	22.77
	$5.00	-9.49	-5.40	-1.31	2.79	6.88	10.97	15.06	19.15	23.24
	$6.00	-9.01	-4.92	-0.83	3.26	7.36	11.45	15.54	19.63	23.72
	$7.00	-8.53	-4.44	-0.35	3.74	7.83	11.92	16.02	20.11	24.20

Examples:

$3.50 and -5%: Answer is $2.07

$2.50 and +2%: Answer is $7.32

Results (contd.)

Cross-tabulations of profit impacts:

No-till versus conventional tillage – wheat-only farms

		Percentage difference between no-till and conventional wheat grain yield								
		-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Diesel price ($/gallon)	$1.00	-47.25	-32.06	-16.87	-1.67	13.52	28.71	43.90	59.09	74.28
	$2.00	-45.62	-30.43	-15.23	-0.04	15.15	30.34	45.53	60.72	75.91
	$3.00	-43.99	-28.79	-13.60	1.59	16.78	31.97	47.16	62.35	77.55
	$4.00	-42.35	-27.16	-11.97	3.22	18.41	33.60	48.79	63.99	79.18
	$5.00	-40.72	-25.53	-10.34	4.85	20.04	35.23	50.43	65.62	80.81
	$6.00	-39.09	-23.90	-8.71	6.48	21.67	36.87	52.06	67.25	82.44
	$7.00	-37.46	-22.27	-7.08	8.11	23.31	38.50	53.69	68.88	84.07

Examples:

$3.50 and -5%: Answer is $2.40

$2.50 and +2%: Answer is $22.04

Results (contd.)

Cross-tabulations of profit impacts:

No-till versus baseline – wheat-only farms

		Percentage difference between no-till and conventional wheat grain yield								
		-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Diesel price ($/gallon)	$1.00	-38.57	-26.18	-13.79	-1.39	11.00	23.39	35.79	48.18	60.57
	$2.00	-37.56	-25.17	-12.77	-0.38	12.01	24.41	36.80	49.19	61.58
	$3.00	-36.55	-24.15	-11.76	0.63	13.03	25.42	37.81	50.21	62.60
	$4.00	-35.53	-23.14	-10.75	1.65	14.04	26.43	38.83	51.22	63.61
	$5.00	-34.52	-22.13	-9.73	2.66	15.05	27.45	39.84	52.23	64.63
	$6.00	-33.51	-21.11	-8.72	3.67	16.07	28.46	40.85	53.25	65.64
	$7.00	-32.49	-20.10	-7.71	4.69	17.08	29.47	41.87	54.26	66.65

Examples:

$3.50 and -5%: Answer is $1.14

$2.50 and +2%: Answer is $17.48

Recommendations

- Farmers need to watch no-till yields
  - Careful management may result in no yield loss and possible increase in yields with no-till
  - That leads most definitely to increased profits and improved soil and water quality
- Are all those herbicide passes needed?
  - If farmers can limit herbicide passes, no-till profits are even better
- Some financial assistance may help with initial years after converting to no-till
  - Farm profits under no-till should improve after the first few years

Conclusions

- Economic impact of tillage depends on a number of factors
- Yield is more important than fuel prices
- If yields are equal, no-till is more profitable
- Even if no-till yields are slightly lower, no-till is still better financially
- If no-till yields are much less, then no-till is not as competitive
- Higher fuel prices also help no-till

Conclusions (contd.)

- No-till yields may start low but should improve over time
- So patience needed to realize full financial benefits of no-till
- No-till profits would be better if farmers used fewer herbicide applications