Economics of Herbicide Resistance Management

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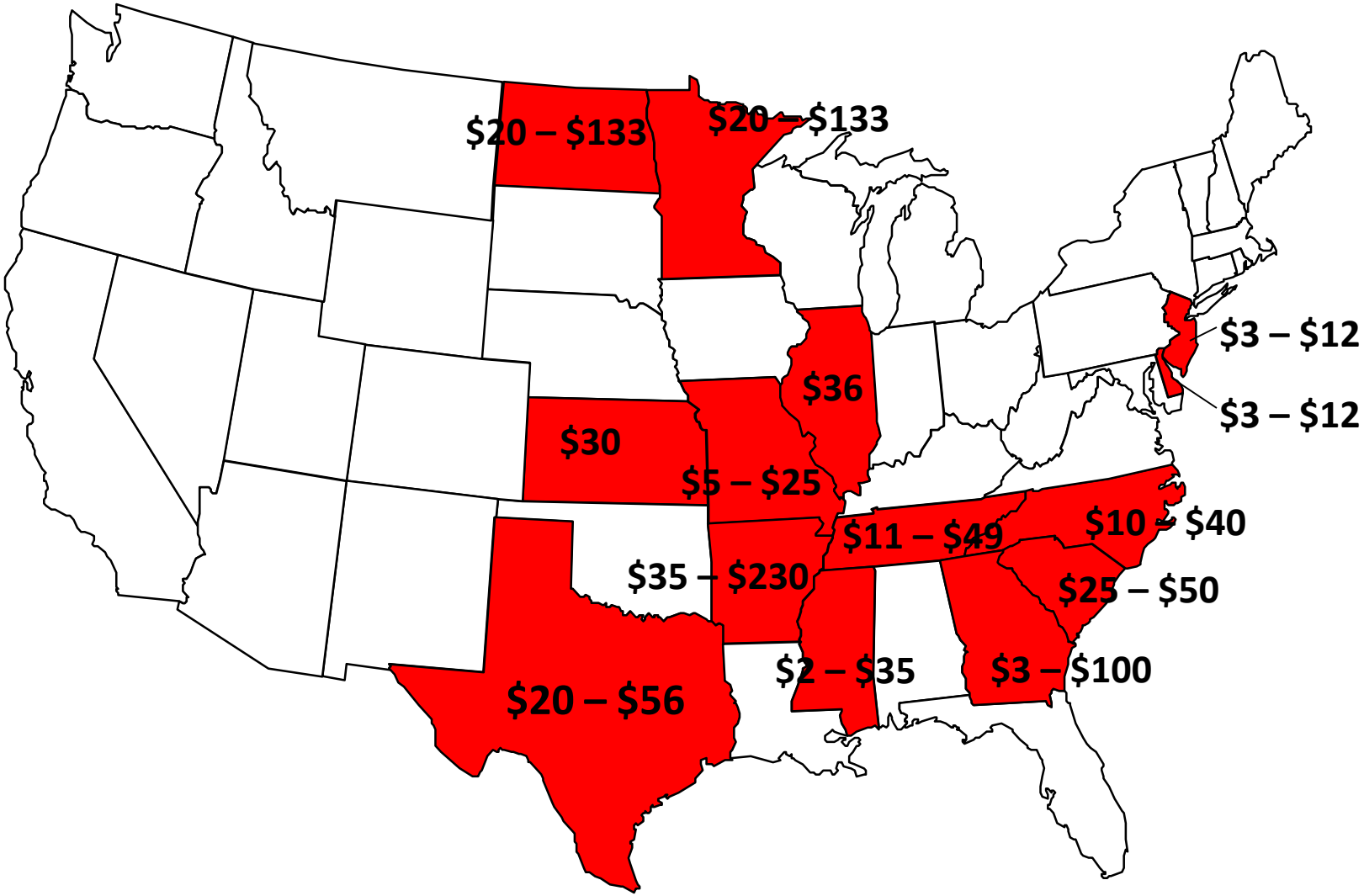
The Issue

- Despite high costs of dealing with HR weeds …
- … adoption of resistance management practices remains inconsistent and incomplete

Questions

- What are the economic barriers to managing herbicide resistance in weeds?
- What might be done to lower these barriers?

Extra per-acre costs of managing HR weeds



Barriers to RM: (short-run certain costs vs. long-run uncertain gains)

"*I believe the primary impediment is the near term costs associated with implementation of best management practices to forestall the problem that may or may not develop at some unspecified time in the future.”*

– David Miller, IA Farm Bureau Federation at National Summit on Strategies to Manage Herbicide Resistant Weeds

Barriers to RM: (belief in a silver bullet)

"two factors that may be hindering the adoption of practices that contribute to glyphosate stewardship:

(1) the belief that a new technology will be developed to solve the resistance (and tolerance) problems and ….

– Webster and Sosnoskie, Weed Science, 2010

Barriers to RM: (tragedy of the commons)

"…. (2) the belief that resistance management strategies will be futile."

Short-run – Long-run tradeoff

- Growers frequently told that proactive RM is their best long-run strategy
- Just how *long* is the long run?

"…*this long run is a misleading guide to current affairs. In the long run we are all dead.*"
– John Maynard Keynes

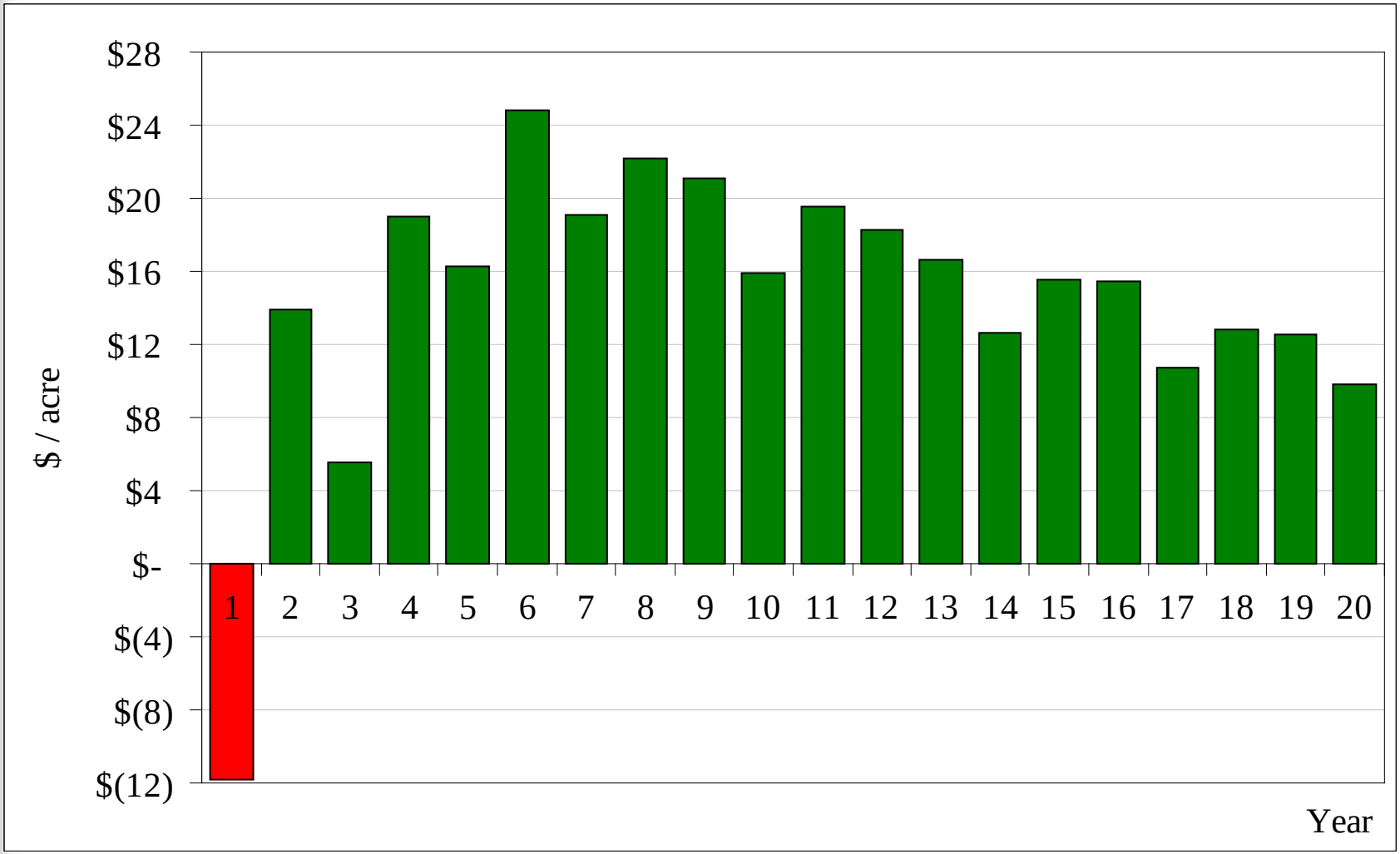
A Better Question to Ask

- How many years will it take for resistance management to “pay for itself?”
- At what point to the cumulative gains outweigh the cumulative costs?
- Similar to “payback period” for an energy efficient appliance

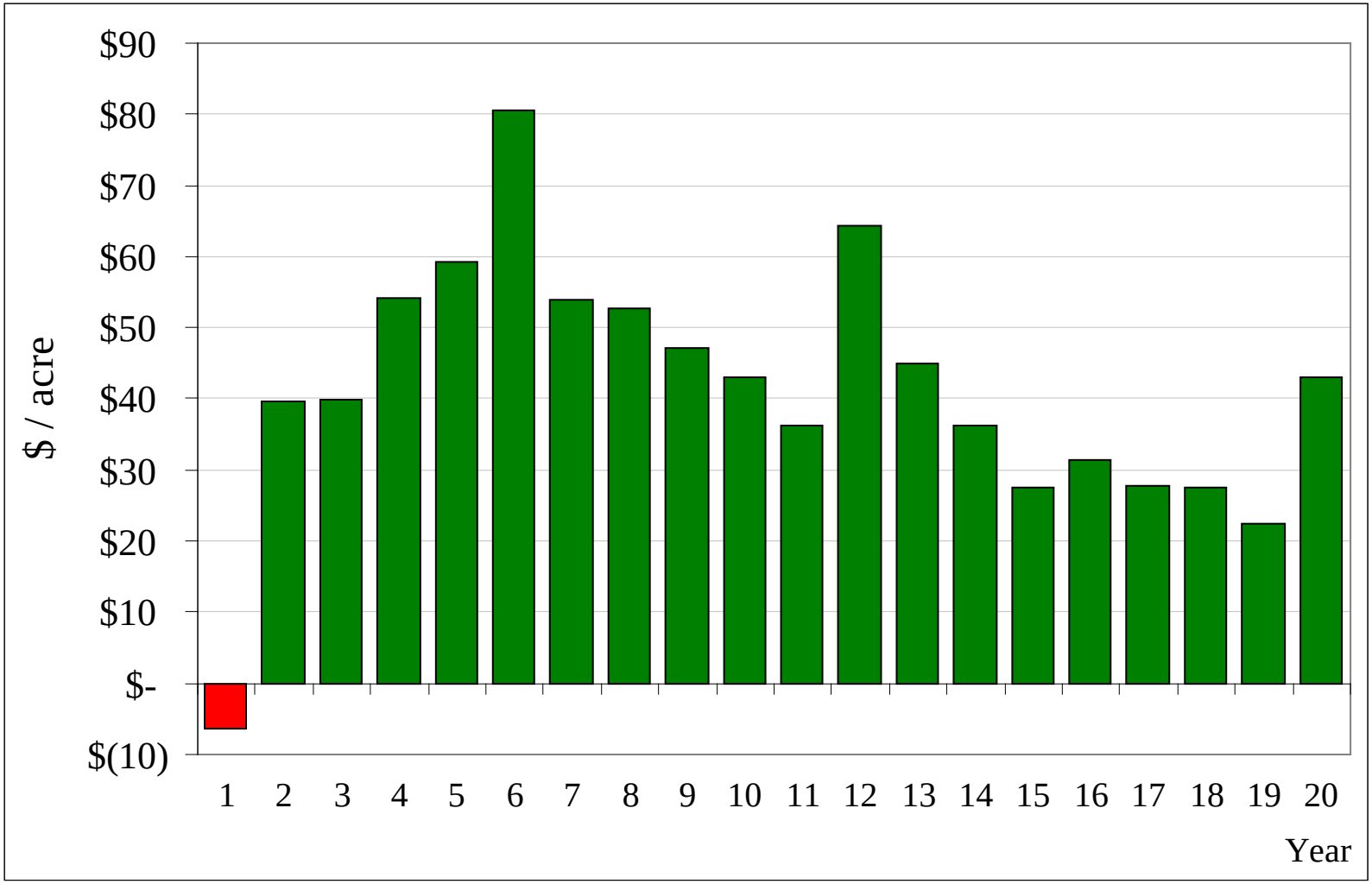
To Answer Question

- Developed a bioeconomic model
  - Includes farm profitability over 20 year planning horizon
  - Biological model of resistance evolution
- Applied to 3 cropping patterns
  - Continuous corn
  - Corn-soybean rotation
  - Continuous soybeans

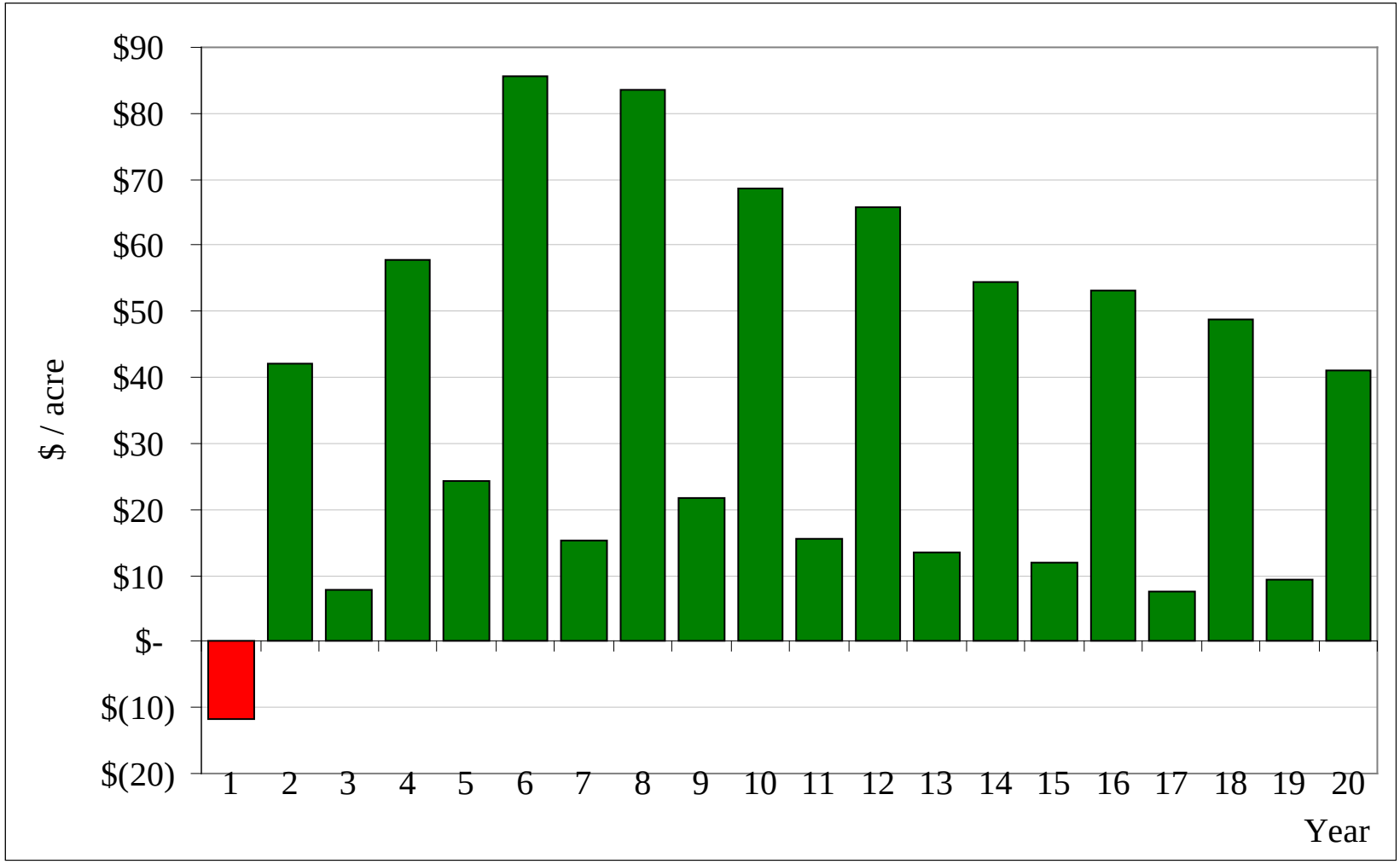
Present Value of Net Returns to Managing Resistance: Continuous Soybeans



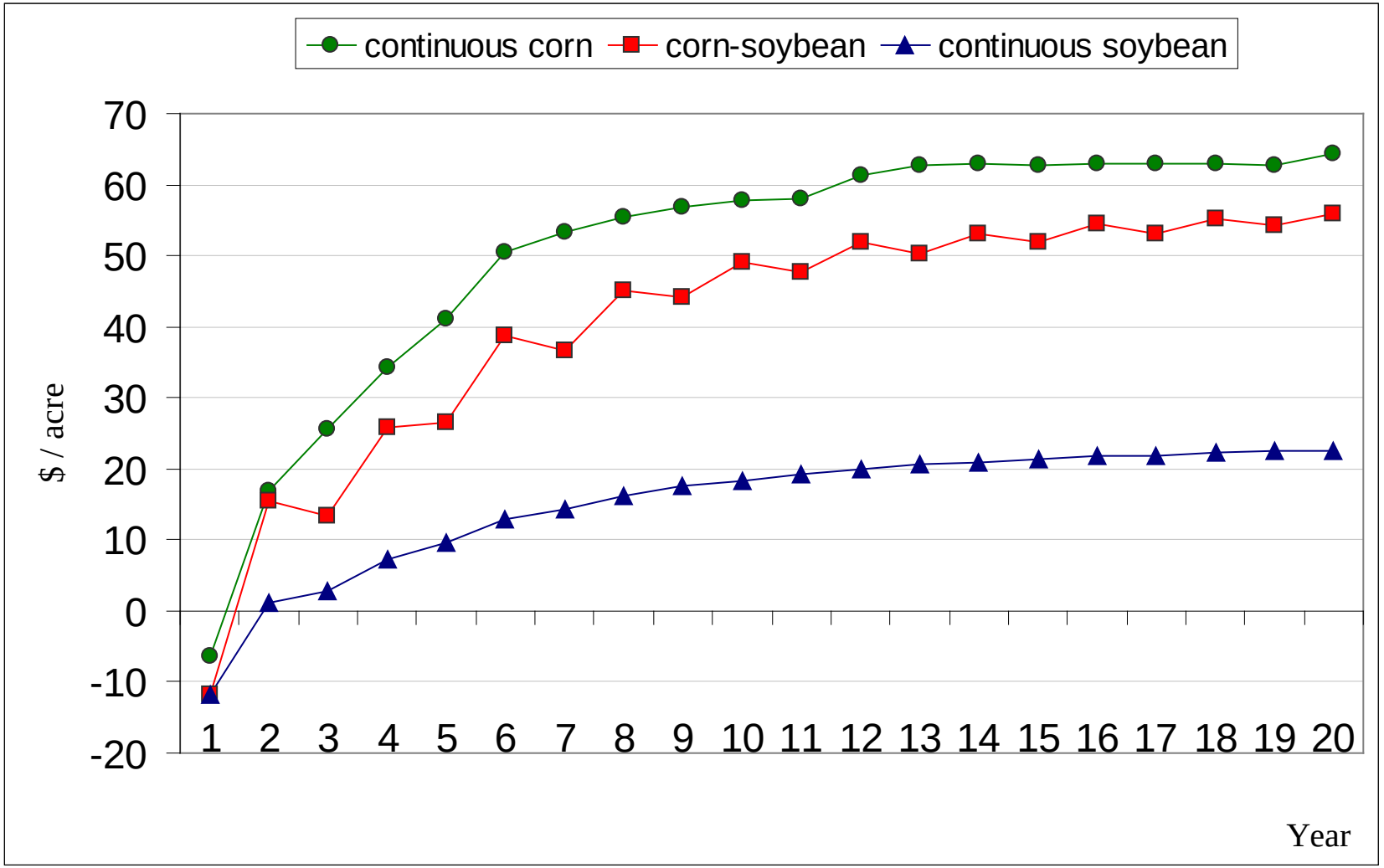
Present Value of Net Returns to Managing Resistance: Continuous Corn



Present Value of Net Returns to Managing Resistance: Corn-Soybean Rotation



Average annual gains to managing herbicide resistance



Returns to managing resistance, long-run averages

	Corn, continuous	Corn-soybean rotation	Soybean, continuous
	$ / acre		
Managing to delay resistance	$431.40	$378.70	$183.30
Not managing to delay resistance	$367.00	$322.90	$160.70
Annual profit gain from managing resistance ($/acre)	$64.30	$55.80	$22.60
Annual profit gain from managing resistance (%)	17.5%	17.3%	14.1%

What about neighbor resistance management?

- What happens when a grower manages resistance, but the grower's neighbor does not?
- What are gains to joint resistance management?
- What does the "tragedy of the commons" look like?

- Coordination can be costly & require facilitation & incentives
- Imperfect information is important
- A problem in Game Theory

Returns to managing resistance, given neighbor behavior

Continuous Corn		Neighbor	
		Manages Resistance	Ignores Resistance
Grower	Manages Resistance	431.72	410.07
	Ignores Resistance	368.19	360.47
	Grower gain from managing resistance	63.53	49.60

Returns to managing resistance, given neighbor behavior

Continuous Corn		Neighbor	
		Manages Resistance	Ignores Resistance
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Best outcome

Returns to managing resistance, given neighbor behavior

Continuous Corn		**Neighbor**	
		Manages Resistance	Ignores Resistance
Grower	Manages Resistance	431.72	410.07
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	Grower gain from managing resistance	63.53	49.60

Resistance management is a “dominant strategy”
RM is the best strategy regardless of what neighbor does

Returns to managing resistance, given neighbor behavior

Corn-Soybean Rotation		Neighbor	
		Manages Resistance	Ignores Resistance
Grower	Manages Resistance	378.36	336.19
	Ignores Resistance	319.44	311.77
	Grower gain from managing resistance	58.92	24.42

Returns to managing resistance, given neighbor behavior

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Returns to managing resistance, given neighbor behavior

Continuous Soybeans		**Neighbor**	
		Manages Resistance	Ignores Resistance
Grower	Manages Resistance	182.70	154.85
	Ignores Resistance	158.79	154.82
	Grower gain from managing resistance	23.91	0.04

Resistance management is a “weakest link public good”
Payoff depends on the person who provides the least effort

Research / Policy Implications

- In some cases, managing resistance pays for itself
  - Quickly
  - Significantly
  - Regardless of what neighbors are doing
- Need to
  - identify these situations for more crops and regions
  - Build this into extension messages

Research / Policy Implications

- In other cases, effective resistance management may need to be ***group management***
  - A collective action problem
  - Rebates for residuals can overcome some collective action problems
- Policy responses
  - Top-down regulatory approaches, versus …
  - Grower-led, voluntary initiatives

Emerging Policy Challenges

- How do you design and implement grower-led, community-based resistance management programs?

- What do you do when relevant growers have very different
  - Time horizons
  - Scales of operation
  - Reliance on farm income
  - Cropping systems
  - Incentives / capacities to manage resistance?

Questions?

Thank you

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