The Economic Importance of Atrazine in the USA

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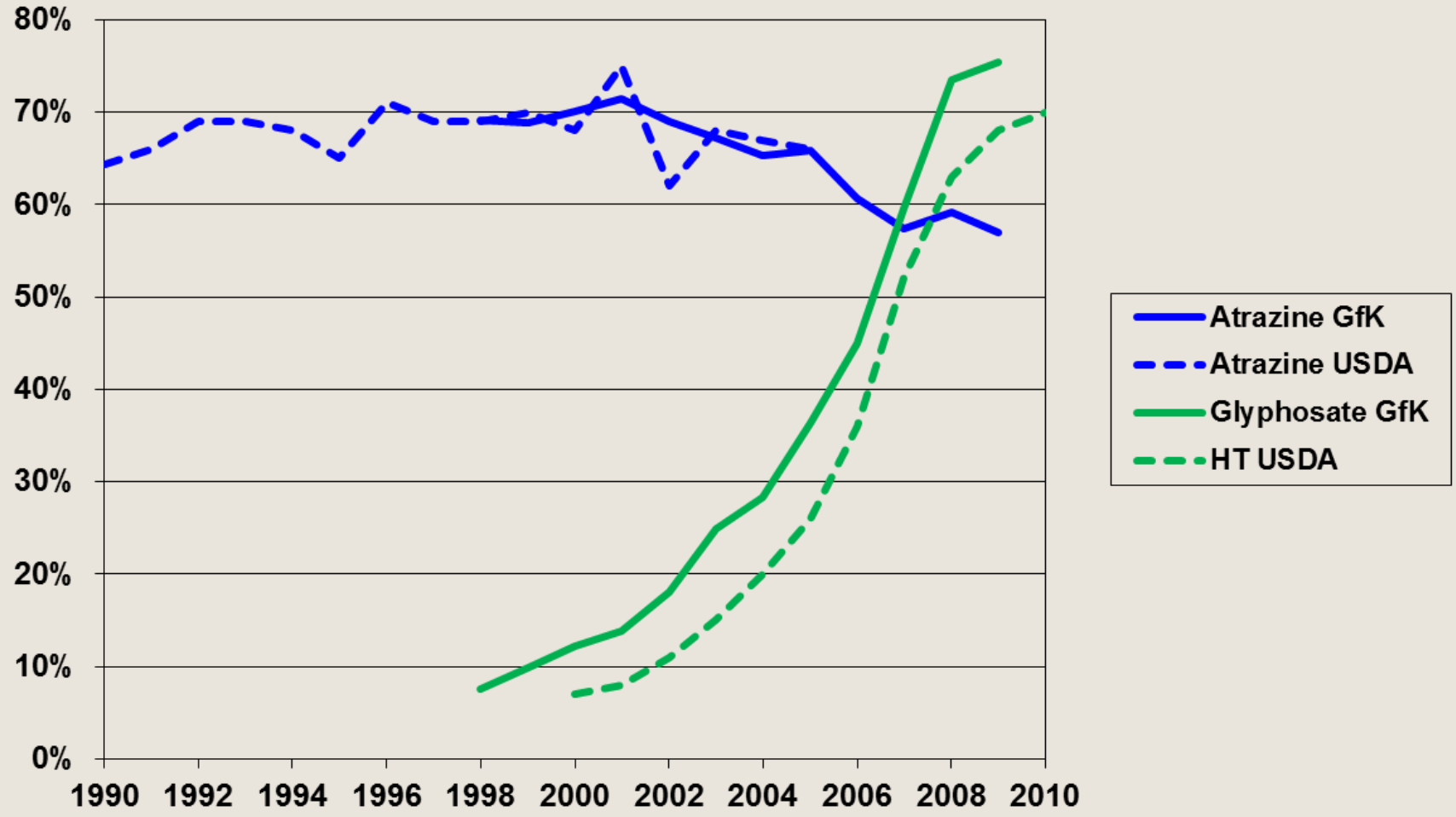
Atrazine Economics

- Last major national-level economic assessment of the benefits of atrazine was in the mid 1990's
- Lots has changed since early 1990s (compare 3-year averages for 1990-1992 to 2009-2011)
  - Corn acres: 76.5 million to 88.8 million
  - Yield per acre: 119.5 bu/ac to 154.7 bu/ac
  - Price per bu: $2.24/bu to $4.34/bu (2008-2010)
  - Total production: 8.3 billion bu to 12.6 billion bu
  - Total farmgate value: $18.6 billion to $54.3 billion (2008-2010)
  - GM Crops: herbicide tolerant and Bt corn: 88% acres in 2011
  - More concern about and problems with herbicide resistant weeds
- It's time for an updated analysis!

Percent of US corn acres treated with atrazine, with glyphosate, & planted with an herbicide-tolerant (HT) variety



Presentation Overview

- Present main findings from two working papers
  - Economic Assessment of the Benefits of Chloro-s-triazine Herbicides to U.S. Corn, Sorghum, and Sugarcane Producers (http://www.aae.wisc.edu/pubs/sps/pdf/stpap564.pdf)
  - Estimating Soil Erosion and Fuel Use Changes and Their Monetary Values with AGSIM: A Case Study for Triazine Herbicides (http://www.aae.wisc.edu/pubs/sps/pdf/stpap563.pdf)
- Overview of methods and assumptions of analysis
  - For you to assess accuracy and correctness
- Summarize economic & environmental benefits of atrazine
- Examine the tradeoff between production per acre and acres in production: Why what you do is important!

Overview Method of Analysis

- Counterfactual Analysis
  - What would world look like without atrazine?
  - Difference between this hypothetical world and current world is the benefit of atrazine
- What would farmers do without atrazine?
  - Switch to alternative herbicides, especially glyphosate and RR crops
  - Increase tillage
    - Atrazine important part of conservation tillage
    - Concerns about & problems with herbicide resistance

Yield and Cost Changes without Atrazine

- Dr. David Bridges developed a model to estimate market shares for other herbicide systems after removing atrazine
- http://www.abac.edu/president/RecentPublications/Bridges_Final_Paper_Wed_Nov9.pdf
- Gathered region-specific data on pressure, crop loss, and herbicide efficacy by weed species
- Estimated new herbicide systems using “protection value” of non-atrazine alternatives and existing market shares
- **Estimated resulting yield losses and cost changes by region if atrazine were not available**
- Predicted more Glyphosate/RR corn, topped out at 100% of acres in many regions
- Two glyphosate scenarios: Constant glyphosate use (at 2009 levels) and increasing glyphosate use (up to 100%)

Yield Loss and Cost Change Assumptions for Corn Based on Bridges (2011)

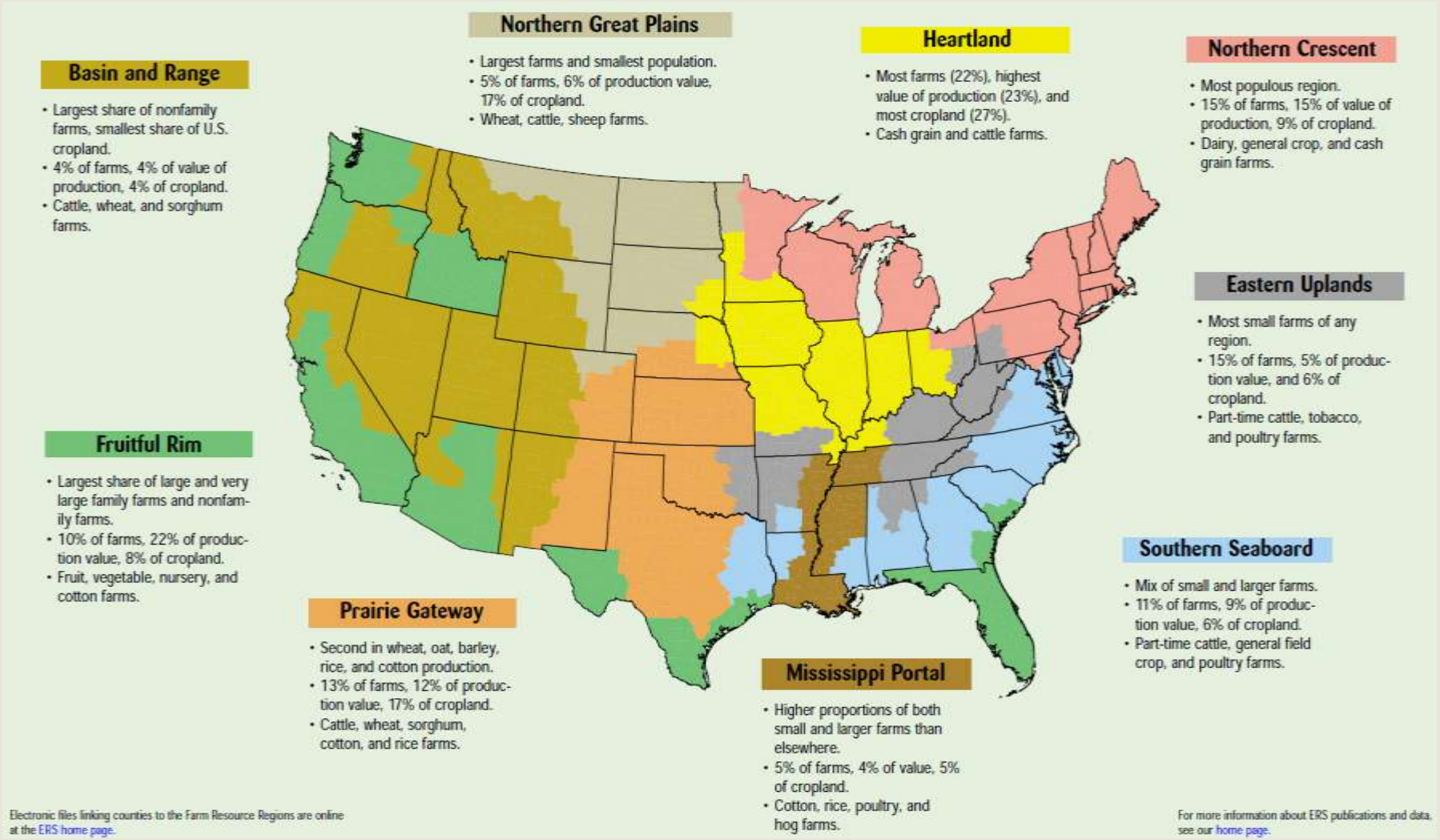
Corn	Increasing glyphosate-treated acres		Constant glyphosate-treated acres	
Region	**Yield Δ**	**Cost Δ**	**Yield Δ**	**Cost Δ**
Heartland	-5.26%	$2.66/ac	-6.04%	-$0.29/ac
Northern Crescent	-3.45%	$1.25/ac	-5.23%	-$2.56/ac
Northern Great Plains	-1.39%	$1.13/ac	-2.27%	$0.59/ac
Prairie Gateway	-1.84%	$0.26/ac	-2.39%	-$0.23/ac
Rest of Nation	-6.24%	$1.74/ac	-9.61%	$0.05/ac

Losses/costs spread over all acres. Thus, a $10/ac increase on 10% of corn acres is a $1/ac average cost increase.

Yield Loss and Cost Change Assumptions Based on Bridges (2011)

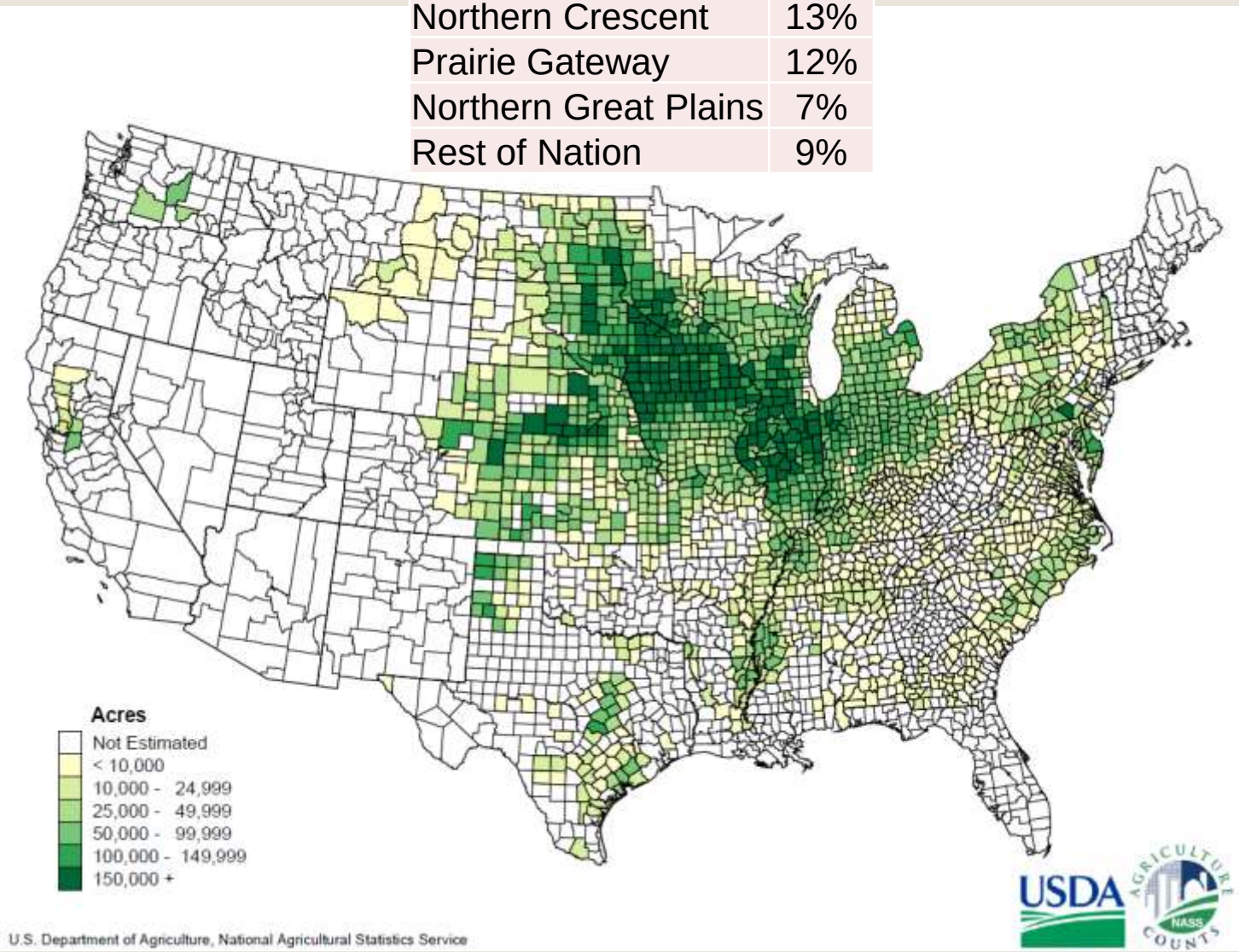
	Sweet Corn		Sorghum		Sugarcane	
Region	**Yield Δ**	**Cost Δ**	**Yield Δ**	**Cost Δ**	**Yield Δ**	**Cost Δ**
Heartland	-20.5%	$1.86				
Northern Crescent	-20.5%	-$1.10				
Fruitful Rim	-19.6%	$0.66			-10% - -25%	-$5.01
Mississippi Portal					-20% - -25%	
Hawaii					-6%	$4.28
Rest of Nation	-20.2%	$0.47	-20.5%	-$2.99		

USDA-ERS's Farm Resource Regions



Source: USDA ERS: http://www.ers.usda.gov/publications/aib760/aib-760.pdf

Region	% US
Heartland	59%
Northern Crescent	13%
Prairie Gateway	12%
Northern Great Plains	7%
Rest of Nation	9%



Source: USDA NASS: http://www.nass.usda.gov/Charts_and_Maps/Crops_County/pdf/CR-PL10-RGBChor.pdf

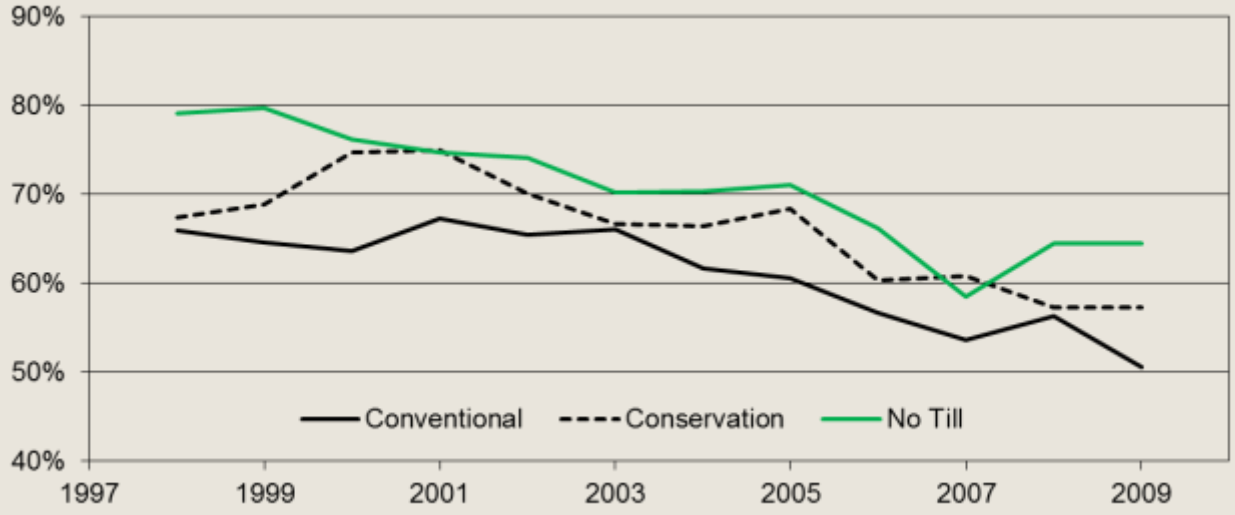
Compare to NCGA Yield Contest

- Estimated 3.5%-6% loss Corn Belt, 1.5%-2.5% on Plains
- Contestants report location, tillage system, herbicide program and harvested yield
- Grouped yield data for 2006-2009 by herbicide programs with atrazine and without atrazine
- **Average yield advantage for atrazine: 6.57 bu/ac**
- **Grouped by year or tillage: 4.19 to 9.09 bu/ac**
- Assuming average yield of 250 bu/ac gives 2.6% and a 1.7% to 3.6% range for by-tillage/by-year averages
  - Using 154.7 bu/ac gives 4.2%, 2.7% and 5.9%
- Even for farmers trying to minimize yield losses, atrazine still gives a substantial yield advantage

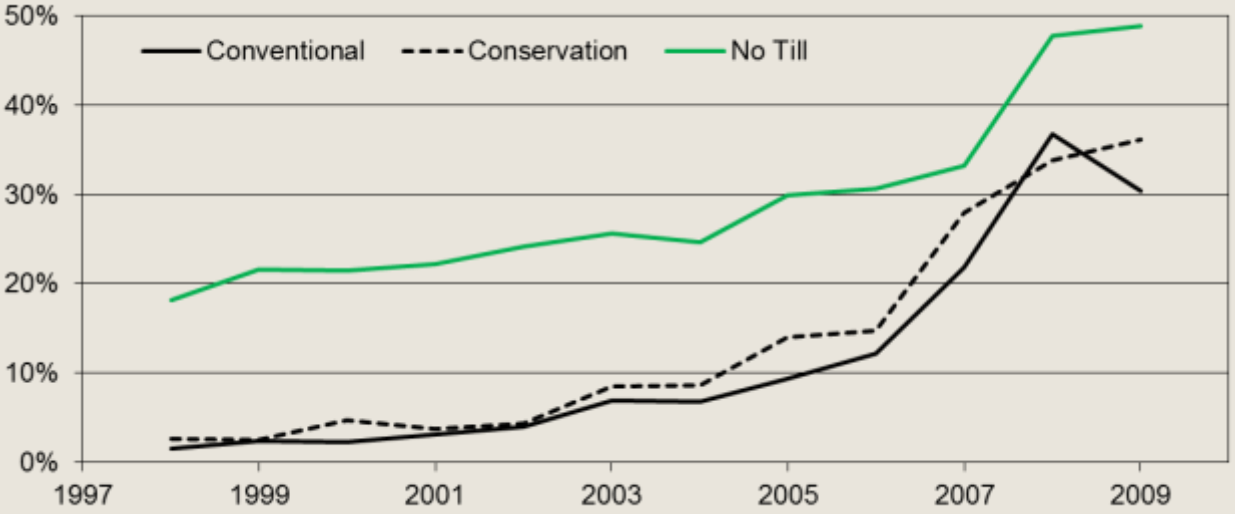
Shift to More Tillage without Atrazine

- Atrazine key part of reduced tillage systems
- Without atrazine, expect increased tillage in corn and sorghum, but also in soybeans and cotton
- Reduced tillage systems less economical without atrazine because cannot control weeds as well
- Accelerated problems with glyphosate resistant and herbicide resistant weeds without atrazine, turn to more tillage for weed control in corn/soybeans/sorghum/cotton
- Atrazine cleans up weed problems in corn/sorghum, so less weed pressure in soybeans/cotton where have fewer herbicide options

Atrazine and Reduced Tillage



Percent of conventional tillage, conservation tillage and no-till corn acres treated with atrazine in the US



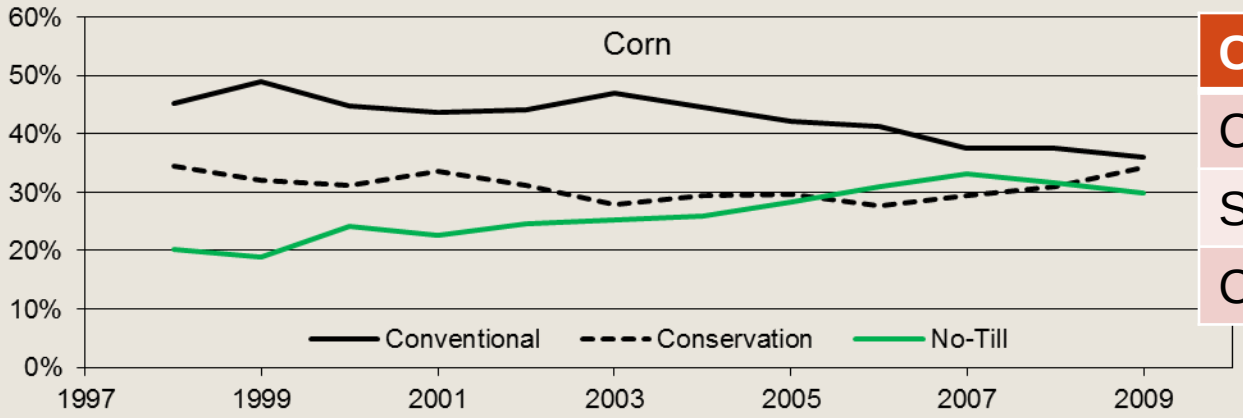
Percent of conventional tillage, conservation tillage, and no-till corn acres treated with both atrazine and glyphosate in the US

Shift to More Tillage without Atrazine

- How much would tillage increase without atrazine?
- Developed three scenarios for shift to more intensive tillage: minor, moderate and substantial
- Assume larger shift in corn and sorghum, smaller shift for soybeans and cotton
  - Small percentage point shifts from current levels in each region

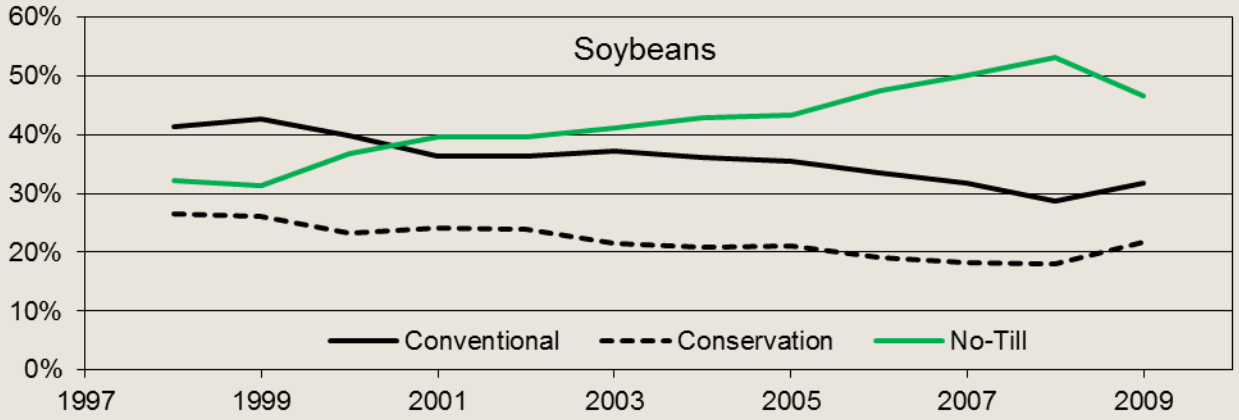
Crop	Tillage Shift	No-Till	Conservation	Conventional
Corn	Minor	-4.5%	2.0%	2.5%
and	Moderate	-6.0%	2.5%	3.5%
Sorghum	Substantial	-7.5%	3.0%	4.5%
Soybeans	Minor	-3.5%	1.5%	2.0%
and	Moderate	-4.5%	2.0%	2.5%
Cotton	Substantial	-5.5%	2.5%	3.0%

National Average Tillage System Adoption Rates



2009 Adoption Rates

Crop	No	Cons	Conv
Corn	29.8	34.3	36.0
Soy	46.6	21.7	31.7
Cotn	16.9	33.4	49.6



Implied tillage shifts of 4.5 to 7.5 % points moves adoption to what it was 5-10 years ago

Cost Changes due to Tillage Shift

- Tillage shift implies higher costs: more machinery and fuel
- Calculated average cost for tillage and planting for no till, conservation and conventional tillage using crop budgets
  - Budgets for 11 states for corn and soybeans, 8 states for cotton
- Tillage shifts implied average cost increases ranging $0.32 to $1.76/ac across crops over all the regions
- **Added these cost changes to herbicide cost changes**
- Corn Average: $1.16/ac, Heartland: $0.83 to $1.43/ac and Northern Crescent: $0.96 to $1.65/ac
- Soybean Average: $1.02/ac, Heartland: $0.80 to $1.22/ac and Northern Crescent: $0.92 to $1.41/ac

Summary: Without Atrazine

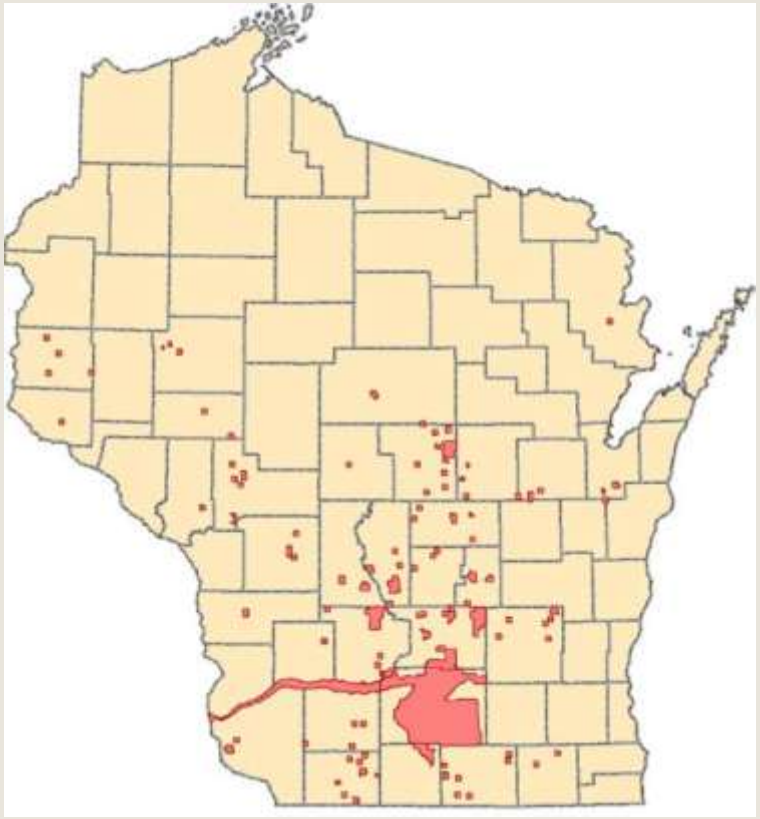
- Assumed corn yield decreases ranging 3.5% to 6% in Corn Belt, 1.4% to 2.4% in Great Plains
  - Larger losses for sorghum, sweet corn, sugarcane
- Assumed cost changes for corn ranged from about +$4/ac to -$1.50/ac depending on region and scenario
- Assumed shifted to more intensive tillage, to adoption rates similar to 5-10 years ago

- These yield and cost changes drive economic results

Digression: Wisconsin Data

- Wisconsin has several atrazine prohibition areas (PA) and DATCP with USDA conducted survey of WI growers in PA
- http://datcp.wi.gov/uploads/Environment/pdf/WeedMgtAtrazinePAs.pdf
- 102 growers in PAs, 38 operated both inside and outside a PA
- Unique opportunity to see what farmers would do without atrazine in one area of US
- WCPB grant with Vince Davis

Atrazine Prohibition Areas in WI



Wisconsin Data Summary

- 39% of 38 said higher cost to control weeds: $13.60/ac average ($5.37/ac if spread over all farms)
- 2 of 35 said yield loss in 11-15 bu/ac range (8.2% of 158.3 bu/ac state average), 84% said no loss, 4 said don't know
- Top alternatives to atrazine: 90% glyphosate, 22% s-Metolachlor, 21% Mesotrione, 19% Acetochlor
- Practices changes without atrazine: 36% tillage, 46% crop rotation, 16% cultivation, 47% scouting, 25% more trips

- More tillage/cultivation and trips = more erosion and fuel
- How sustainable is dependence on glyphosate in PA?
- Higher costs, lower losses than our study, but few obs.

Short-Term Immediate Impacts if Farmers did not have Atrazine

- Total Loss = % Loss x Average Yield x Acres x Price + Cost x Acres
- By region, using 3-yr average yields, prices and acres

- $3.0 to $3.3 billion loss to farmers if lost atrazine
  - $2.35 to $2.65 billion in corn
  - $340 million sorghum
  - $210 million sweet corn
  - $60-$120 million in sugarcane

Summary of Total Losses ($ million per year)

Crop	Heartland	Northern Crescent	N. Great Plains	Prairie Gateway	Rest of Nation	US Total
Corn						
Glyphosate						
Increasing	1,769	183	48	112	245	2,356
Constant	1,857	226	70	140	355	2,647
Sorghum				243	97	341
Sweet Corn	32	54			123	210
Sugarcane						
Low					60	60
High					119	119
US Total						
Low	1,801	238	48	356	525	2,966
High	1,889	280	70	383	694	3,316

Longer-Term Impacts if Farmers did not have Atrazine

- Estimate price changes and crop acreage shifts due to yield and cost changes
- Use AGSIM model of 10 program crops + CRP
  - Impose same yield and cost changes on corn, sorghum, soybeans and cotton, but allow markets and acreages to adjust
- Estimate soil erosion increase due to increased tillage and shift in crop acres using National Nutrient and Soil Loss Database averages by crop and region

- Social cost of soil erosion via Hansen and Ribuado (2008)
- Additional fuel used for tillage estimated using USDA-NRCS's "Energy Estimator: Tillage" tool.

Longer-Term Impacts if Farmers did not have Atrazine

- Price Changes
  - Corn $0.24 - $0.30/bu higher
  - Sorghum $0.62 - $0.66/bu higher
  - Minimal effects on other crops
- Acreage Changes
  - Corn 900,000 to 1,100,000 increase
  - Sorghum 445,00 to 465,000 decrease
  - CRP 620,000 to 880,000 decrease
  - Wheat and soybeans small increases, rest minimal
- Consumer Surplus Losses due to higher prices
  - $3.6 to $4.4 billion, almost all corn (sorghum $210-$230 million)
  - Higher prices for meat, dairy, eggs and other foods

Soil Erosion if Farmers did not have Atrazine

- Expand corn and crop acres by decreasing CRP and converting non-cropped land to crop production
  - Yield losses, cost increases and crop price increases
  - Tradeoff btwn production per acre and acres in production
- Soil Erosion increases 56 to 85 million tons (9% to 13%)
  - About half due to conversion of land from CRP/non-crop uses and half due to increased tillage
- Social cost of soil erosion increase ranges $210 to $350 million/year based on Hansen and Ribaudo (2008)
- Increases use of diesel fuel about 18 – 28 million gallons, or 180,000 to 280,000 1,000 Mg/yr of CO_2
- **Total Benefit of Atrazine: $3.8 to $4.8 billion per year**

Production per Acre vs Acres in Production

- Any policy that reduces production per acre increase acres in production, which has large environmental effects
- Simple Illustration: Suppose a policy to address a problem with corn production reduces average corn yields by 1%
- This 1% yield loss implies 175,000 more corn acres planted, with 125,000 of these acres coming from CRP and non-crop uses
- Losing 125,000 CRP acres is a swath 10 miles wide and 20 miles long, converted from grass and trees to corn
- CRP reduces soil erosion, improves water quality, provides wildlife habitat and rural green space, so this loss of CRP acres has environmental costs

Consider the Environmental Implications

- The work you do to increase crop yields in an environmentally responsible way keeps land out of crop production and in CRP and other non-crop uses, which generates environmental benefits that would be lost if this land were put into crops
- Consider inputs saved by not planting 175,000 corn acres
  - Based on US average application rates and % acres treated for corn in 2010 (http://www.ers.usda.gov/Data/FertilizerUse/)
  - Almost 12,000 tons of nitrogen, 4,100 tons of phosphate and 4,200 tons of potash not applied
  - Consider the fuel saved and pesticides not applied

Atrazine's Environmental Benefits

- Estimated 620,000 to 880,000 acres kept in CRP and non-crop uses by atrazine
  - A swath roughly 10 miles wide and 100 to 130 miles long kept in grass and trees rather than corn
  - 42,000 to 60,000 tons of nitrogen not applied
  - 14,500 to 21,000 tons of phosphate not applied
  - 15,000 to 21,000 tons of potash not applied
  - Fuel saved? Pesticides not applied?
- **No such thing as a free lunch!**
- **Losing atrazine would generate unintended consequences**

Conclusions

- Atrazine's Economic Benefit
  - Immediate: $3.0 to $3.3 billion each year for farmers
  - Longer Term: $3.6 - $4.4 billion in consumer surplus and $210 to $350 million in prevented soil erosion
  - Total: $3.8 billion to $4.8 billion per year
- Atrazine's Environmental Benefit
  - 56 to 85 million tons of soil not eroded
  - 620,000 to 880,000 acres kept in CRP
  - 18-28 million gallons of diesel fuel saved
- Atrazine means less soil erosion and more rural green space!

Thanks for Your Attention!

Questions?

Economic Assessment of the Benefits of Chloro-s-triazine Herbicides to U.S. Corn, Sorghum, and Sugarcane Producers
(http://www.aae.wisc.edu/pubs/sps/pdf/stpap564.pdf)

Estimating Soil Erosion and Fuel Use Changes and Their Monetary Values with AGSIM: A Case Study for Triazine Herbicides
(http://www.aae.wisc.edu/pubs/sps/pdf/stpap563.pdf)

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