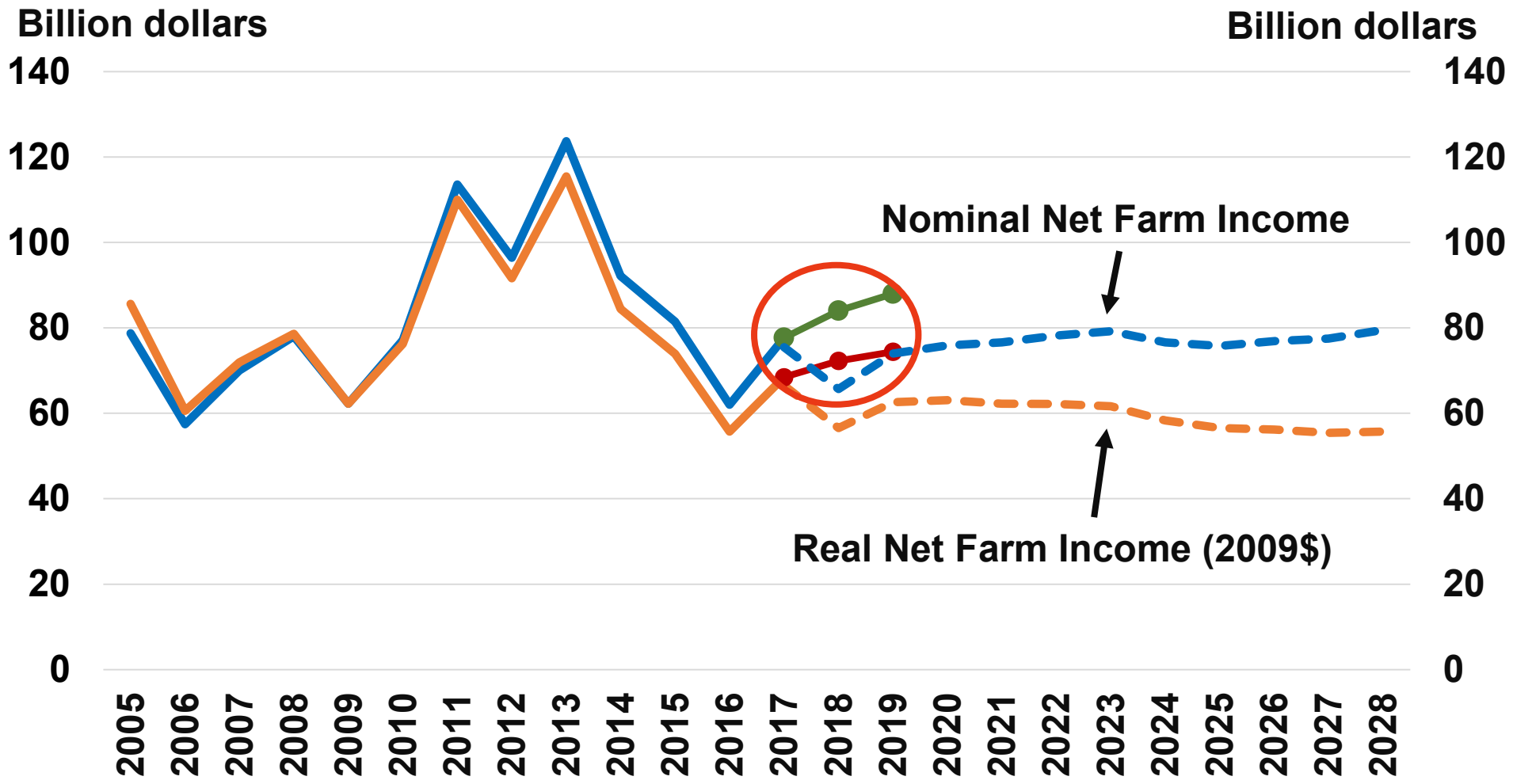
Enhancing environmental and financial performance on Midwestern farms

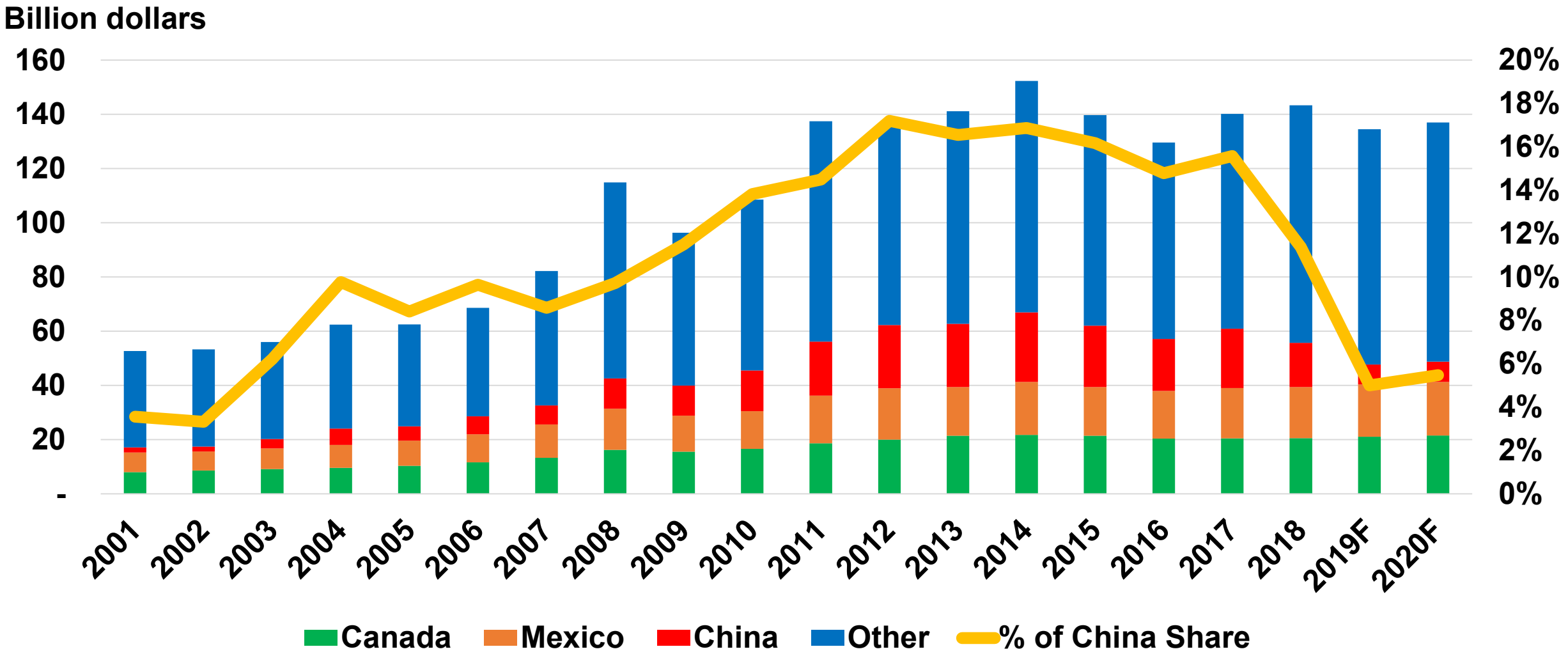
Rob Johansson
Chief Economist, USDA
Chicago, November 2019

Real net farm income is projected to fall.



Data: USDA-ERS

Agricultural export values projected to rise slightly in 2020, China share to remain down significantly

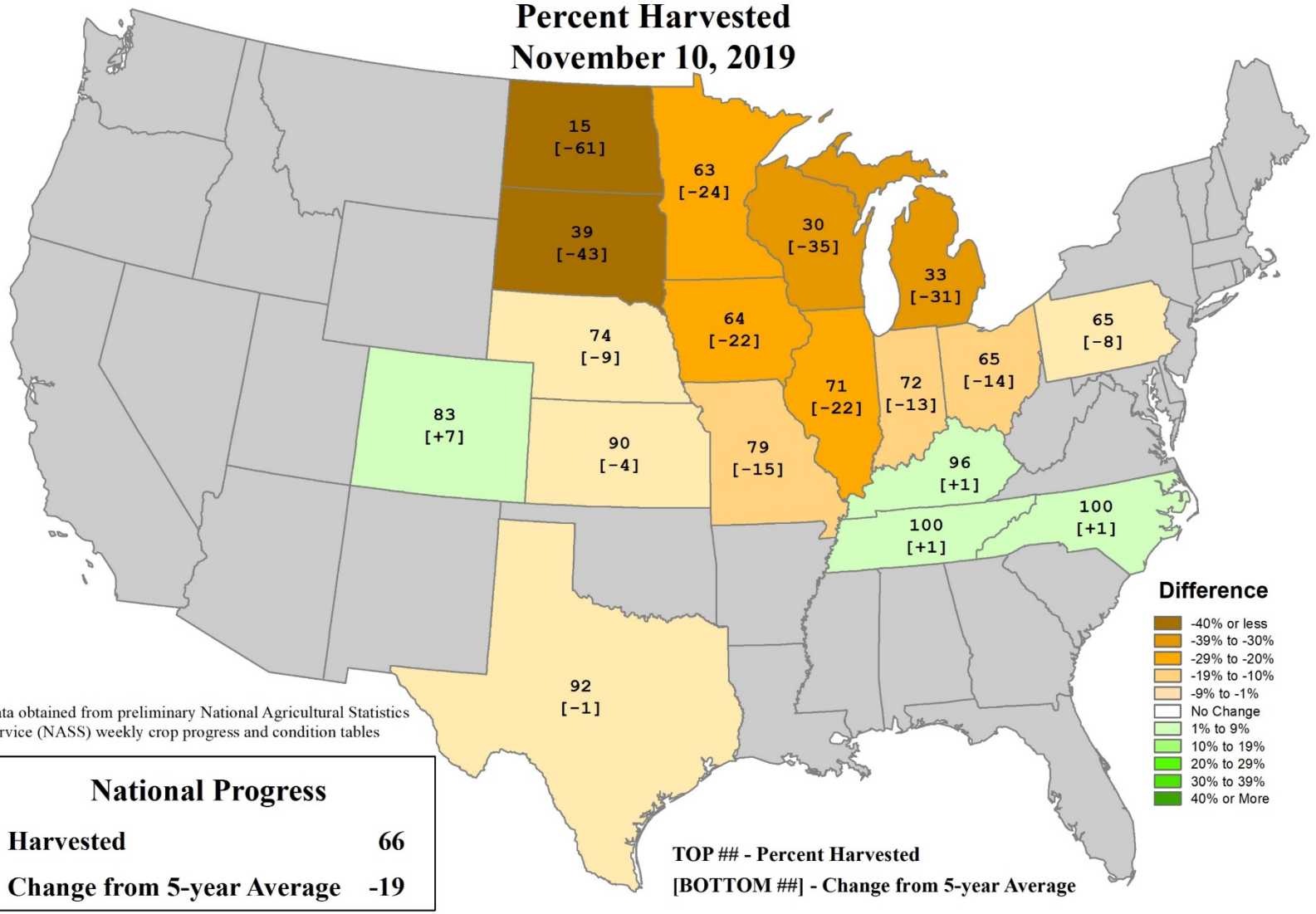


Data: USDA

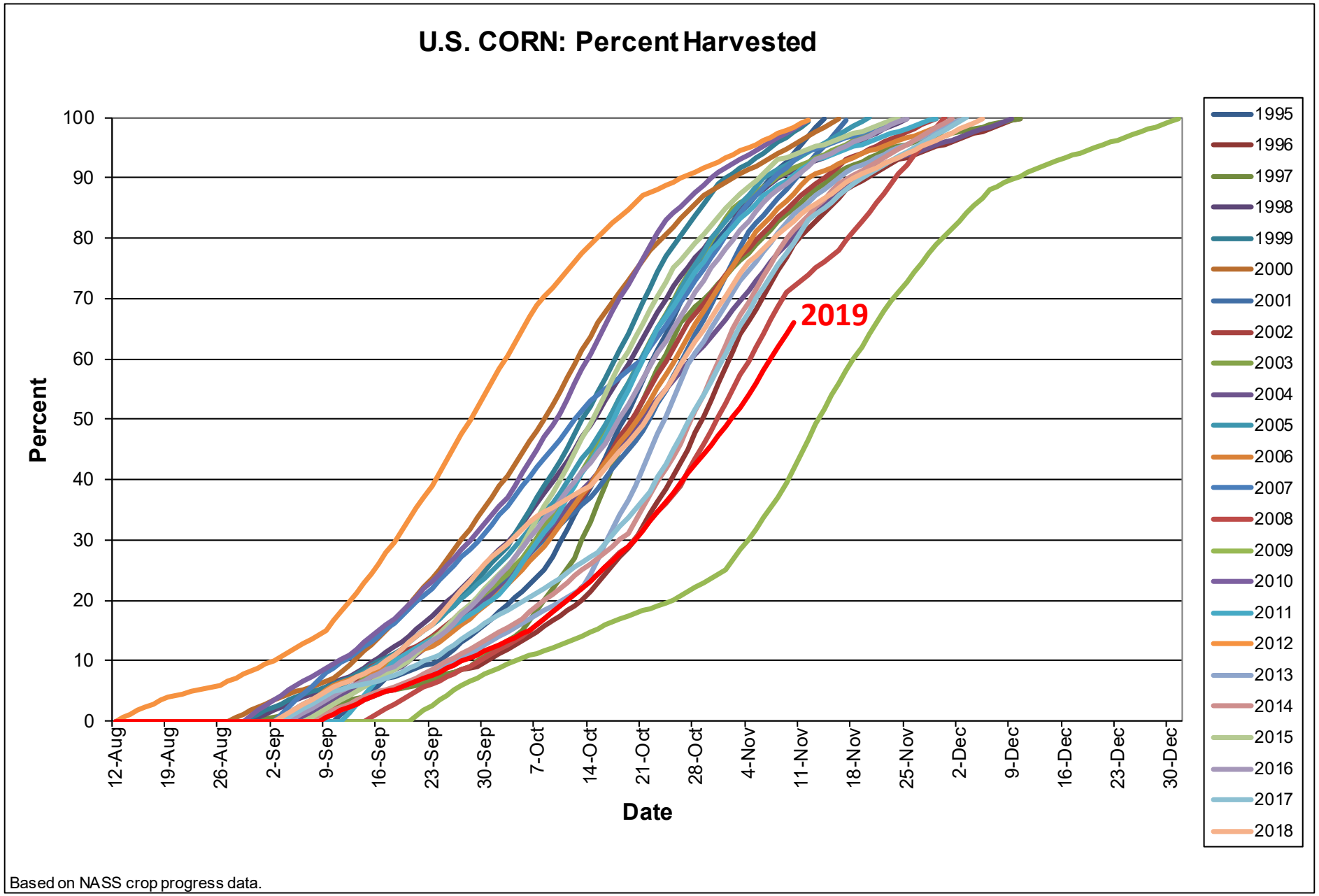
Least U.S. Corn Harvested by November 10, 1995-2019

1.	2009	42%
2.	2019	66%
3.	2008	72%

U.S. Corn Progress



Source: USDA NASS Crop Progress Data



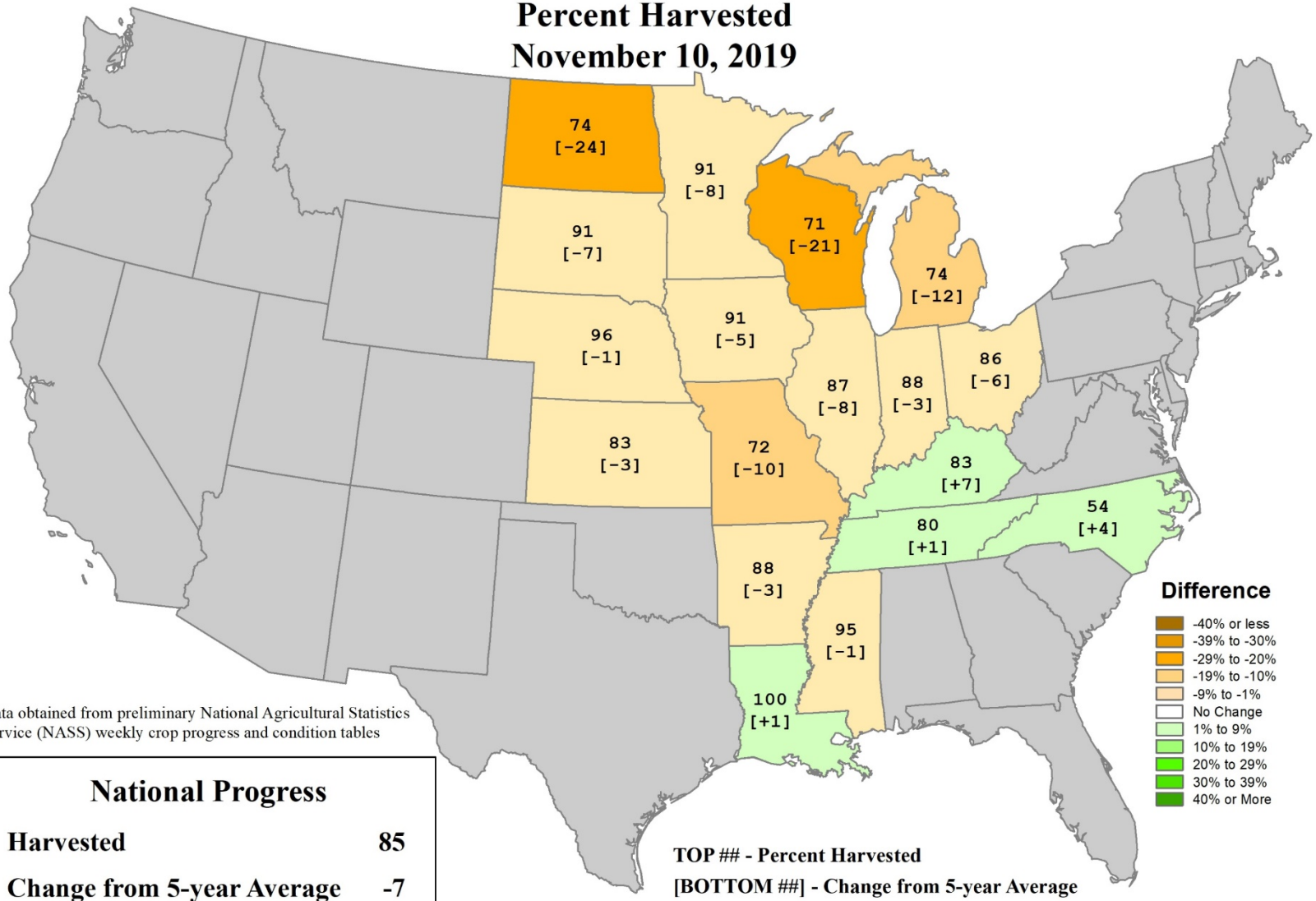
Source: USDA NASS Crop Progress Data

Fewest U.S. Soybeans Harvested by November 10, 1995-2019

1.	2009	79%
2.	2019	85%
3.	2018	87%

U.S. Soybeans Progress

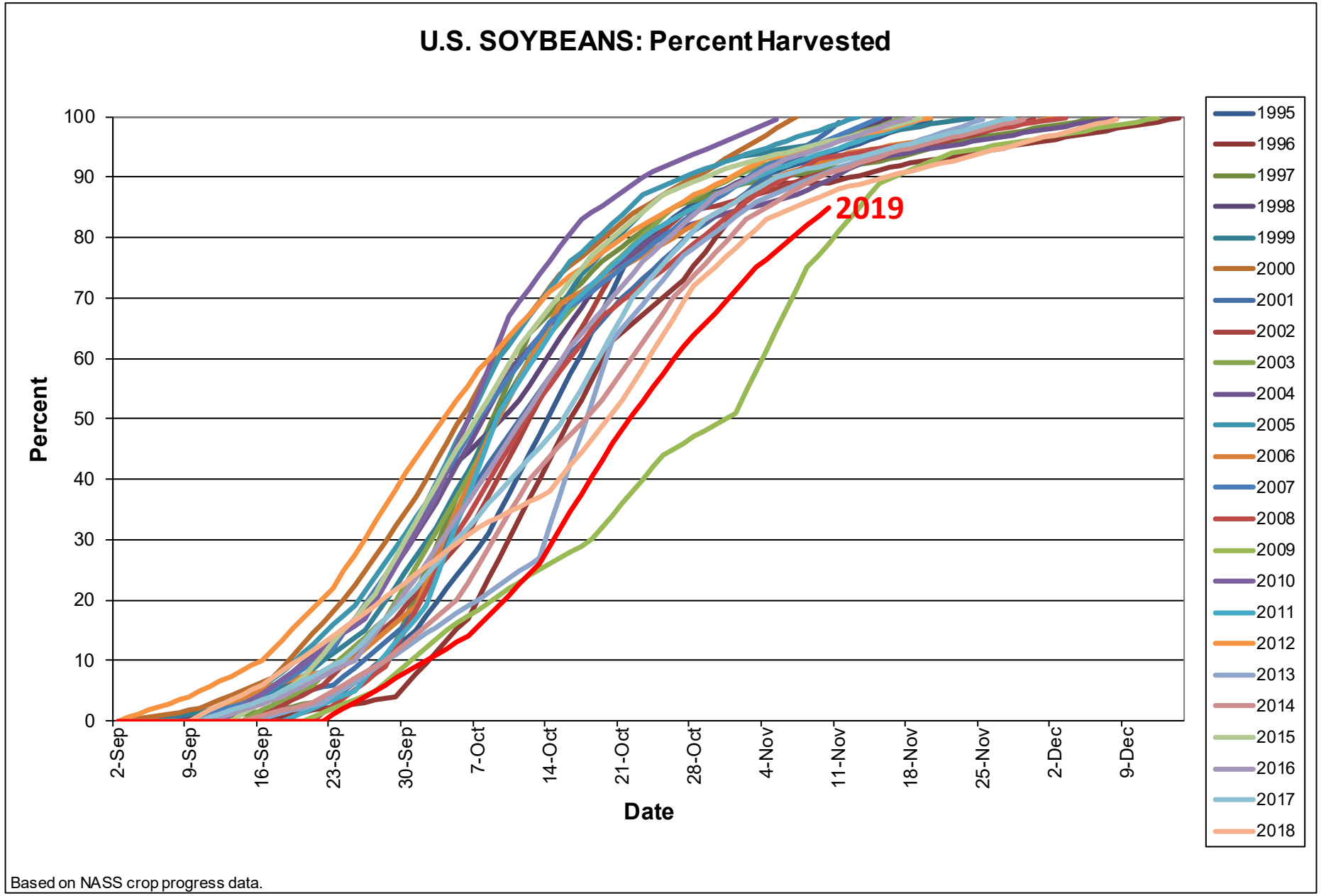
Percent Harvested
November 10, 2019



Data obtained from preliminary National Agricultural Statistics Service (NASS) weekly crop progress and condition tables

National Progress	
Harvested	85
Change from 5-year Average	-7

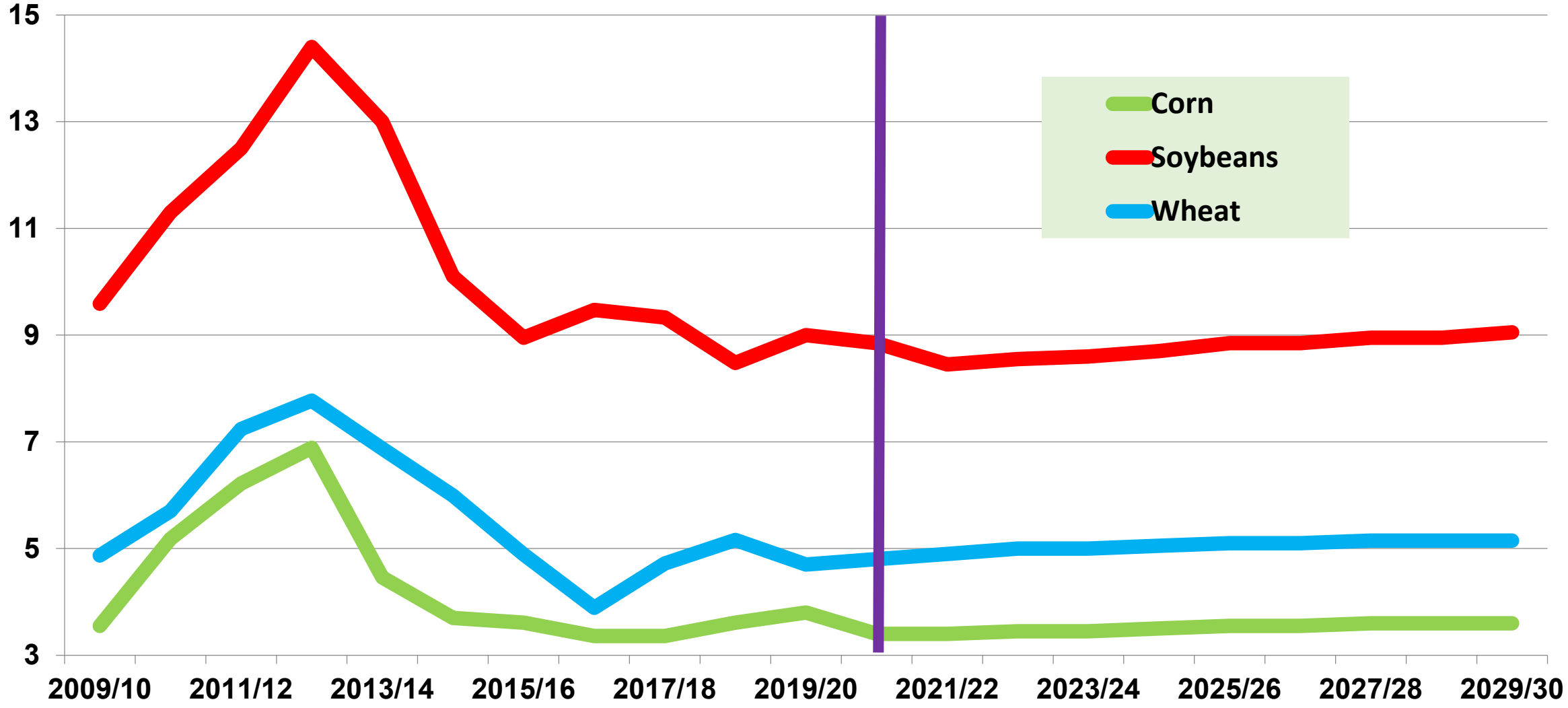
Source: USDA NASS Crop Progress Data



Source: USDA NASS Crop Progress Data

Wheat, corn, and soybean prices

Dollars per bushel



Data: USDA

So, why focus on environmental performance now? First, most everyone cares a lot about farm and food production, and the environment.

Farmers

- **Recreation**
- **Uses: clean air, water, clean water**
- **Profitability**
- **Liability**

Public

- **Recreation**
- **Uses: clean air, water, clean water**

Americans farms created value added of roughly $400 billion in 2017.

Americans spent about $1.6 trillion on food at home and away from home in 2017.

https://www.ers.usda.gov/data-products/food-expenditure-series/

"…Every year, American consumers spend more on outdoor recreation [$887 billion] than they do on pharmaceuticals and fuel, combined. In fact, the impact of outdoor recreation on America's economy is almost as big as that of hospital care…"

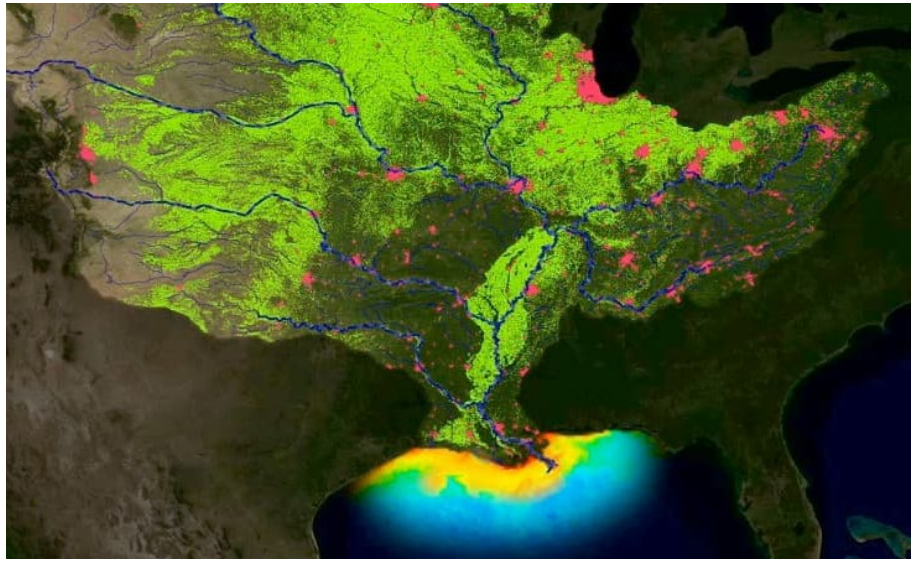
> Roughly $170 billion in the Midwest

https://outdoorindustry.org/wp-content/uploads/2017/04/OIA_RecEconomy_FINAL_Single.pdf

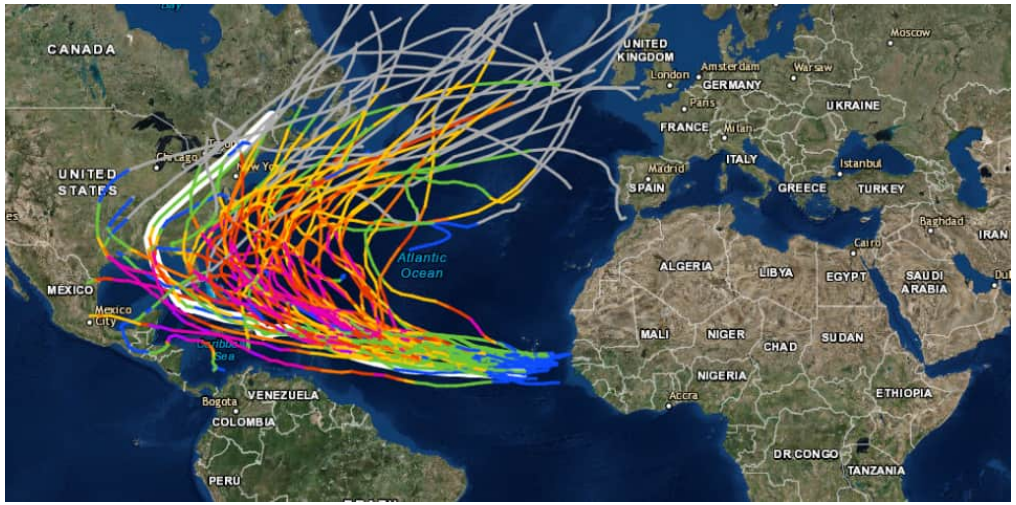
But secondly, because we can focus on improving the financial performance of farms, and limiting their environmental impacts

1. Technology and innovation
2. USDA programs
3. Remaining challenges

https://www.canr.msu.edu/resources/management_of_nitrogen_fertilizer_to_reduce_nitrous_oxide_emissions_from_fi

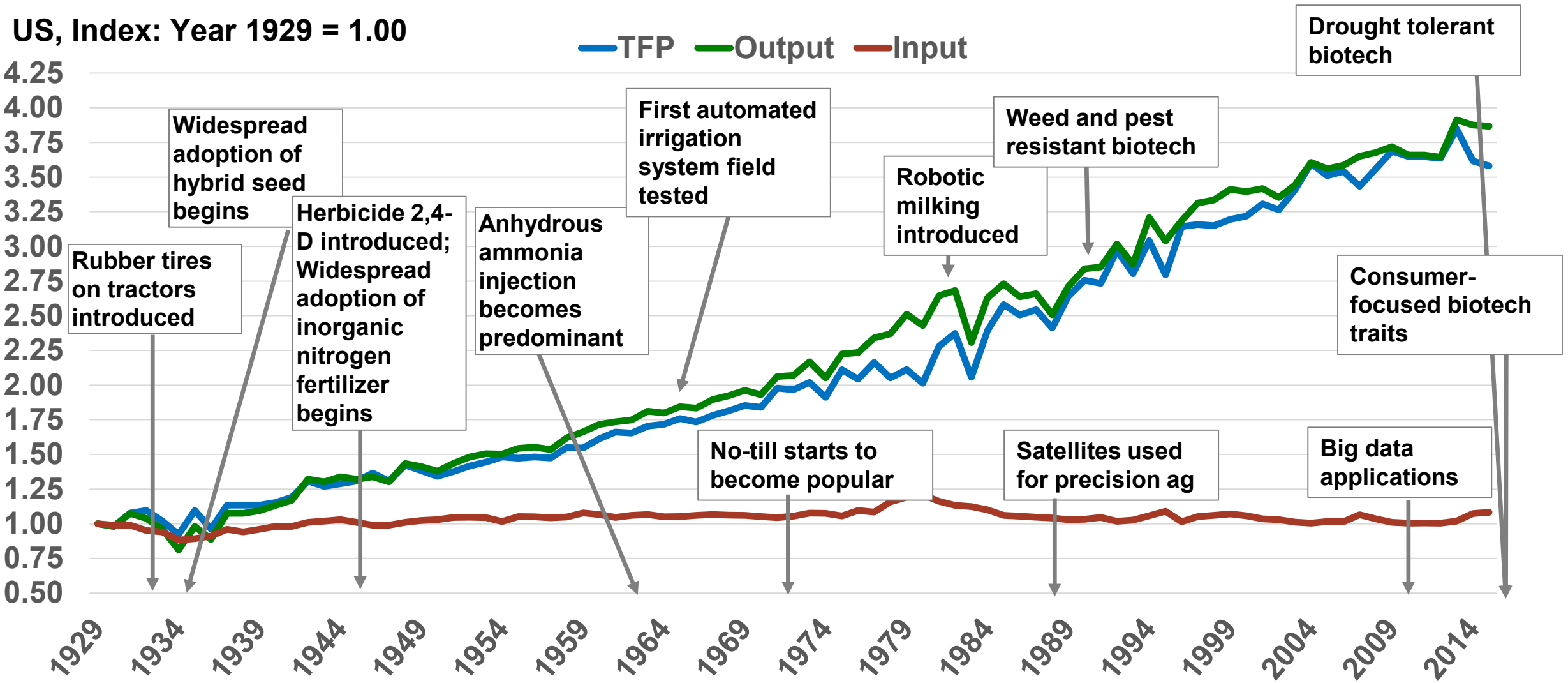


https://oceanservice.noaa.gov/facts/deadzone.html



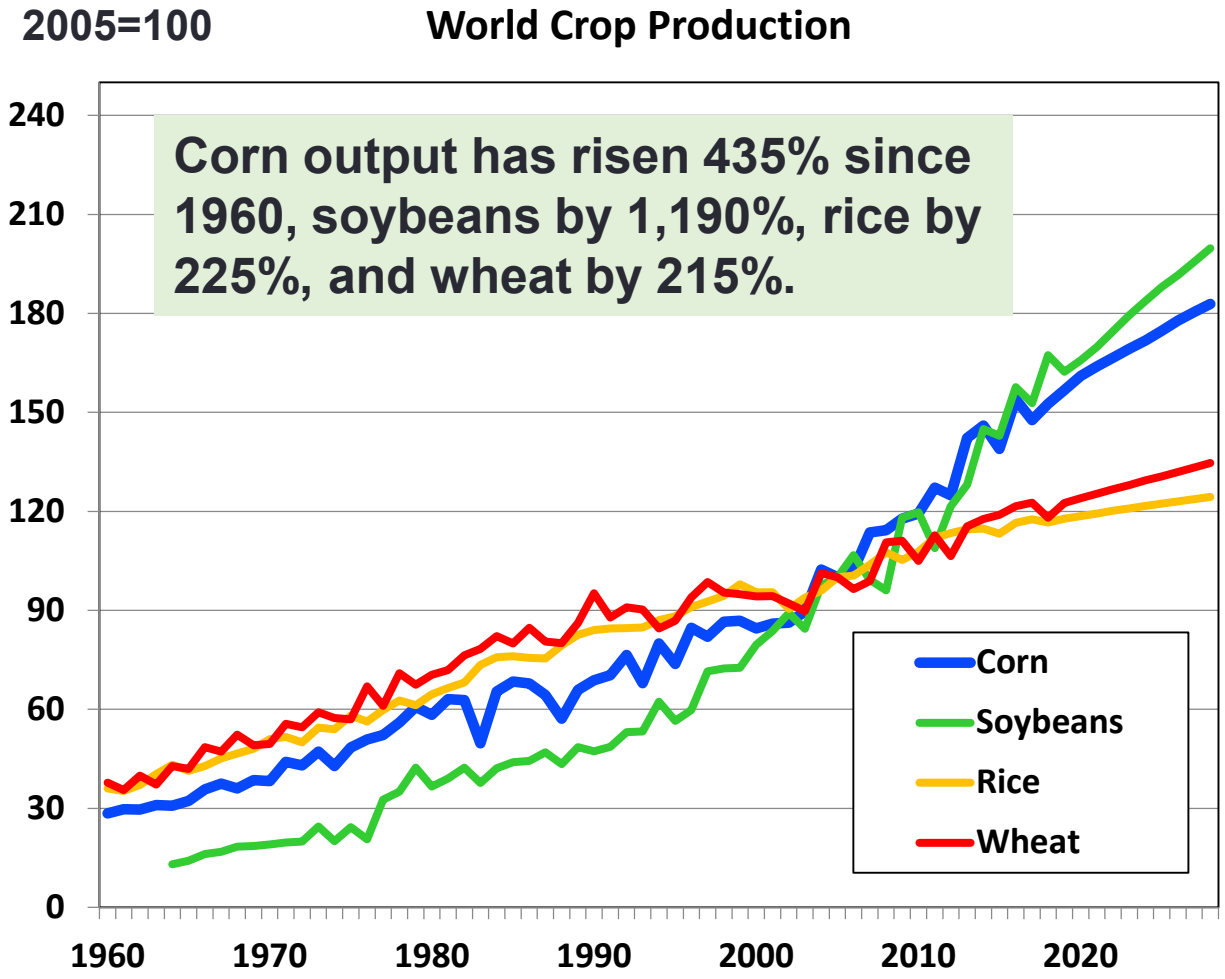
https://oceanservice.noaa.gov/news/historical-hurricanes/

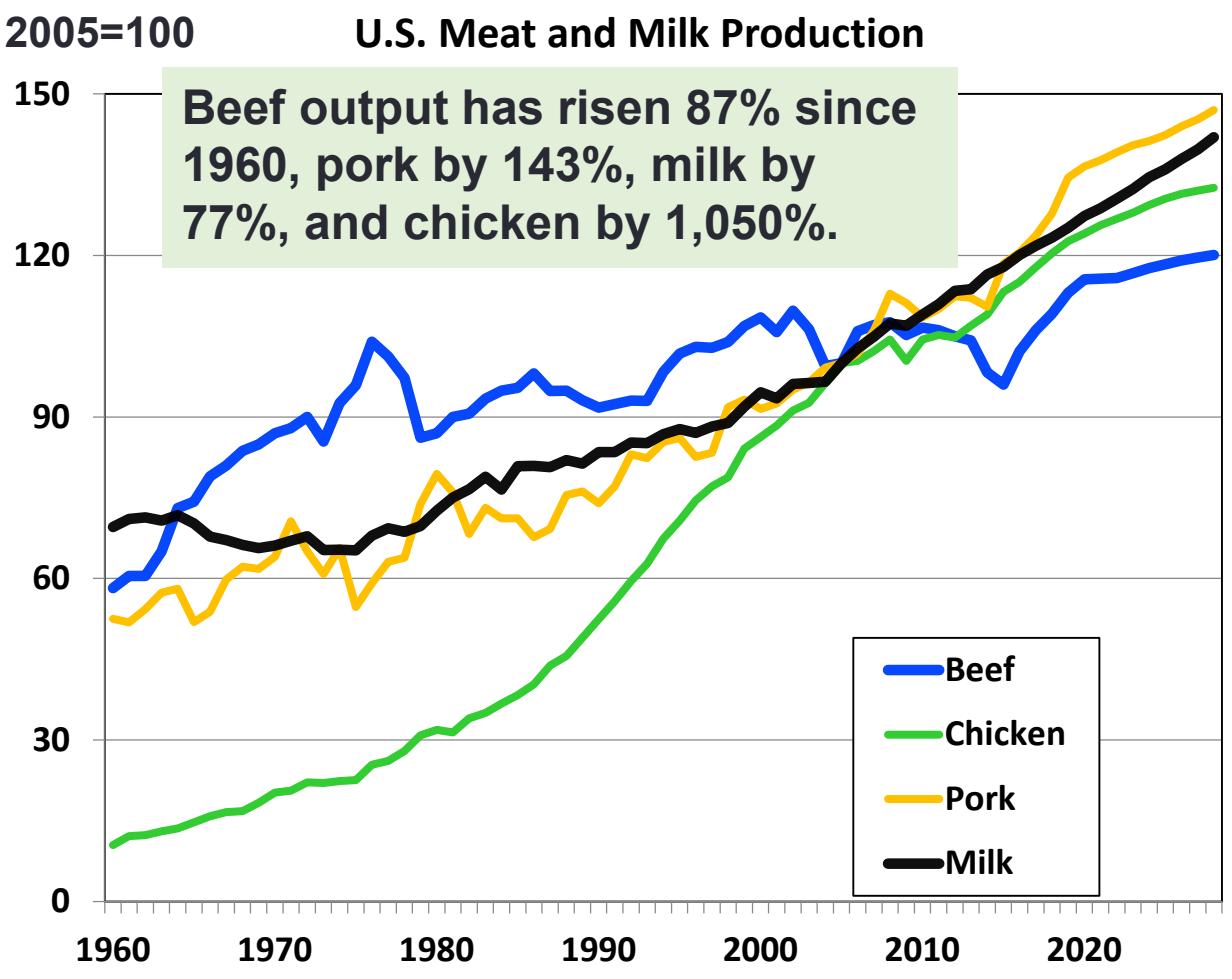
Technological innovations have helped push up agricultural productivity



Source: USDA-OCE using data from USDA-ERS and historic USDA data (pre-1948)

Technological innovations have helped push up agricultural productivity



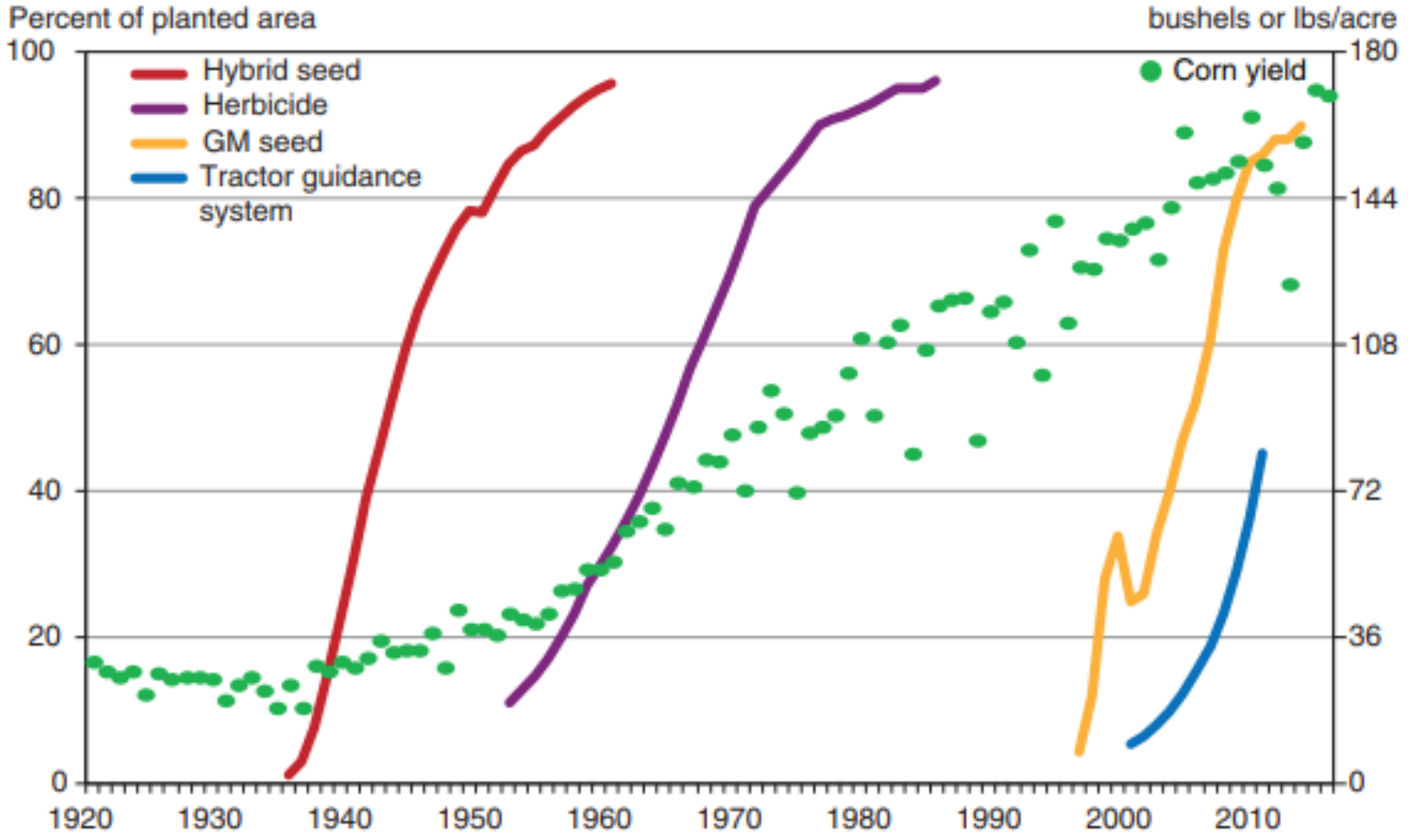


Data: USDA, BLS

Example: Rising corn yields through technological innovation

Figure 1.5.1

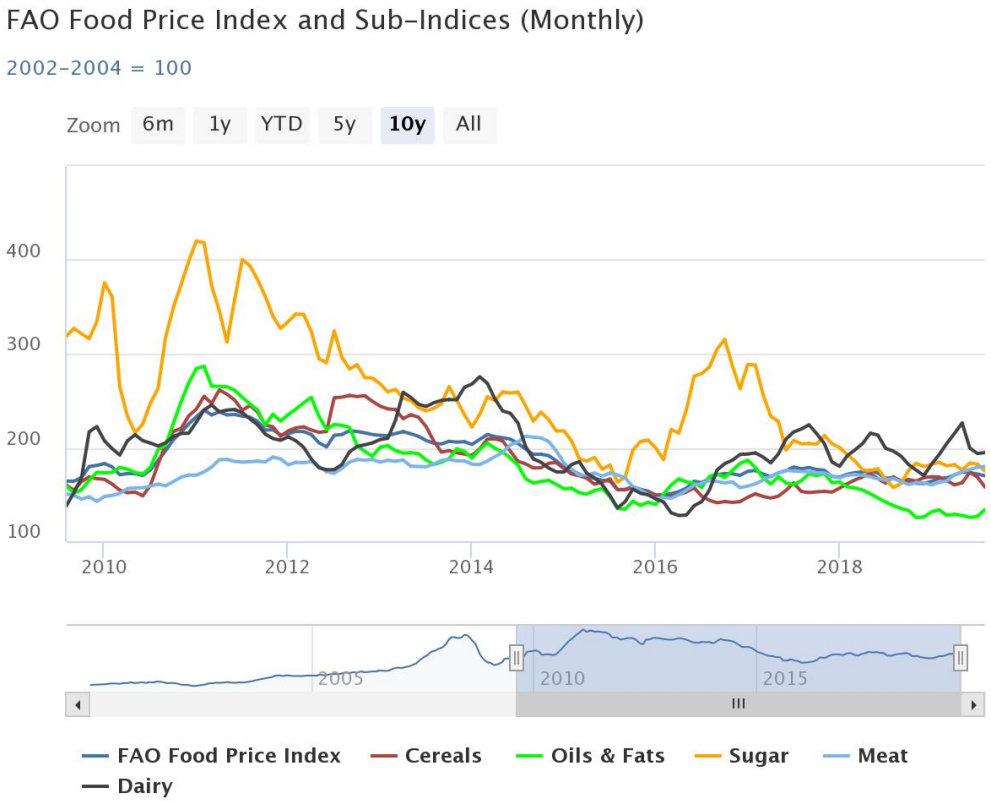
Effect on corn yields as different innovations become adopted, 1920-2014

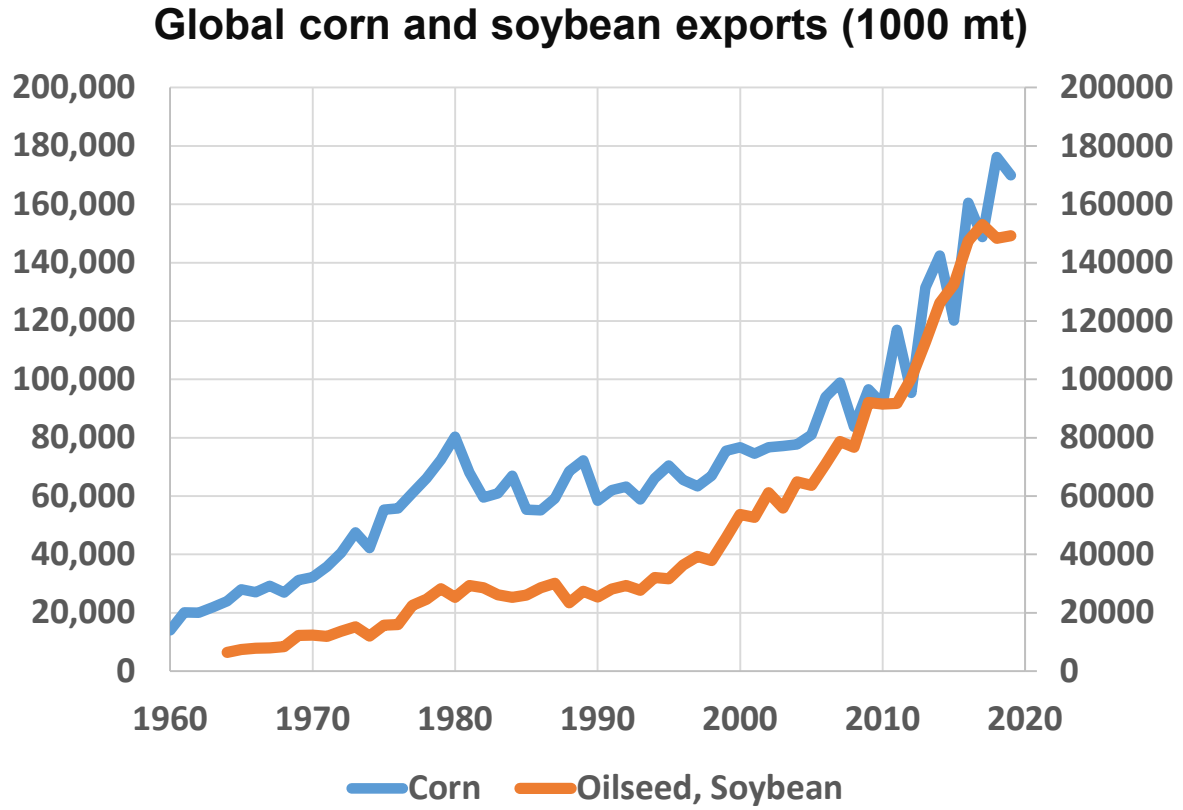


Note: GM = genetically modified.
Source: USDA, Economic Research Service analysis using data from the National Agricultural Statistics Service, Agricultural Statistics yearbook and the Agricultural Resource Management Survey.

Data: USDA ERS Agricultural Resources and Environmental Indicators, 2019: https://www.ers.usda.gov/webdocs/publications/93026/eib-208.pdf?v=2348.3

Recent trends and policies have generally led to falling food prices and growth in trade





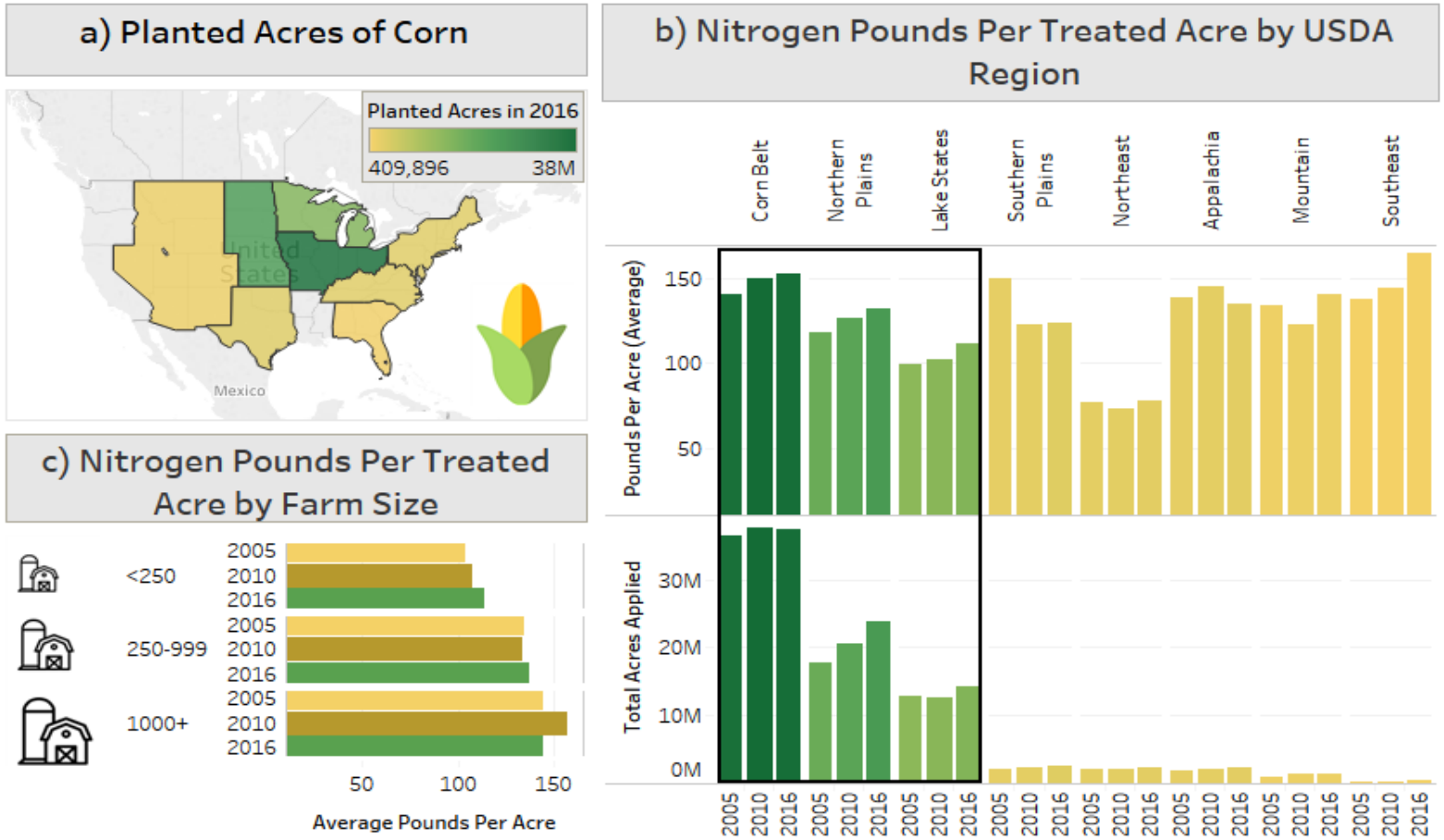
http://www.amis-outlook.org/indicators/prices/en/

Data: USDA

Productivity also can drive environmental performance

>>> increasing lbs per acre application

Example: Nitrogen Application Quantity: Corn



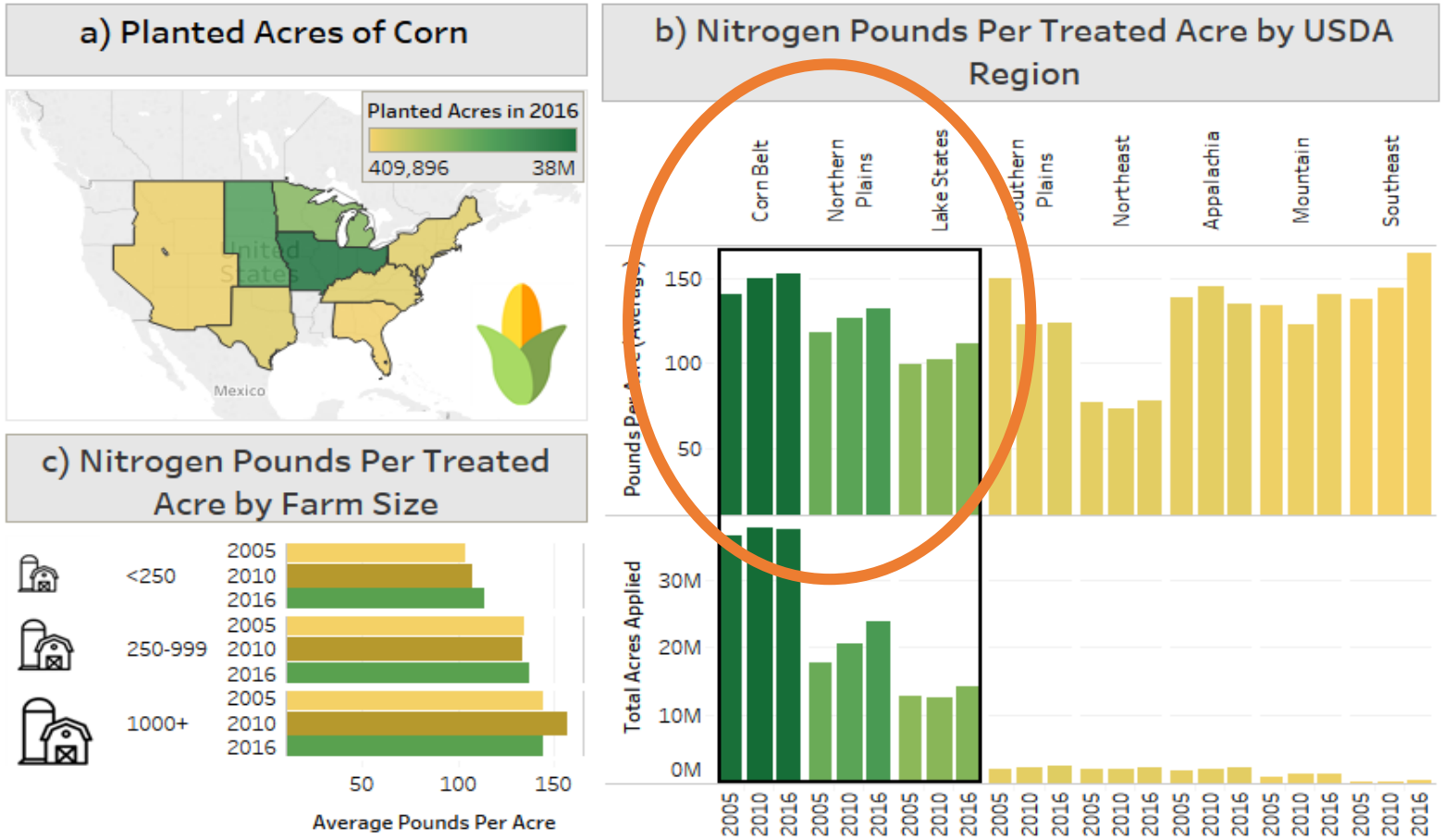
Source: USDA Economic Research Service based on Agricultural Resource Management Survey (ARMS) data for 2005, 2010, and 2015. https://www.usda.gov/oce/oeep/USDA_Conservation_Trends.pdf

Productivity also can drive environmental performance

>>> increasing lbs per acre application

The quantity of nitrogen applied on corn acres are increasing

Example: Nitrogen Application Quantity: Corn

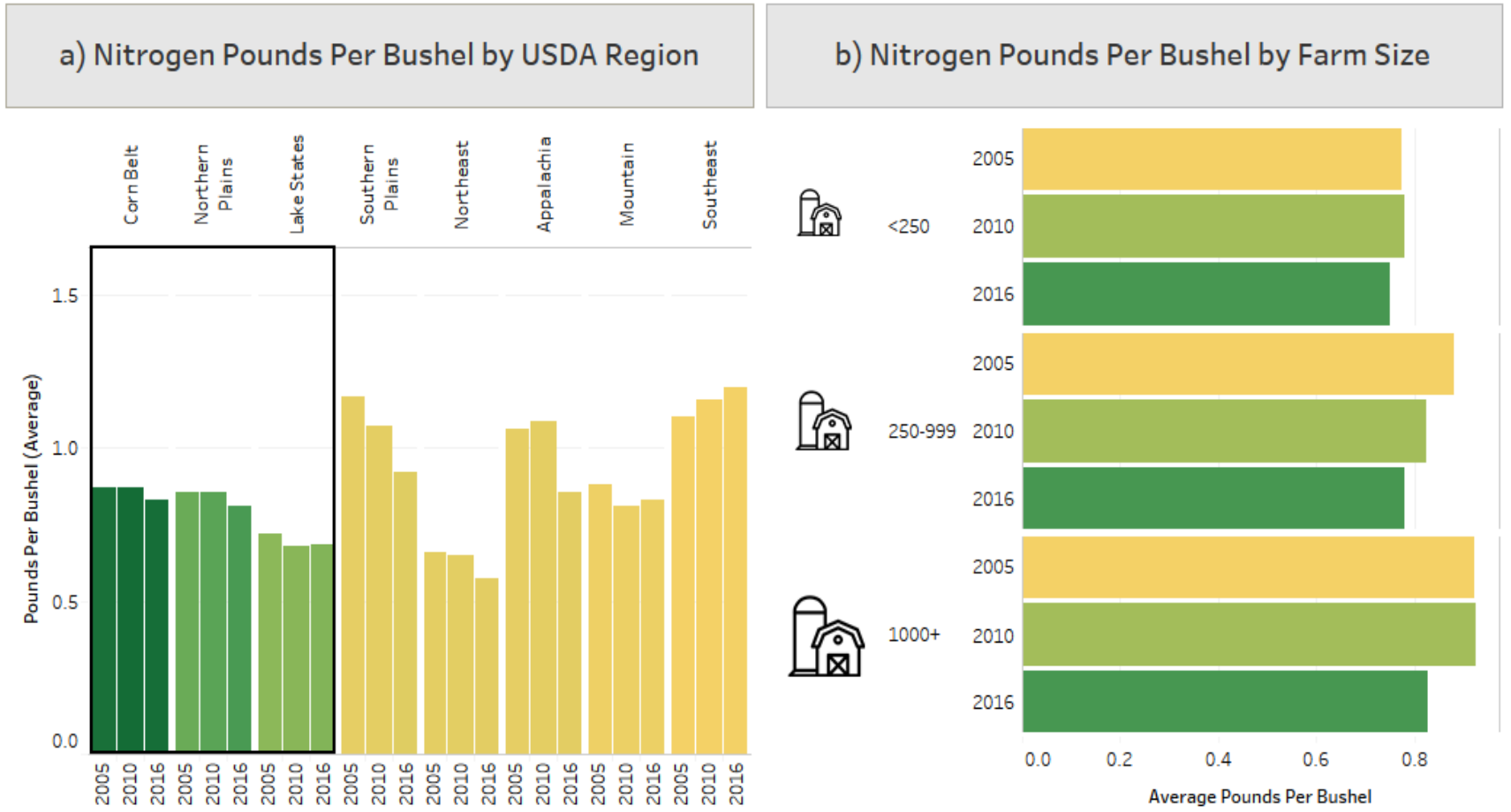


Source: USDA Economic Research Service based on Agricultural Resource Management Survey (ARMS) data for 2005, 2010, and 2015. https://www.usda.gov/oce/oeep/USDA_Conservation_Trends.pdf

Nitrogen Application per Bushel: Corn

But declining excess nitrogen applications

>>> decreasing lbs per bushel



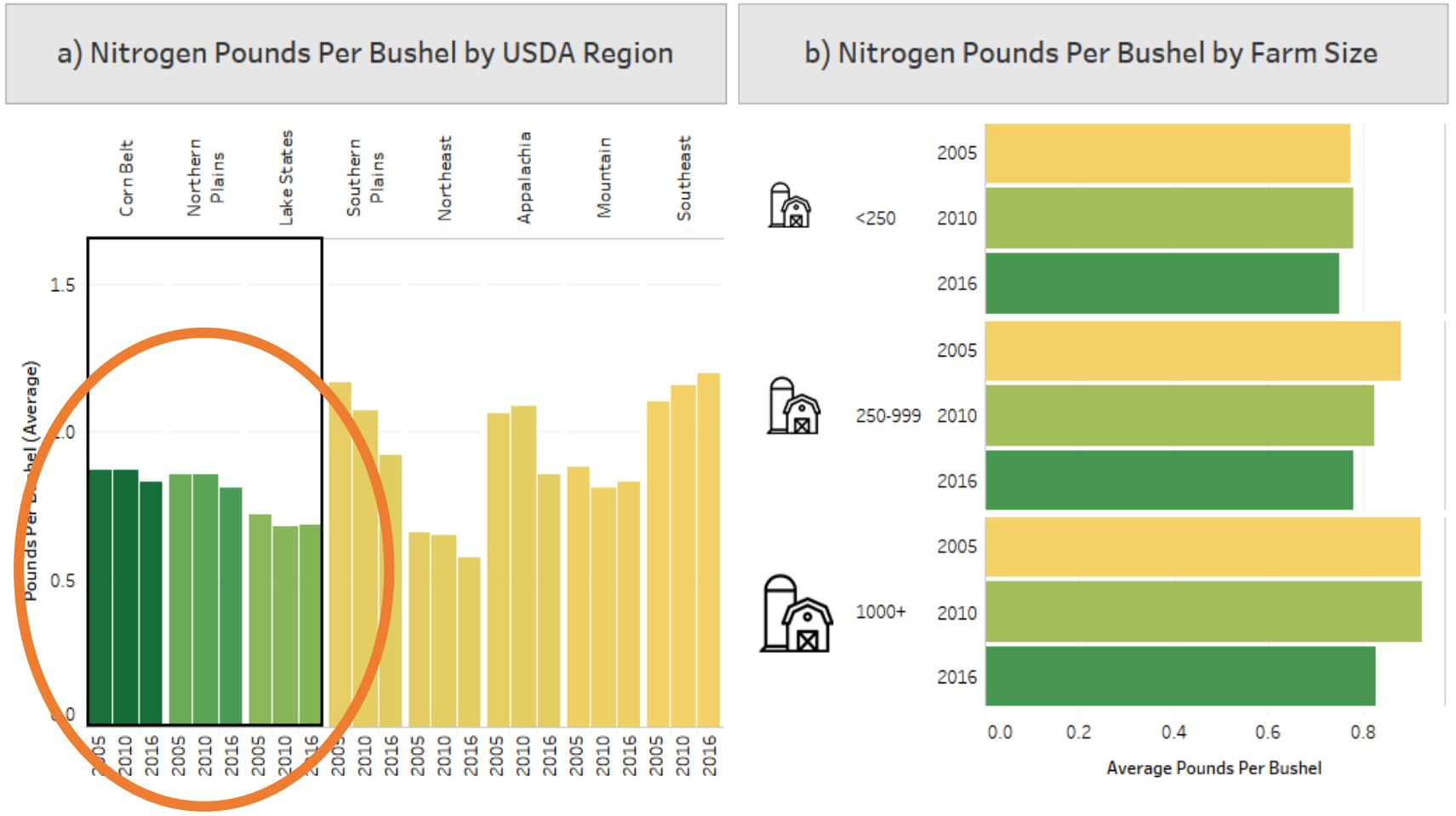
Source: USDA ERS based on ARMS data for 2005, 2010, and 2015.
https://www.usda.gov/oce/oeep/USDA_Conservation_Trends.pdf

Nitrogen Application per Bushel: Corn

But declining excess nitrogen applications

>>> decreasing lbs per bushel

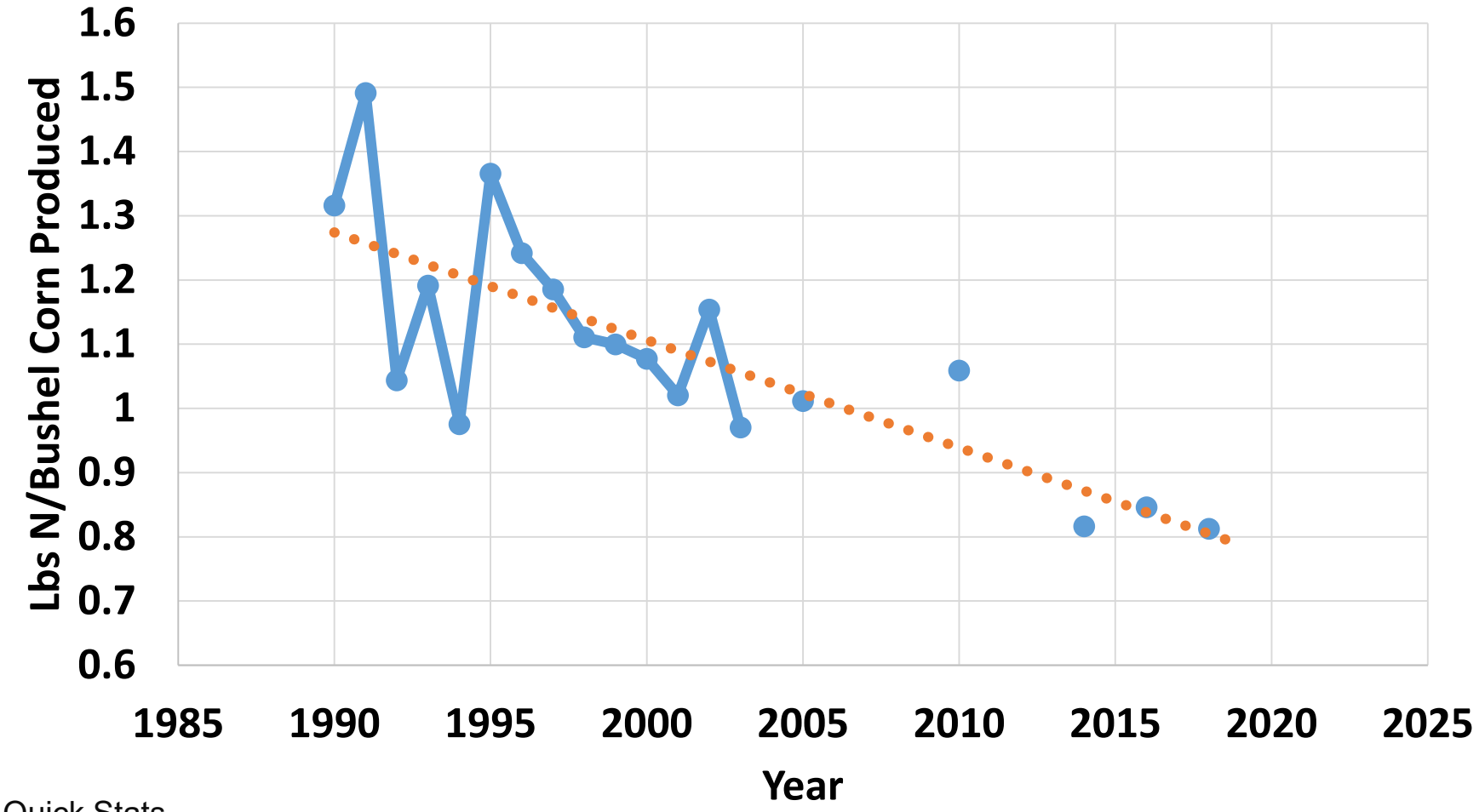
But nitrogen applications per bushel are decreasing. This demonstrates increasing efficiency of production.



Source: USDA ERS based on ARMS data for 2005, 2010, and 2015.
https://www.usda.gov/oce/oeep/USDA_Conservation_Trends.pdf

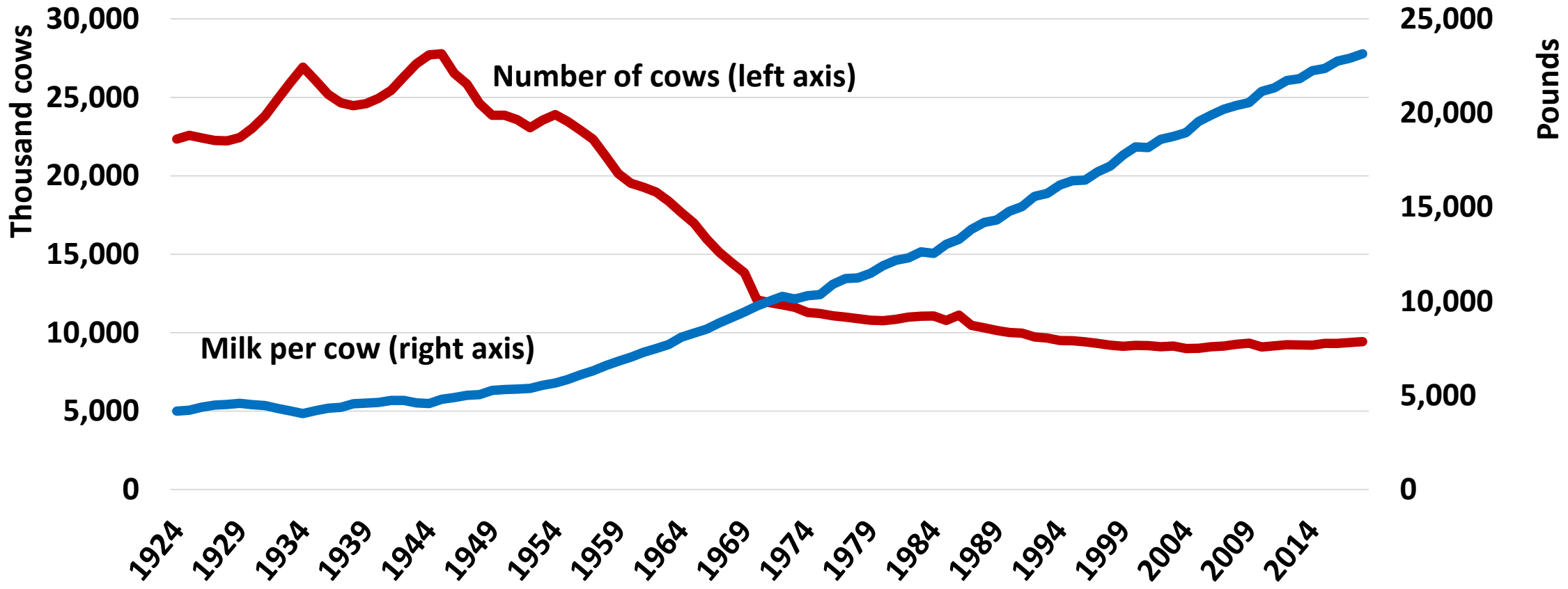
New focus on intensification can improve productivity and environmental outcomes

Pounds Nitrogen Applied per Bushel Corn Produced in Illinois, 1990-2020



Source: USDA-NASS Quick Stats

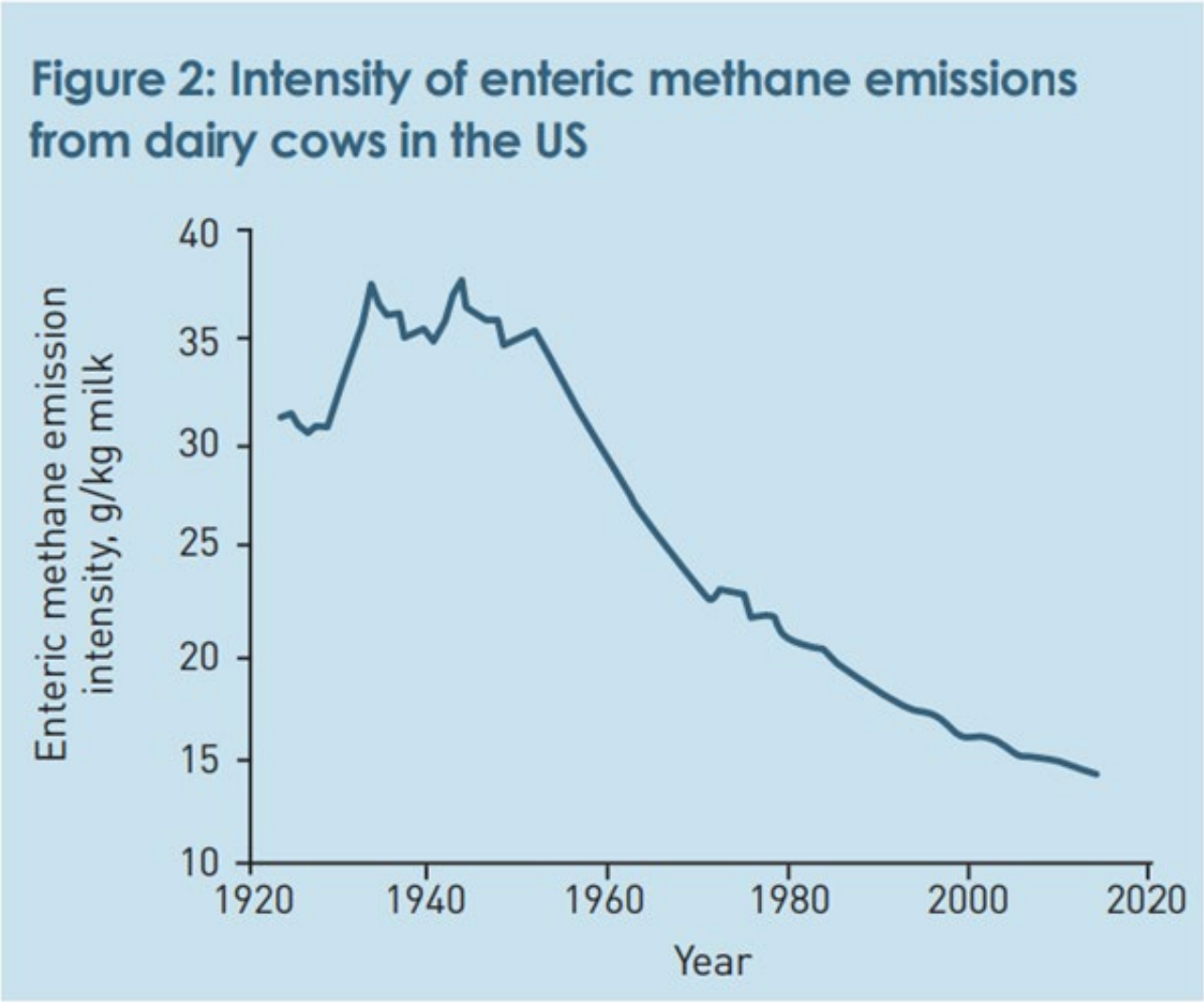
Cow numbers have been falling since the mid-20th century, while milk per cow has increased steadily



Data: USDA-NASS

Focus: enhancing productivity and the environment

Enteric methane emissions in dairy has dropped 55% from 31 g methane/kg milk in 1924, to 14 g methane/kg milk in 2014



Source: Global Research Alliance: https://globalresearchalliance.org/wp-content/uploads/2015/11/USA-national-dairy-CH4.pdf

Farming will generate externalities.
How can we achieve MC = MB?

Voluntary Programs

Generally, there will be positive private benefits to conservation practices, but there could be underinvestment.

USDA and other similar programs can provide incentives to boost investments to achieve private and public benefits.

How can we promote conservation adoption?

On-Farm Economic Benefits

- Certain practices can have financial and environmental benefits.
  - Reduced tillage
  - Reduced N applications
  - Precision agriculture
  - Cover crops

Incentive Programs

- USDA offers a variety of programs to incentivize adoption of conservation practices.
  - CRP
  - EQIP
  - CSP

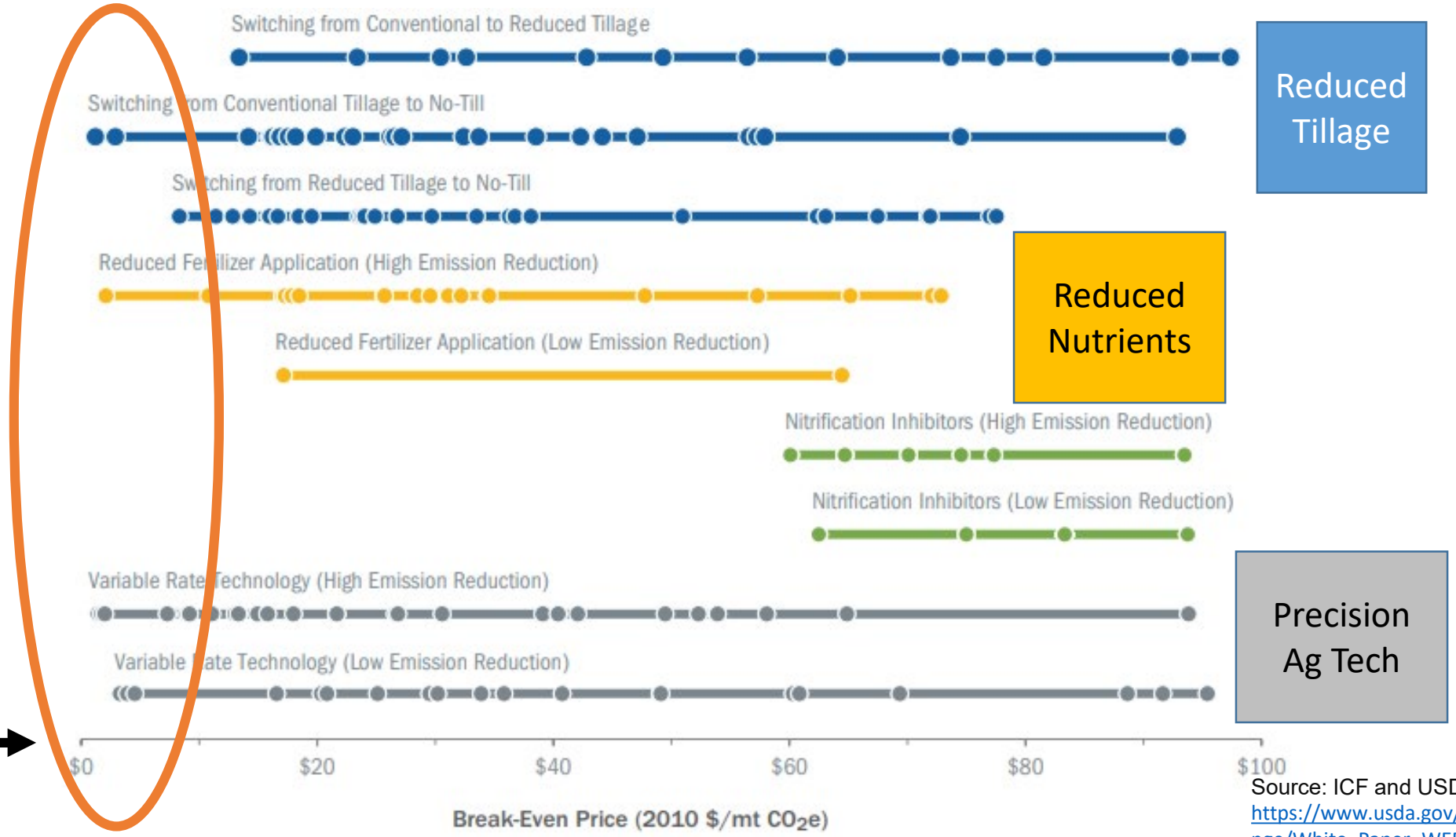
Break-even prices for conservation adoption

Range in incentive prices from $0-$100

Source: ICF and USDA, 2016
https://www.usda.gov/oce/climate_change/White_Paper_WEB_Final_v3.pdf

Break-even prices for conservation adoption

Reduced tillage, using precision ag and reducing N applications can pencil out for farmers



Range in incentive prices from $0-$100

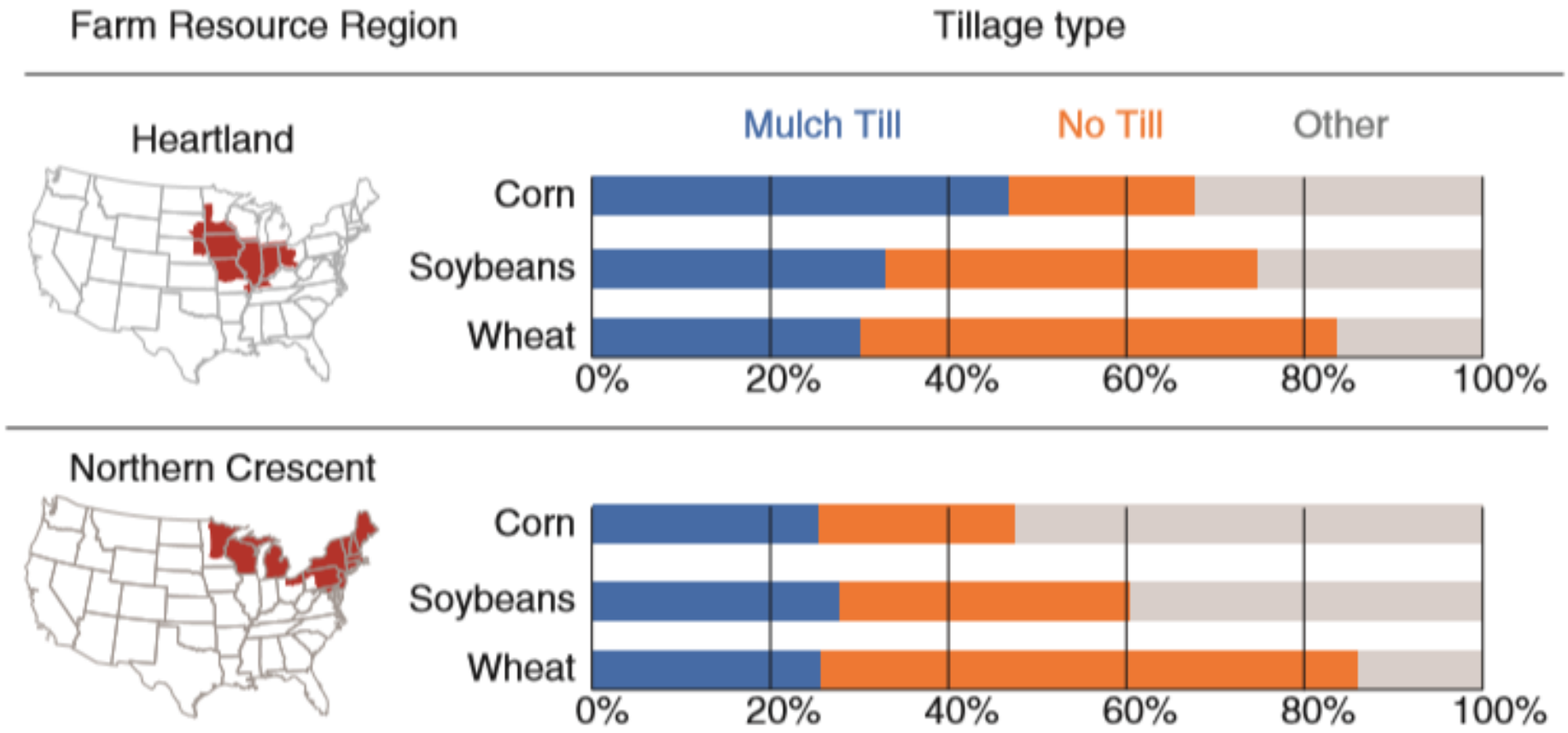
Source: ICF and USDA, 2016
https://www.usda.gov/oce/climate_change/White_Paper_WEB_Final_v3.pdf

Conservation Tillage Benefits:

- Reduces soil erosion
- Reduces runoff
- Improves water management
- Improves soil health
- Reduced time/fuel use

Source: USDA NRCS
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_066824.pdf

Mulch till and no-till adoption vary by region



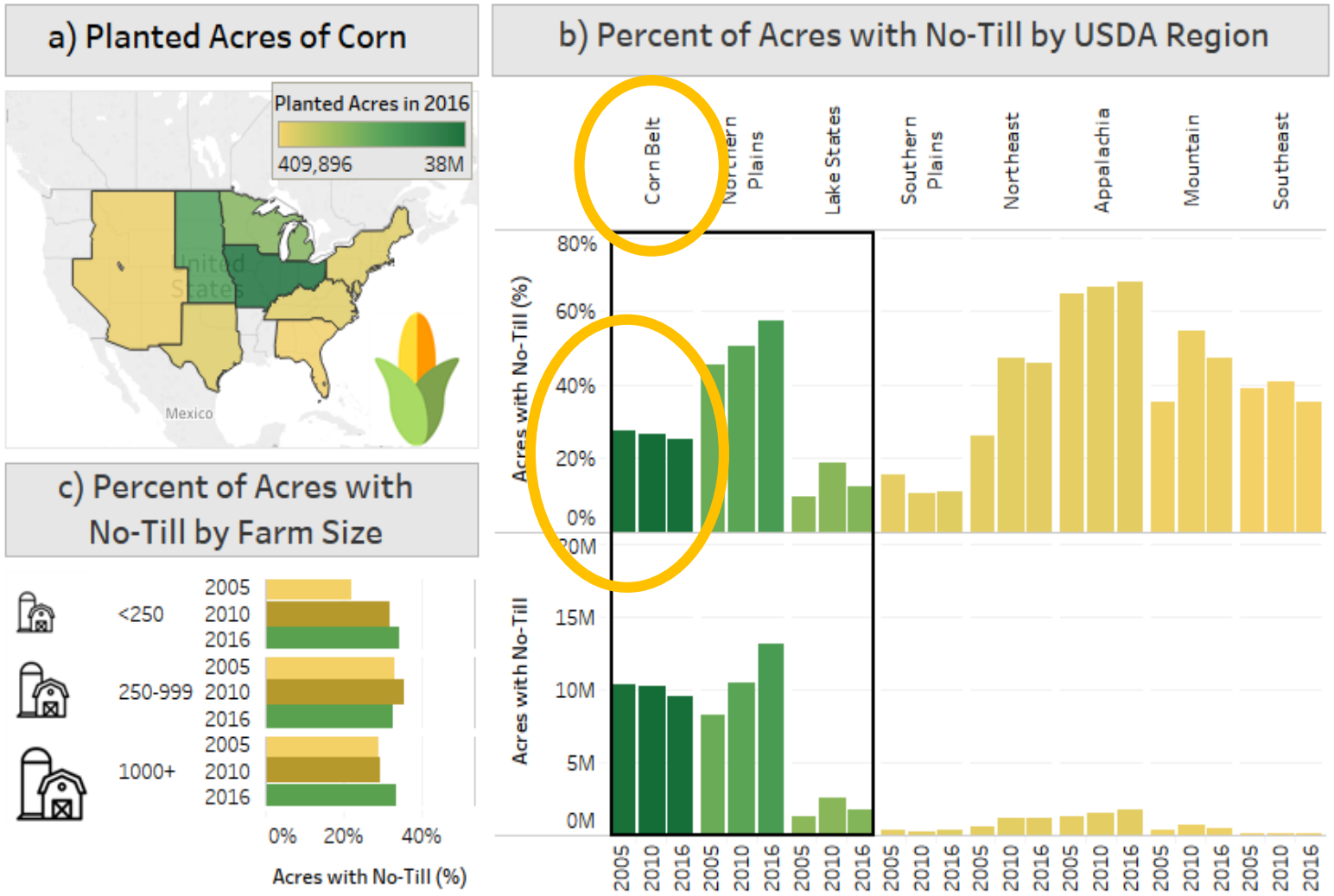
More farmers are using mulch till than no-till in the Heartland

Fewer farmers are using conservation tillage in the Northeast/Lake States

Source: USDA Agricultural Resource Management data for wheat (2017), corn (2016), and soy (2012): https://www.ers.usda.gov/webdocs/publications/90201/eib-197.pdf?v=1783.8

No-Till Adoption: Corn

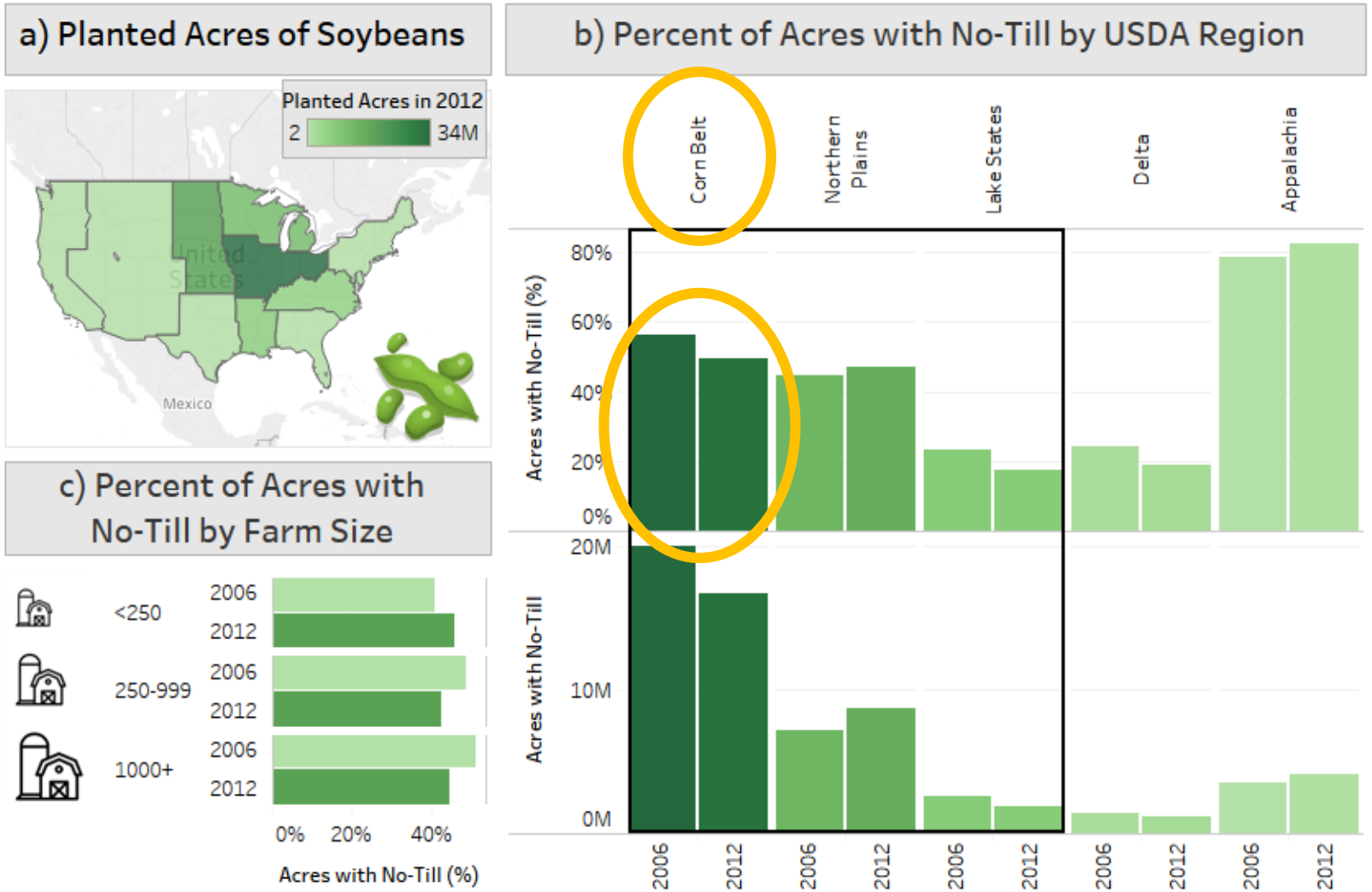
No-till adoption on corn acres in the Corn Belt is slightly decreasing, and is around 20% (2005-2016)



Source: USDA ERS based on ARMS data for 2005, 2010, and 2015.
https://www.usda.gov/oce/oeep/USDA_Conservation_Trends.pdf

No-Till Adoption: Soybeans

No-till adoption on soy acres in the Corn Belt is slightly decreasing, but relatively high– around 50% (2005-2016)



Source: USDA ERS based on ARMS data for 2006 and 2012.

https://www.usda.gov/oce/oeep/USDA_Conservation_Trends.pdf

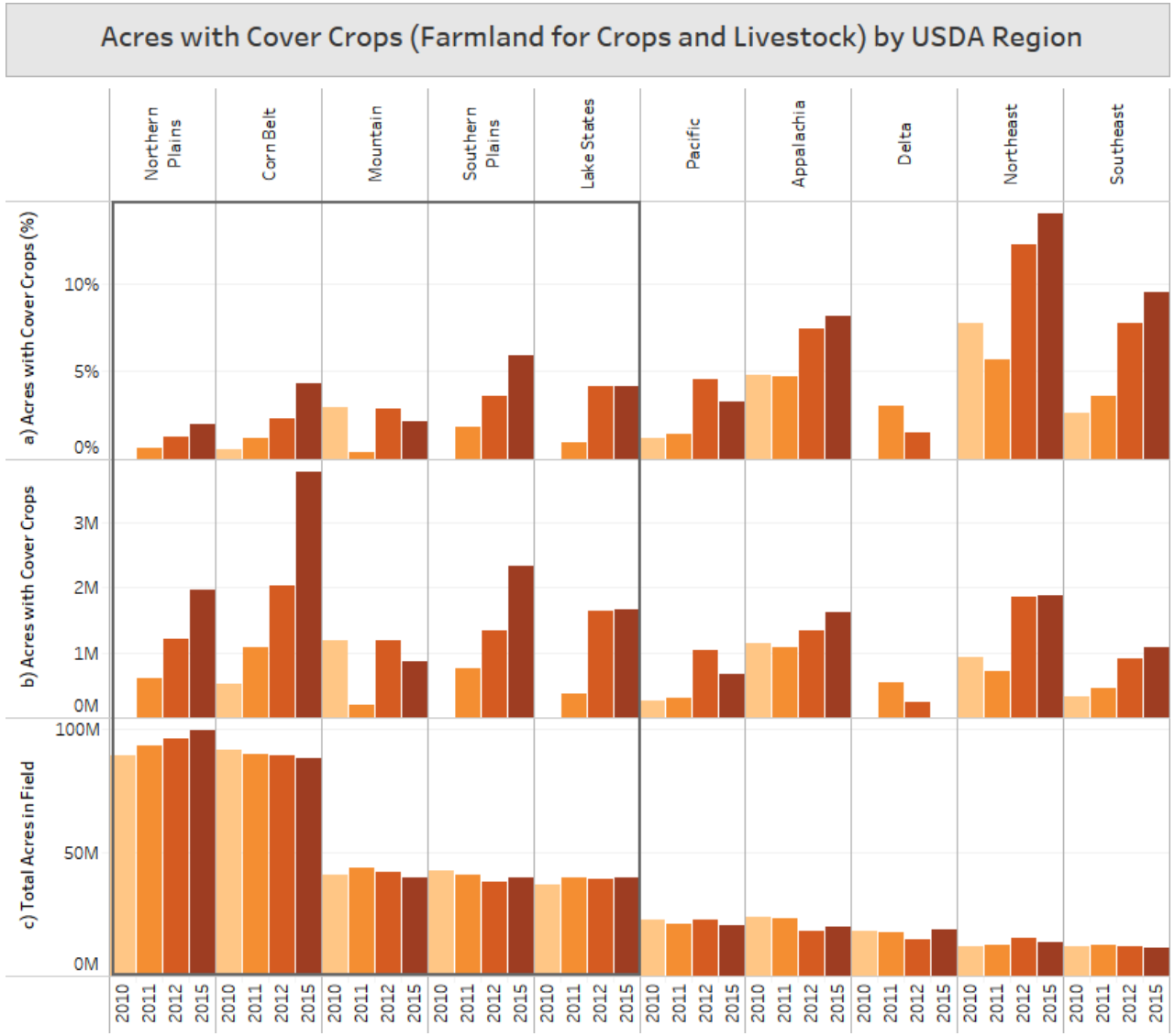
Cover Crop Benefits:

- Reduce soil erosion
- Reduce runoff
- Improve water management
- Improve soil health
- Provide additional nutrients
- Suppress weeds

Source: USDA NRCS
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1082778.pdf

Cover Crop Adoption—All Crops

Cover crop adoption is increasing, but still low overall (about 5%)

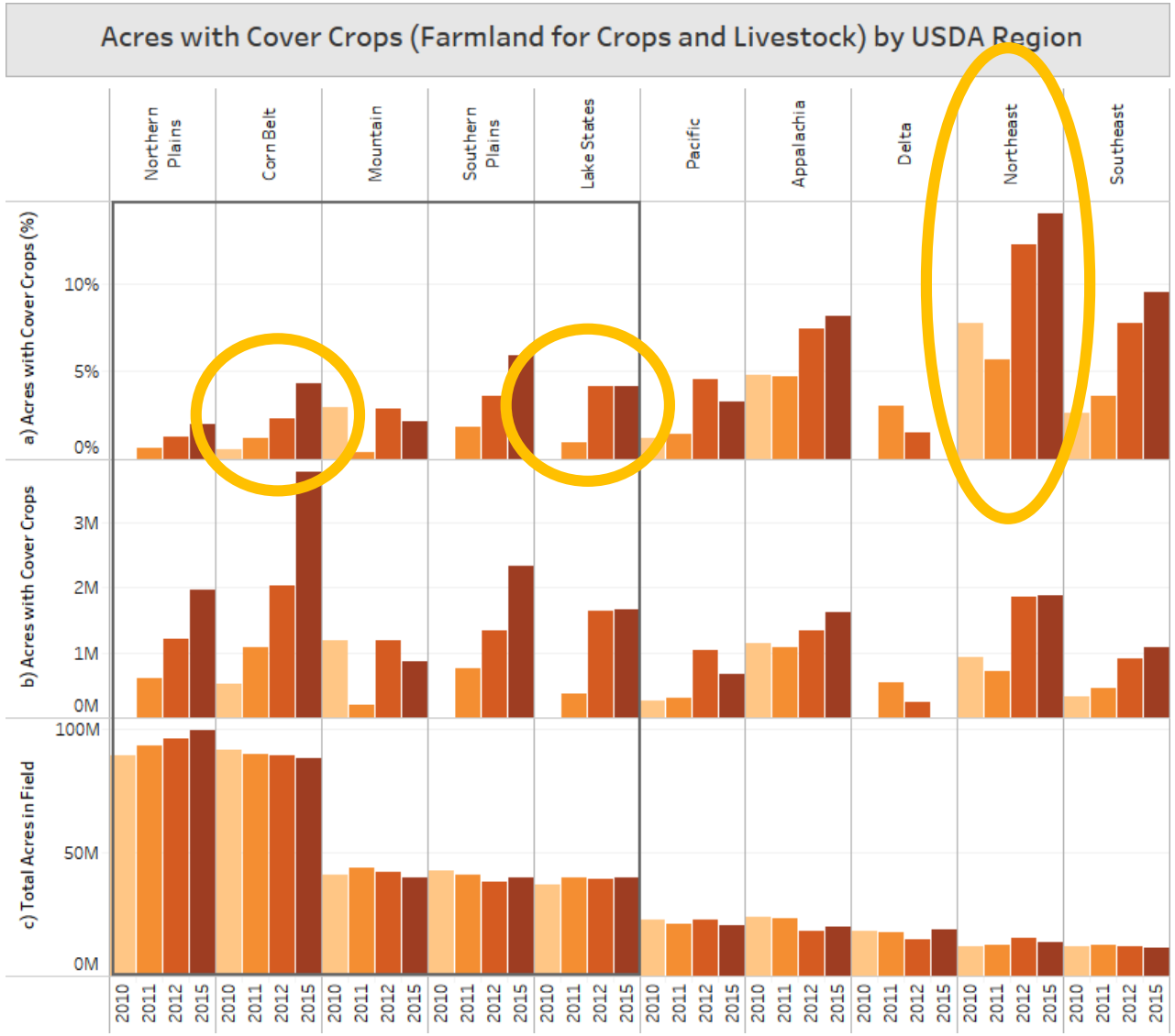


Source: USDA ERS based on ARMS data for 2010, 2011, 2012, and 2015. https://www.usda.gov/oce/oeep/USDA_Conservation_Trends.pd

Cover Crop Adoption—All Crops

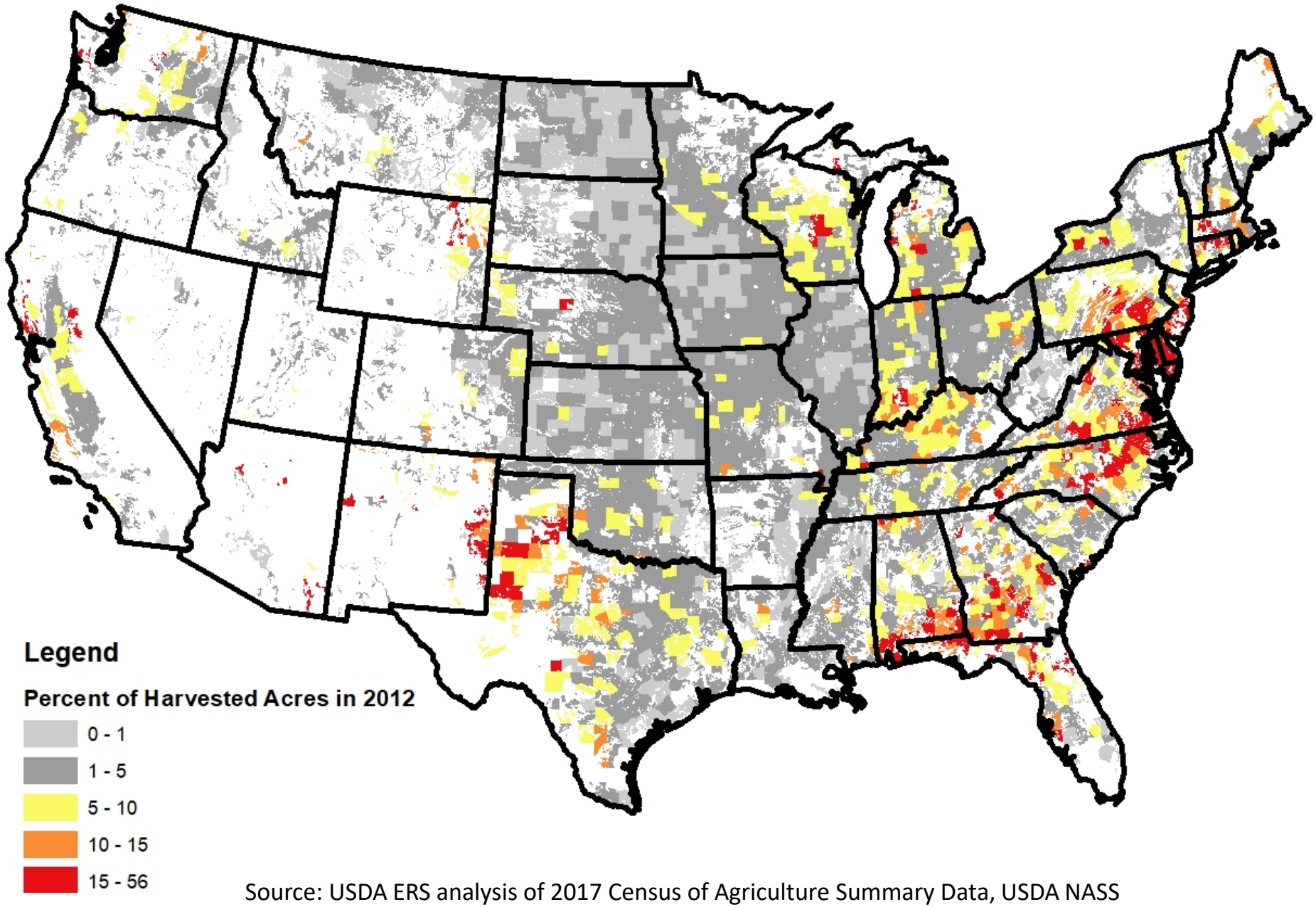
Cover crop adoption is increasing, but still low overall (about 5%)

The Corn Belt and Lake States are at about 5% adoption, but the Northeast is much higher (around 20%)



Source: USDA ERS based on ARMS data for 2010, 2011, 2012, and 2015. https://www.usda.gov/oce/oeep/USDA_Conservation_Trends.pd

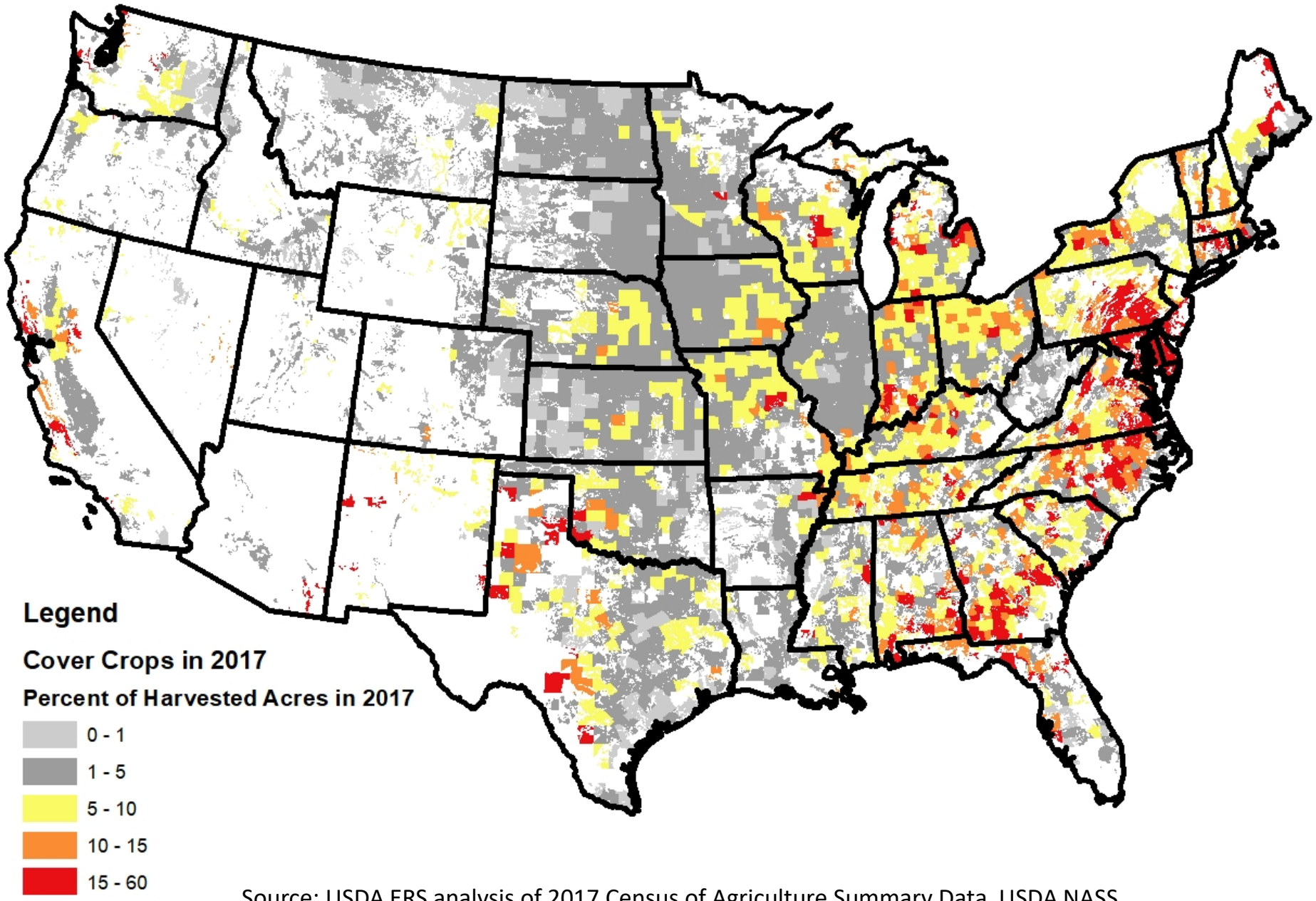
Percent of acres using cover crops in 2012



Source: USDA ERS analysis of 2017 Census of Agriculture Summary Data, USDA NASS

Percent of acres using cover crops in 2017

Increased adoption in the Eastern and Midwestern States

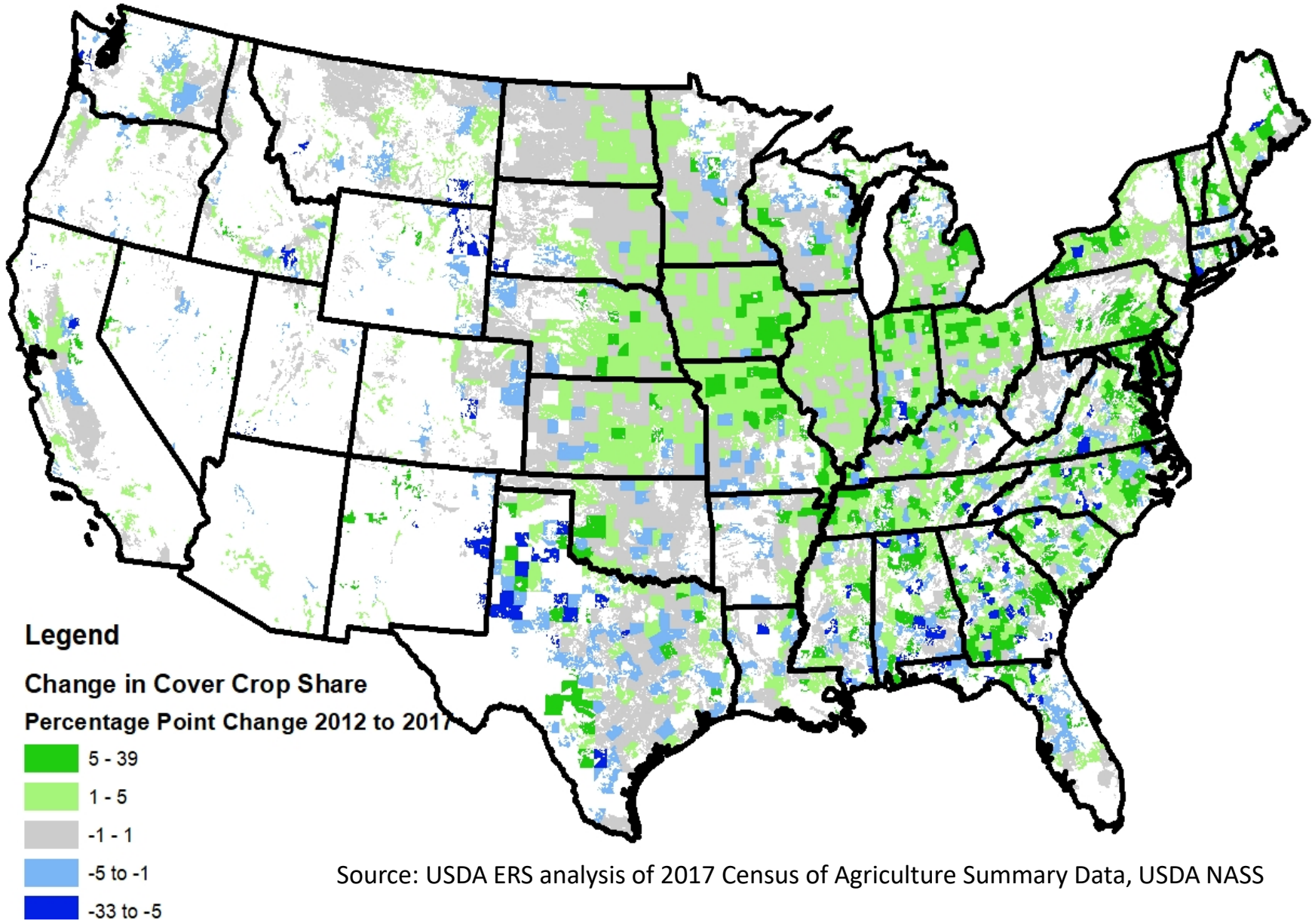


Source: USDA ERS analysis of 2017 Census of Agriculture Summary Data, USDA NASS

Change in cover crop acreage 2012-2017

Bright green represents a 5-39% increase

Dark blue represents a 5-35% decrease



Source: USDA ERS analysis of 2017 Census of Agriculture Summary Data, USDA NASS

Cover crops can provide yield returns:

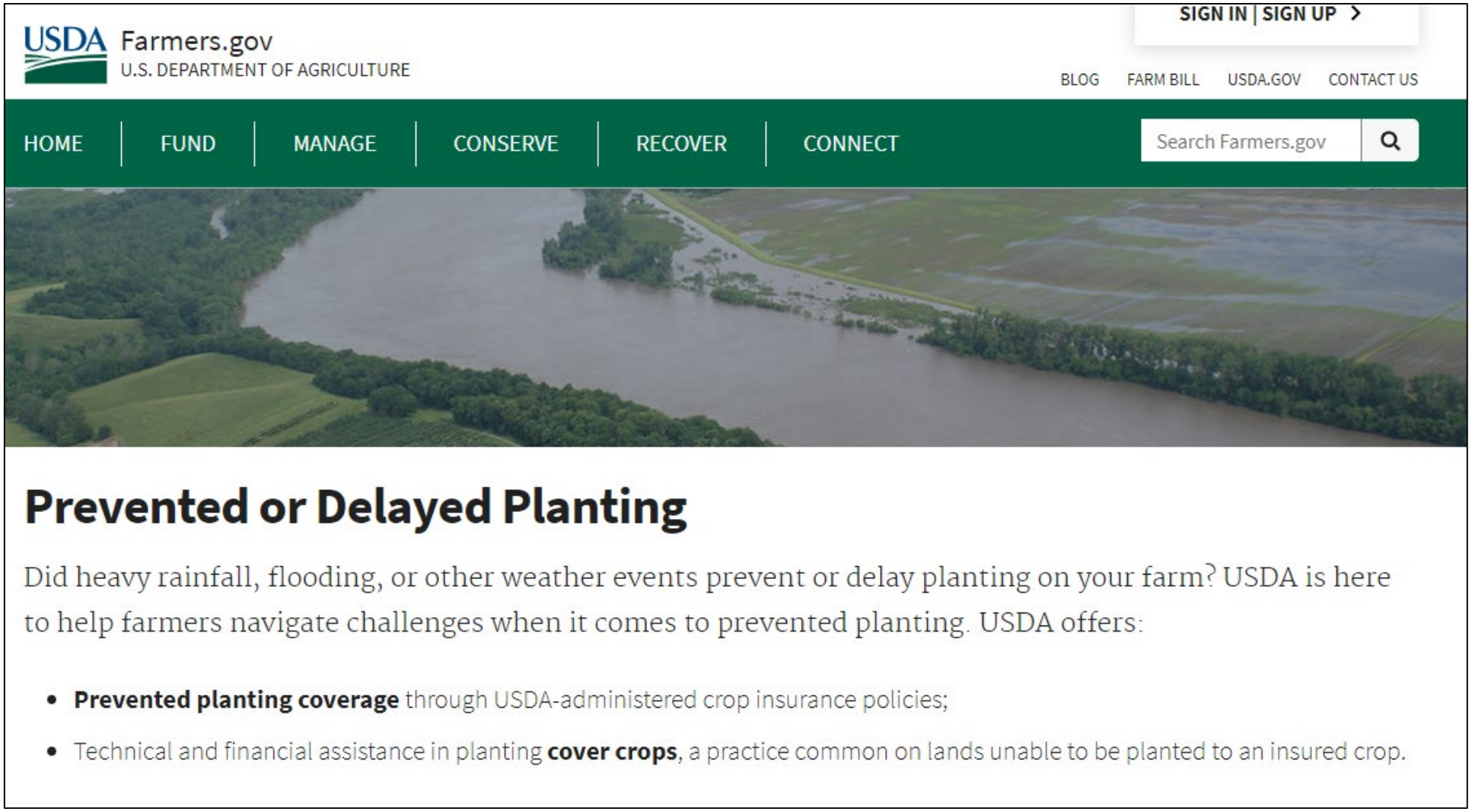
TABLE 2. Percent increase in corn and soybean yields after one, three and five years of consecutive cover crop use on a field, based on a regression analysis of data for crop years 2015 and 2016[1]

	ONE YEAR	THREE YEARS	FIVE YEARS
Corn	0.52%	1.76%	3%
Soybeans	2.12%	3.54%	4.96%

[1]Figures shown are an average of yields from the 2015 and 2016 growing seasons, with yield data obtained from about 500 farmers each year through the SARE/CTIC National Cover Crop Survey.

Source: SARE Cover Crop Economics, 2019
https://www.sare.org/Learning-Center/Bulletins/Cover-Crop-Economics

USDA encouraged cover crop planting on prevented plant acres this year:



Source: USDA
https://www.farmers.gov/manage/prevented-planting

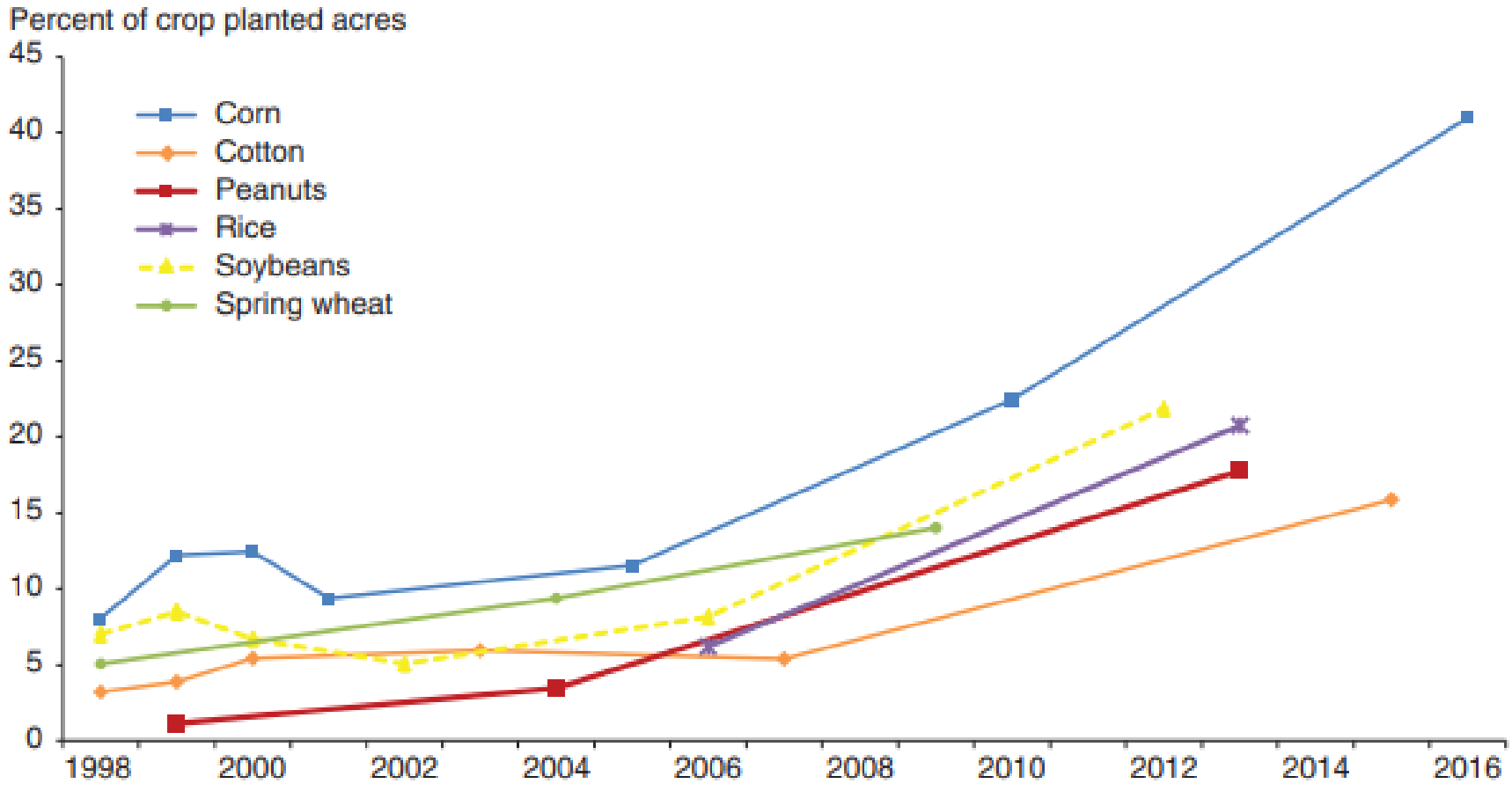
Precision Agriculture Benefits:

- Apply fertilizer and other inputs in the right place and right rate
- Maximize nutrient benefits while minimizing overapplication
- Financial benefits by reducing inputs

Source: USDA ERS https://www.ers.usda.gov/amber-waves/2016/december/precision-agriculture-technologies-and-factors-affecting-their-adoption/

Variable Application Rate Technology Adoption (1998-2016)

VRT adoption, especially on corn (blue line), rapidly increased from 2005-2016



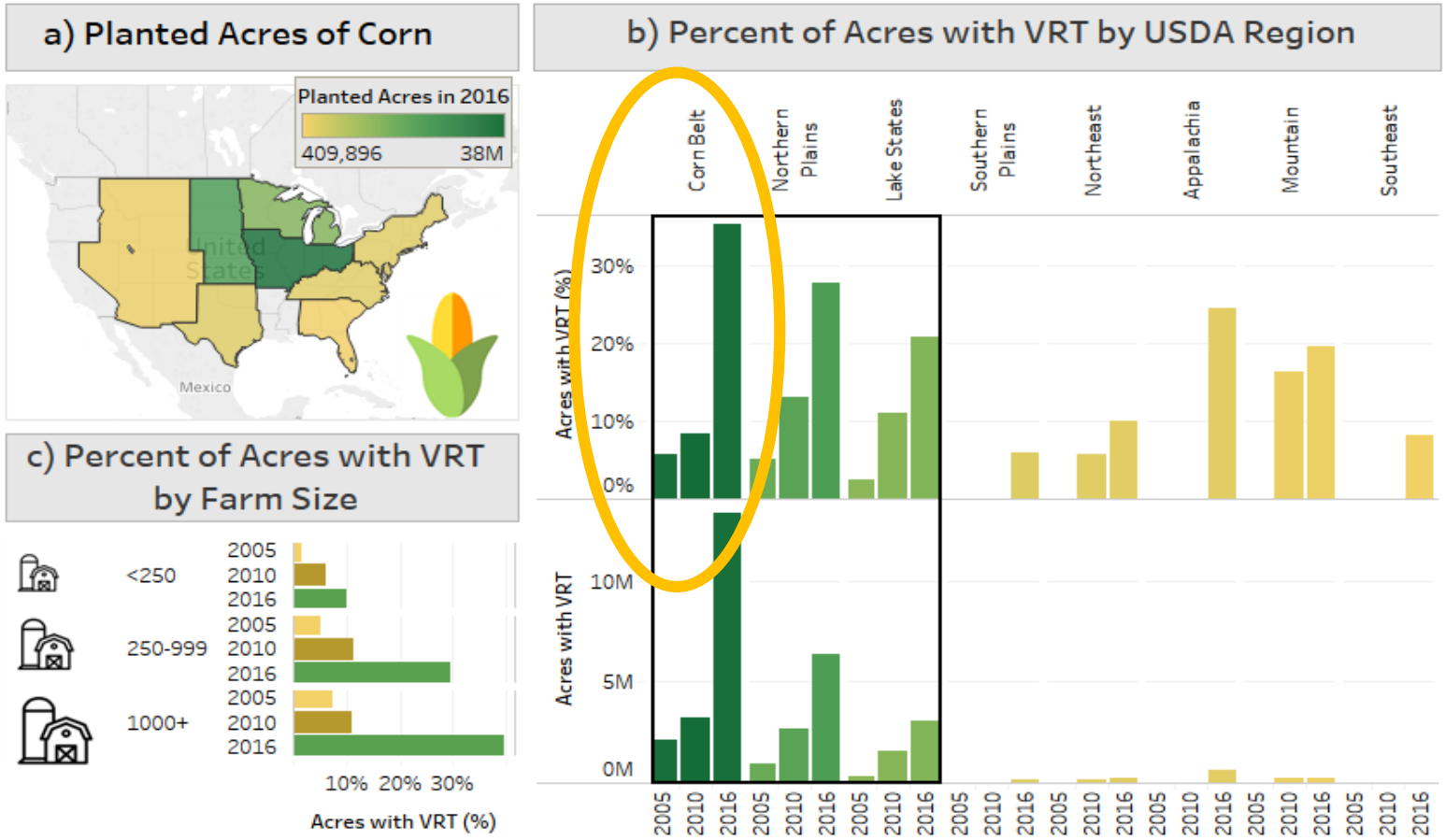
Note: Line markers indicate survey years for each crop.
Source: USDA, Economic Research Service (ERS) estimates using data from ERS and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, Phase II.

Data: USDA ERS Agricultural Resources and Environmental Indicators, 2019: https://www.ers.usda.gov/webdocs/publications/93026/eib-208.pdf?v=2348.3

Variable Application Rate Technology for Fertilizers: Corn

In 2005, around 5% of corn farmers used VRT in the Corn Belt.

By 2016, almost 40% of corn farmers used VRT in the Corn Belt.



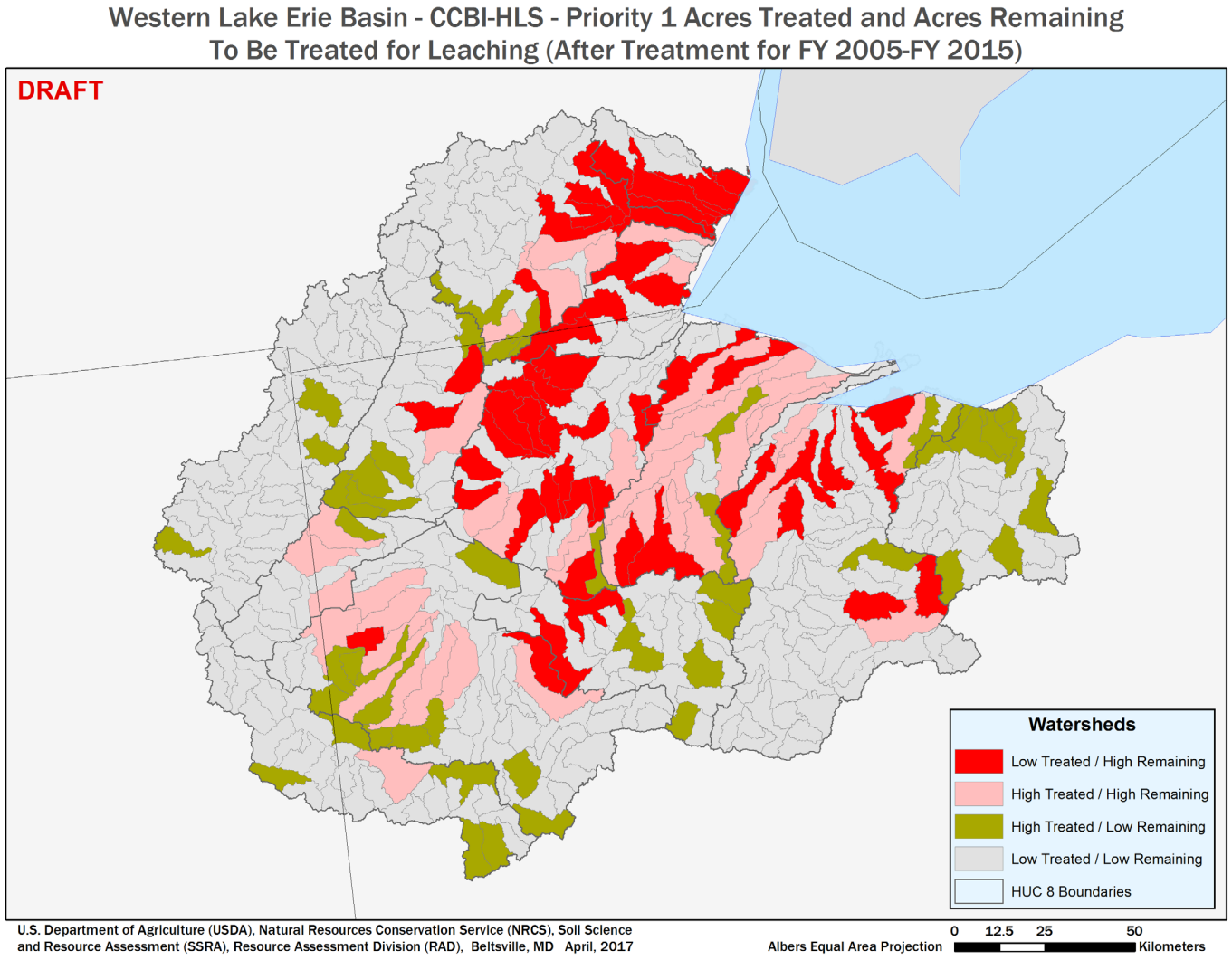
Source: USDA ERS based on ARMS data for 2010, 2011, 2012, and 2015. https://www.usda.gov/oce/oeep/USDA_Conservation_Trends.pd

USDA's broadband programs support precision ag adoption

- USDA's *"A Case for Rural Broadband"* report found that meeting rural broadband needs could provide $18 billion in additional economic benefits
- The USDA ReConnect Program offers grants and loans for broadband infrastructure
- USDA has invested over $51m to date

Acres with high leaching potential in the Western Lake Erie Basin

Targeting resources applies to both a farm level and a programmatic level



Source: USDA CEAP Data, 2015

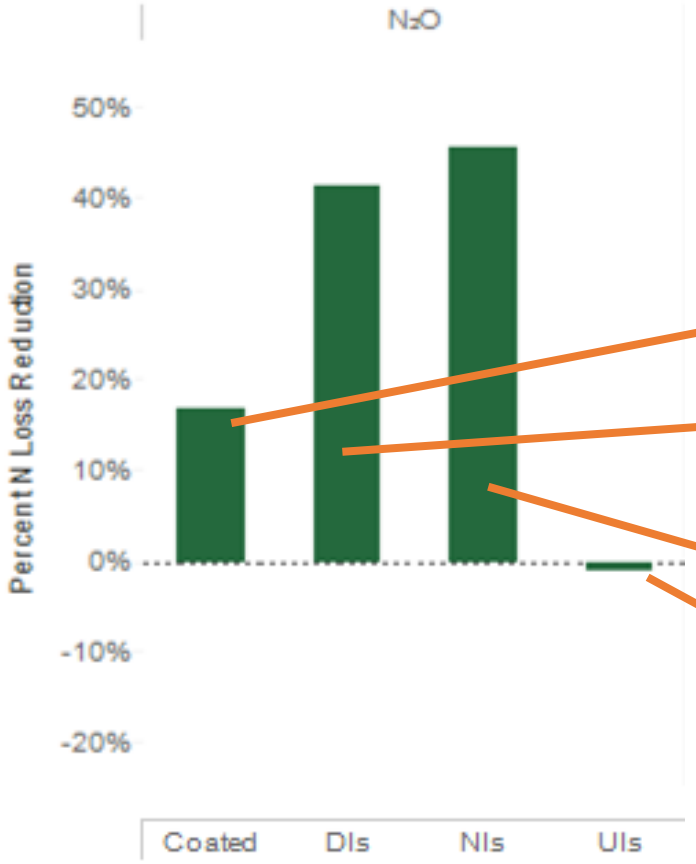
New technologies will continue to drive efficiencies in production

Example: Enhanced Efficiency Fertilizers (EEFs)

- Reduce nitrogen losses to water and air
  - Nitrous oxide emissions from fertilizers are the largest source of greenhouse gas emissions from the ag sector (almost 50% of ag emissions)

- Improve nitrogen use efficiency and yield

Impact of Enhanced Efficiency Fertilizers on Nitrous Oxide Reductions



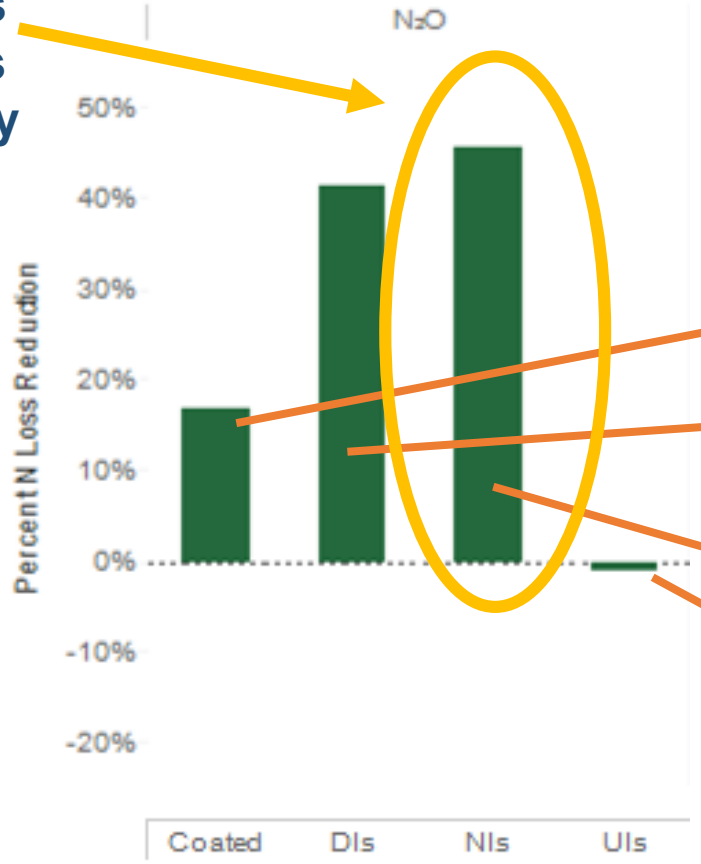
Enhanced Efficiency Fertilizers:

- Coated fertilizers
- Double inhibitors (nitrification and urease inhibitors)
- Nitrification inhibitors
- Urease inhibitors

Source: ICF and USDA, 2019. Draft memo. Data from Akiyama et al, 2010; Kim et al, 2012; Li et al, 2018; Shcherbak et al, 2014; Zhang et al, 2019

Impact of Enhanced Efficiency Fertilizers on Nitrous Oxide Reductions

Nitrogen inhibitors can reduce nitrous oxide emissions by over 40%



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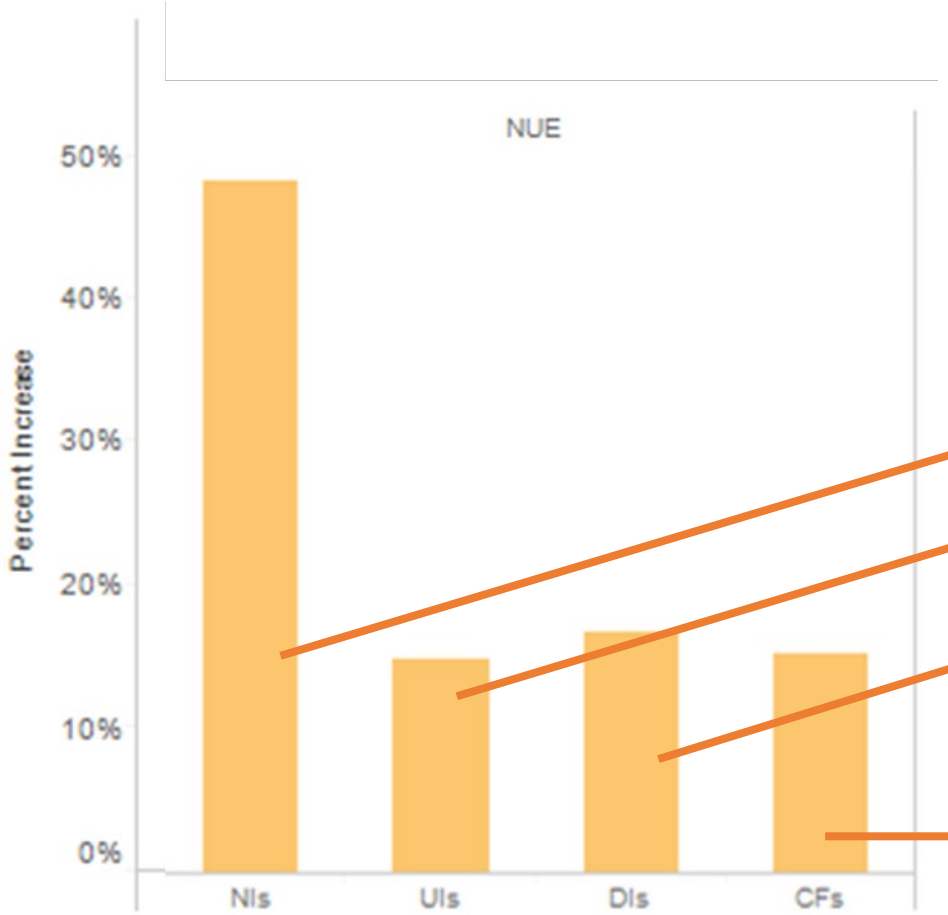
- Nitrification inhibitors
- Urease inhibitors

Source: ICF and USDA, 2019. Draft memo. Data from Akiyama et al, 2010; Kim et al, 2012; Li et al, 2018; Shcherbak et al, 2014; Zhang et al, 2019

Impact of Enhanced Efficiency Fertilizers on Nitrogen Use Efficiency



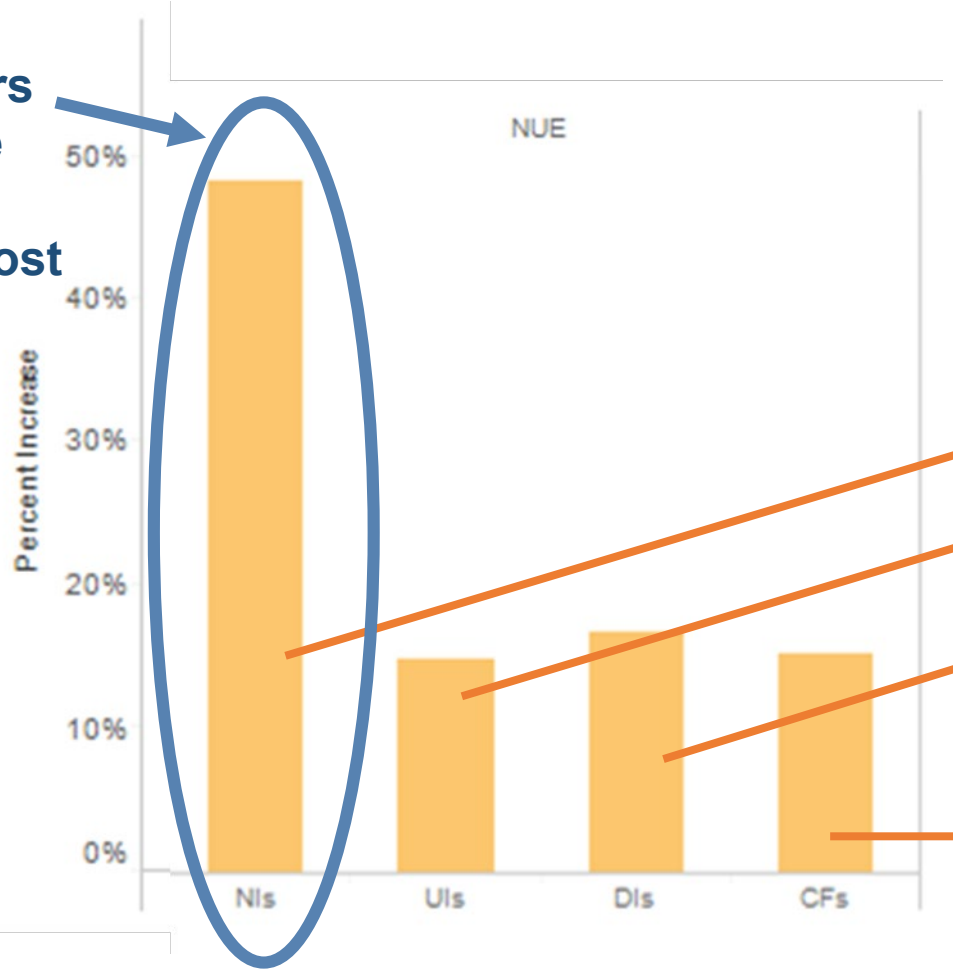
Enhanced Efficiency Fertilizers:

- Nitrification inhibitors
- Urease inhibitors
- Double inhibitors (nitrification and urease inhibitors)
- Coated fertilizers

Source: ICF and USDA, 2019. Draft memo. Data from Akiyama et al, 2010; Kim et al, 2012; Li et al, 2018; Shcherbak et al, 2014; Zhang et al, 2019

Impact of Enhanced Efficiency Fertilizers on Nitrogen Use Efficiency

Nitrogen inhibitors can also increase nitrogen use efficiency by almost 50%



Enhanced Efficiency Fertilizers:

- Nitrification inhibitors
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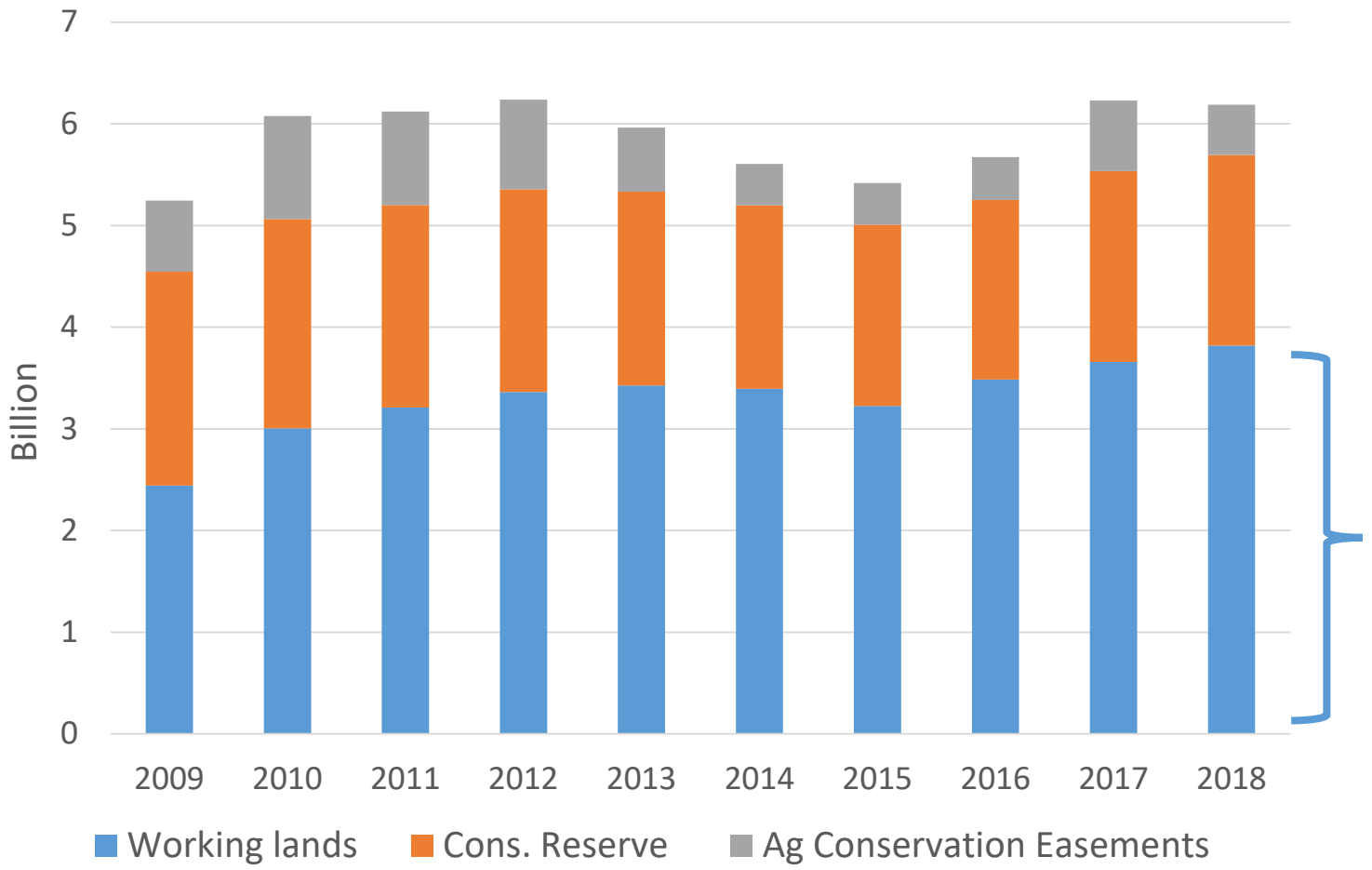
Source: ICF and USDA, 2019. Draft memo. Data from Akiyama et al, 2010; Kim et al, 2012; Li et al, 2018; Shcherbak et al, 2014; Zhang et al, 2019

USDA has a role to play in incentivizing conservation adoption

- **USDA makes significant investments through Farm Bill programs (EQIP, CSP, CRP, etc.)**

- **These investments have led to reductions in soil loss, runoff, and sequestered carbon**

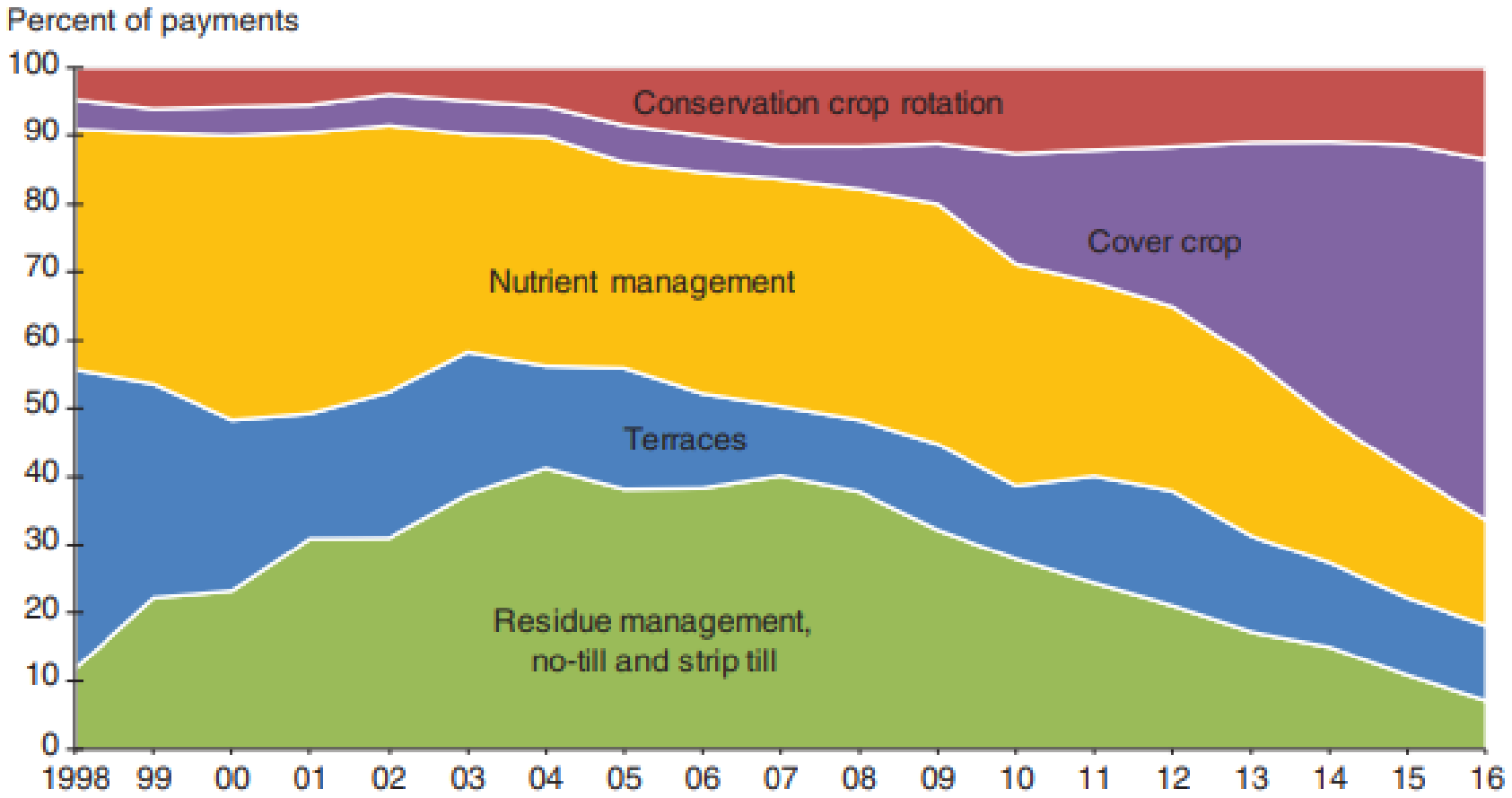
USDA investments in conservation (2009-2018)



Working lands programs have made up a higher share of USDA conservation spending over time

Note: Data expressed in 2018 dollars. Working lands includes: Environmental Quality Incentives Programs, Conservation Stewardship Program and Conservation Technology Assistance. Conservation Reserve Program, Agricultural Conservation Easement Program. All programs include these and their predecessors.

Expenditures on top 5 EQIP practices 1998-2015



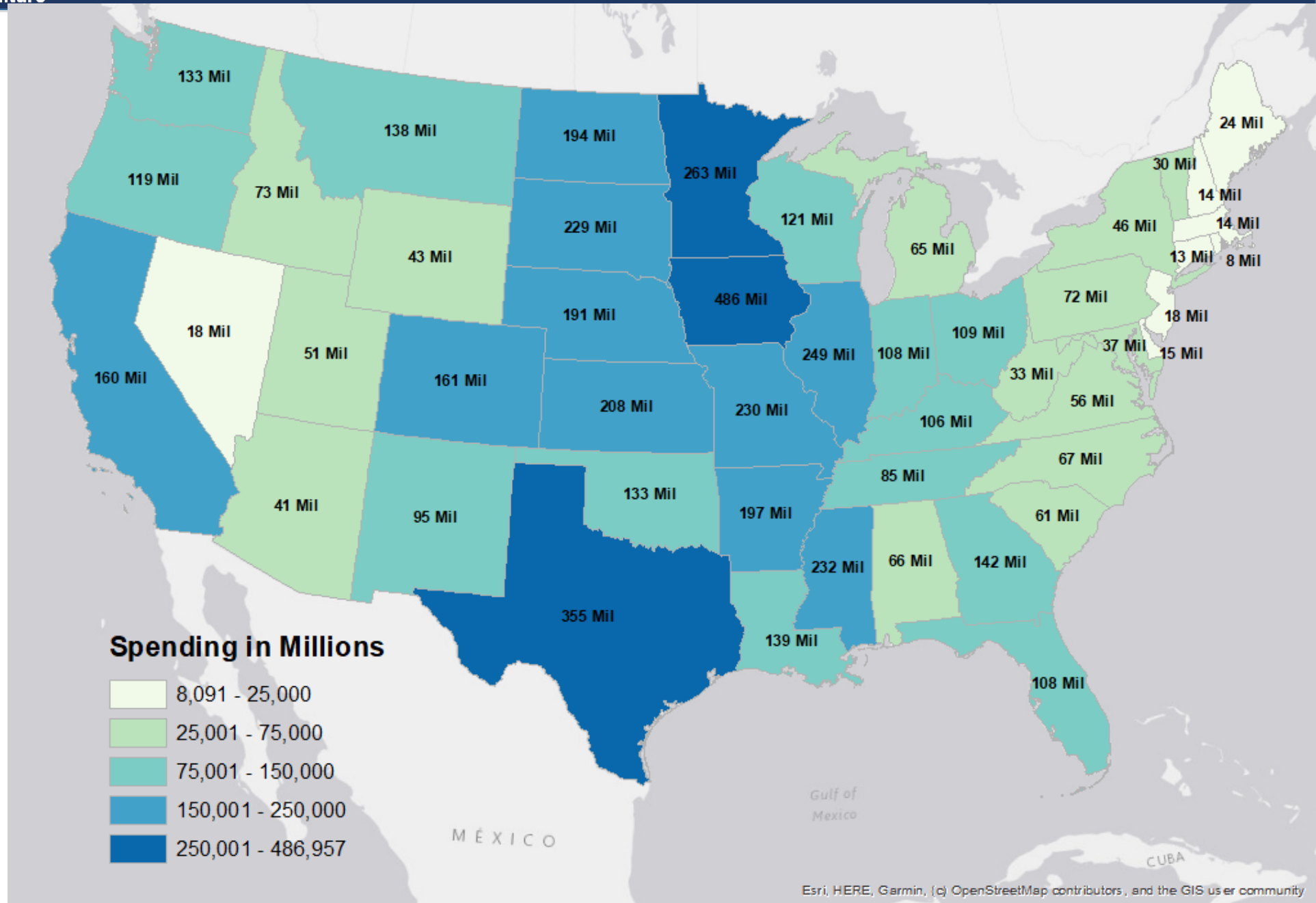
Cover crops account for more of EQIP spending over time

Data: USDA ERS Agricultural Resources and Environmental Indicators, 2019: https://www.ers.usda.gov/webdocs/publications/93026/eib-208.pdf?v=2348.3

USDA conservation spending by state in 2018

Total US Spending 2018: 6,187 Million

Note: Data expressed in 2018 dollars. Includes these programs and predecessors: Environmental Quality Incentives Programs, Conservation Stewardship Program, Conservation Technology Assistance, Conservation Reserve Program, Agricultural Conservation Easement Program.

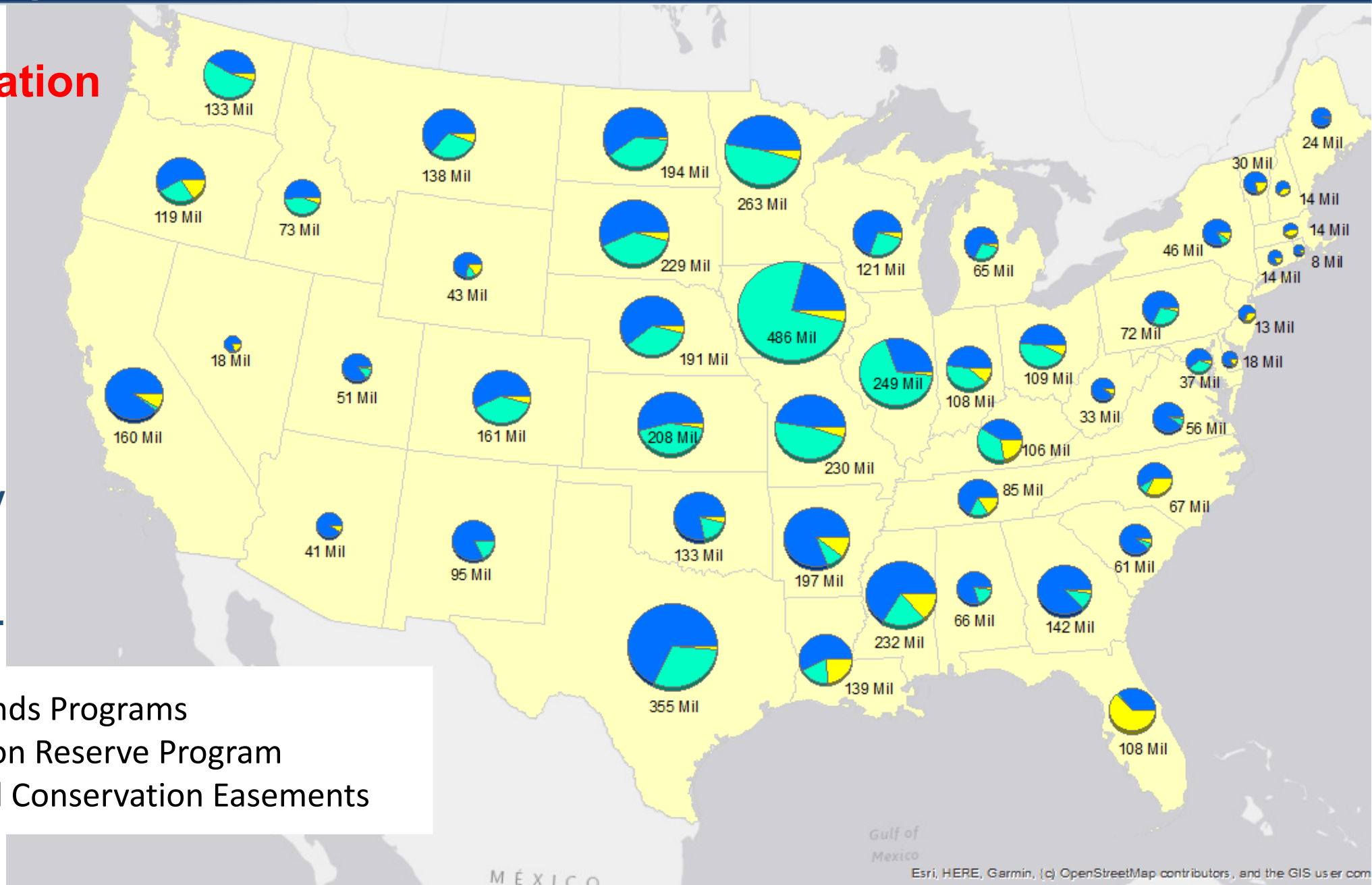


Source: NRCS RCA Reports

Distribution of USDA conservation spending by program, 2018

Total US Spending 2018: 6,187 Million

Working lands programs include: Environmental Quality Incentives Program, Conservation Stewardship Program.

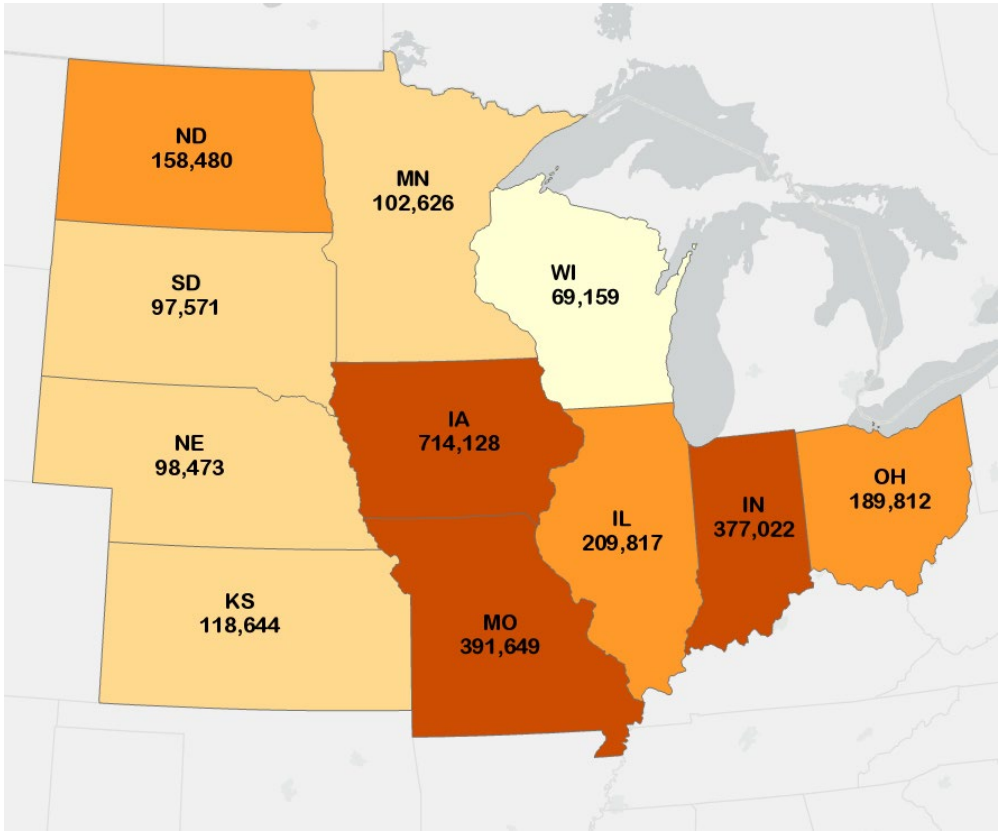


Working lands Programs
Conservation Reserve Program
Agricultural Conservation Easements

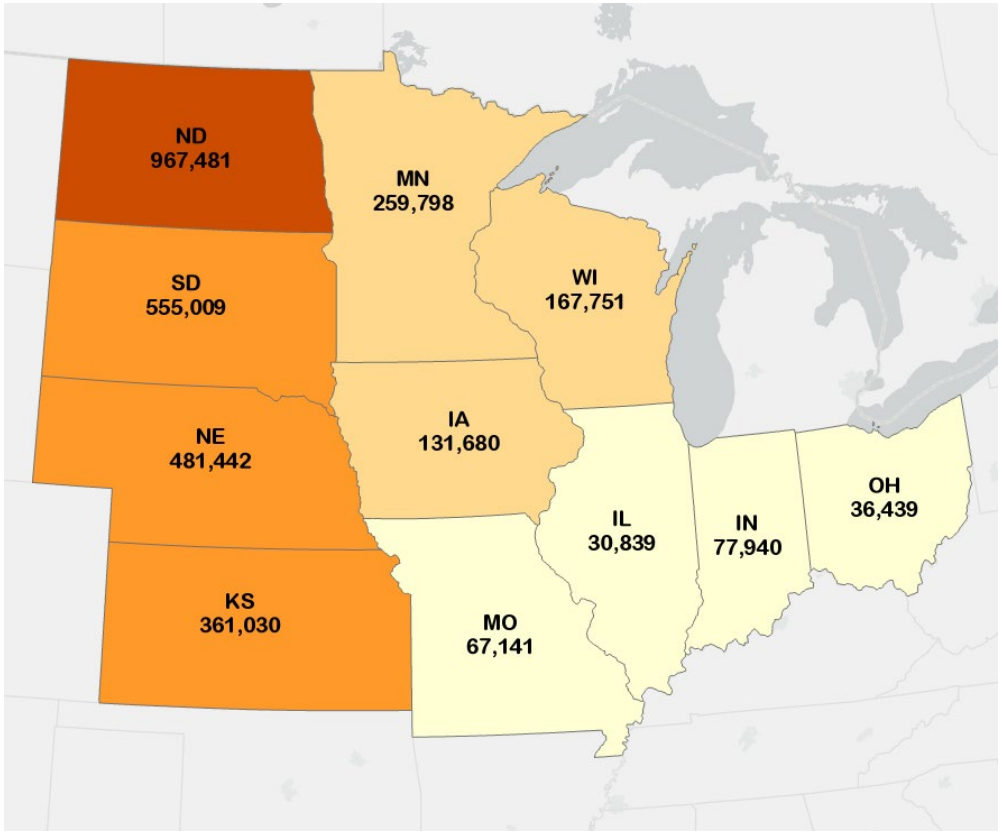
Source: NRCS RCA Reports

Outcomes from USDA conservation investments:

Average Sediment Loss Reduction 2017–18
2.52 million tons



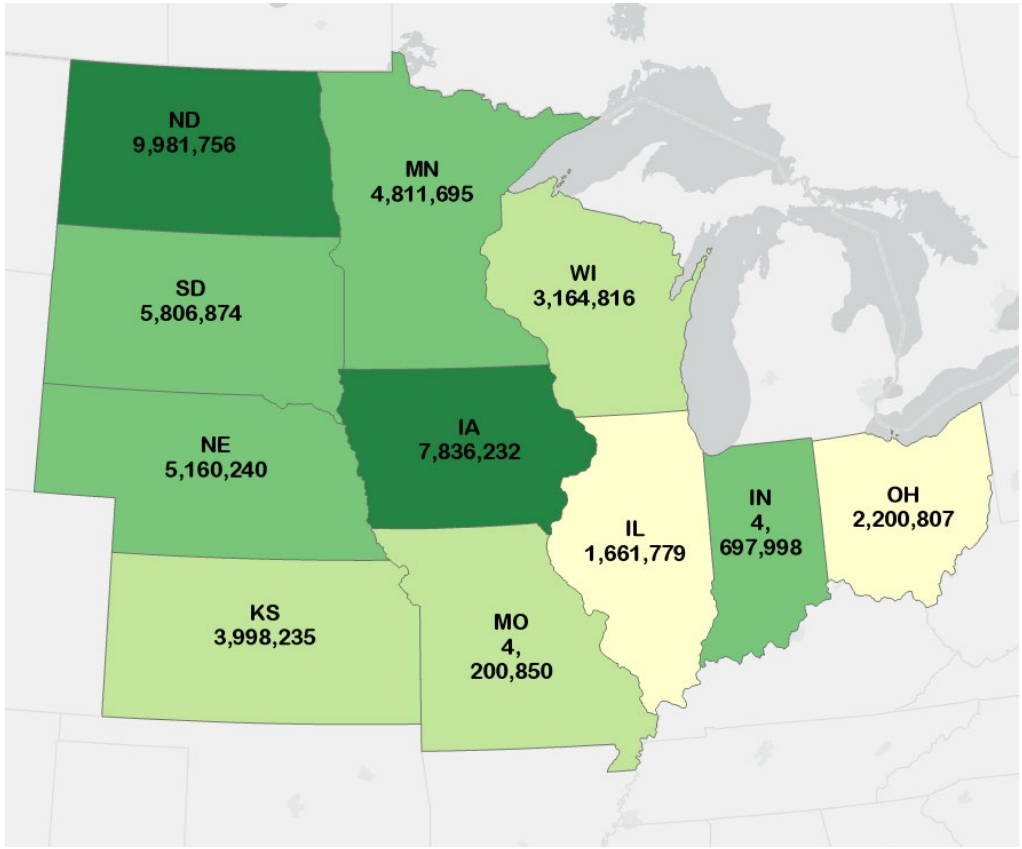
Average Wind Erosion Loss Reduction 2017–18
3.13 million tons



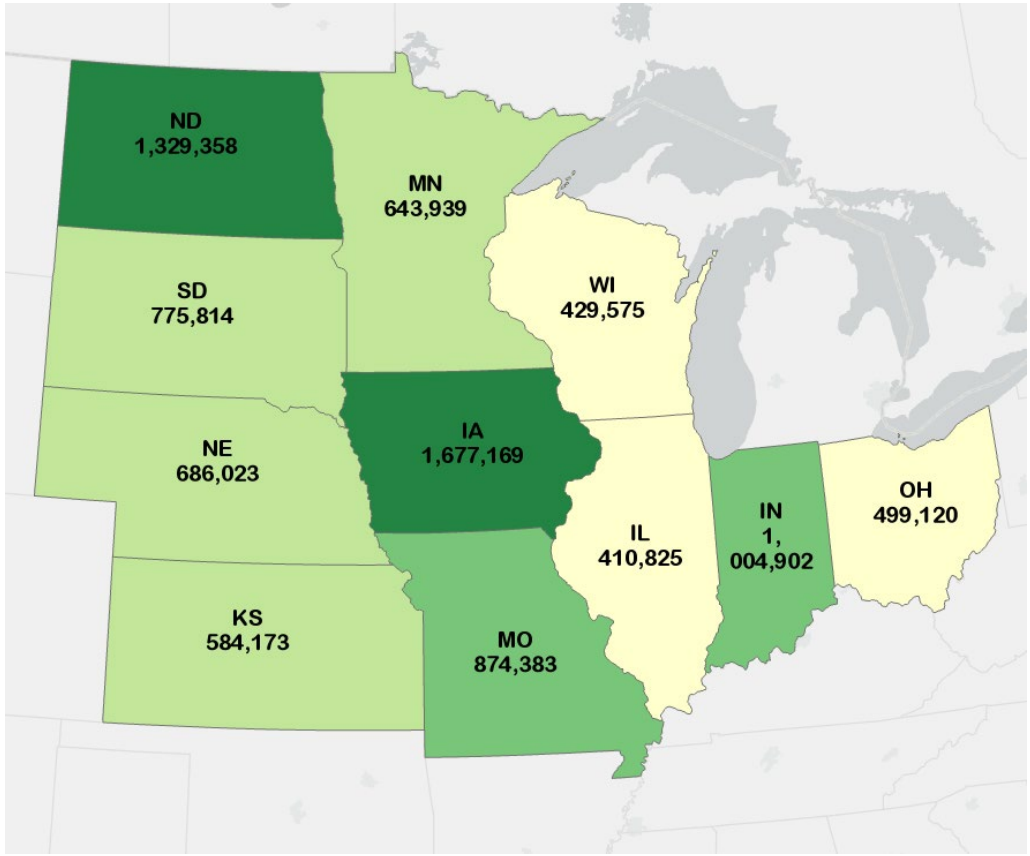
Source: USDA CEAP Data

Outcomes from USDA conservation investments:

Average nitrogen runoff 2017–18 down 53.5 million lbs.

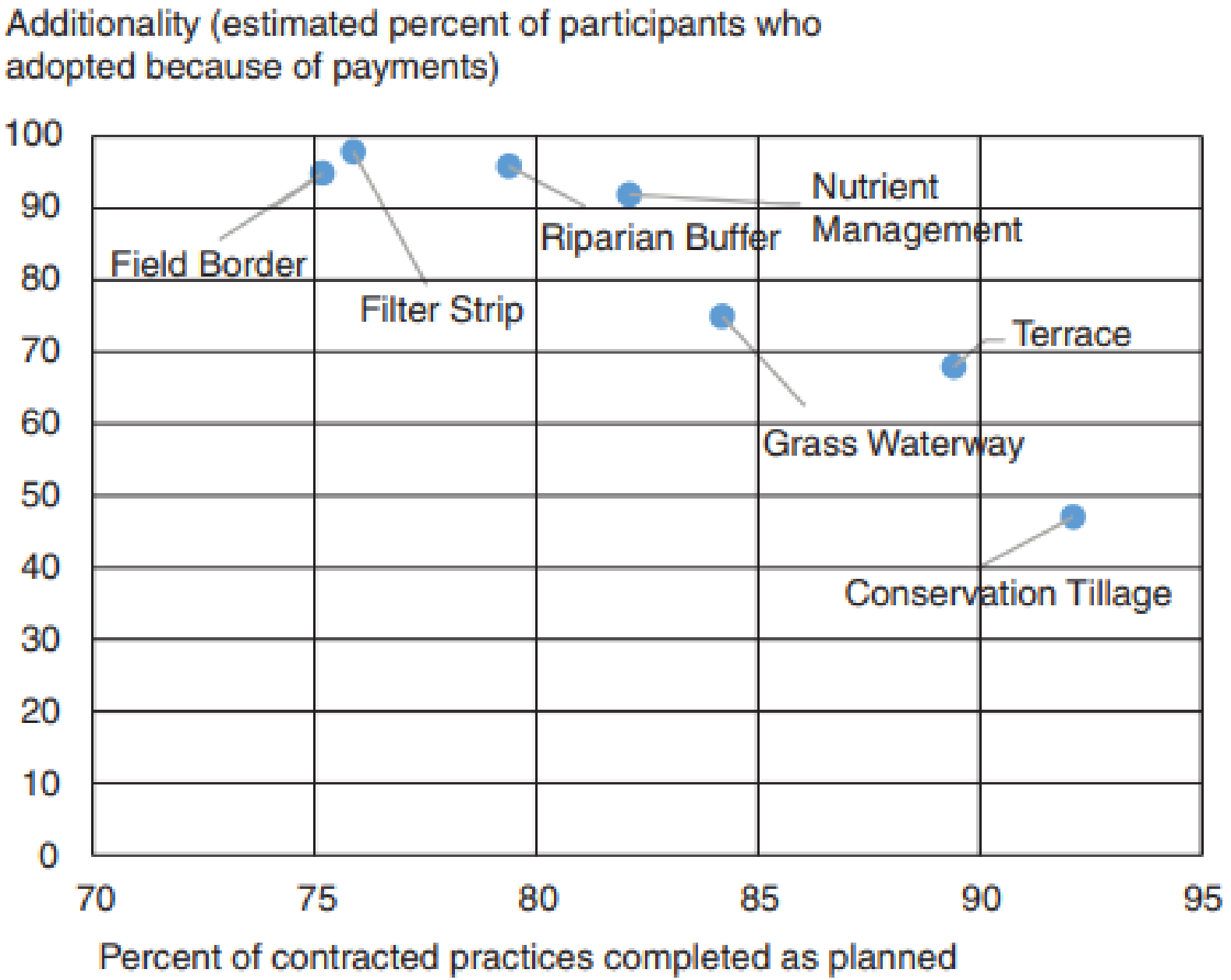


Average phosphorus runoff 2017–18 down 8.91 million lbs.



Source: USDA CEAP Data

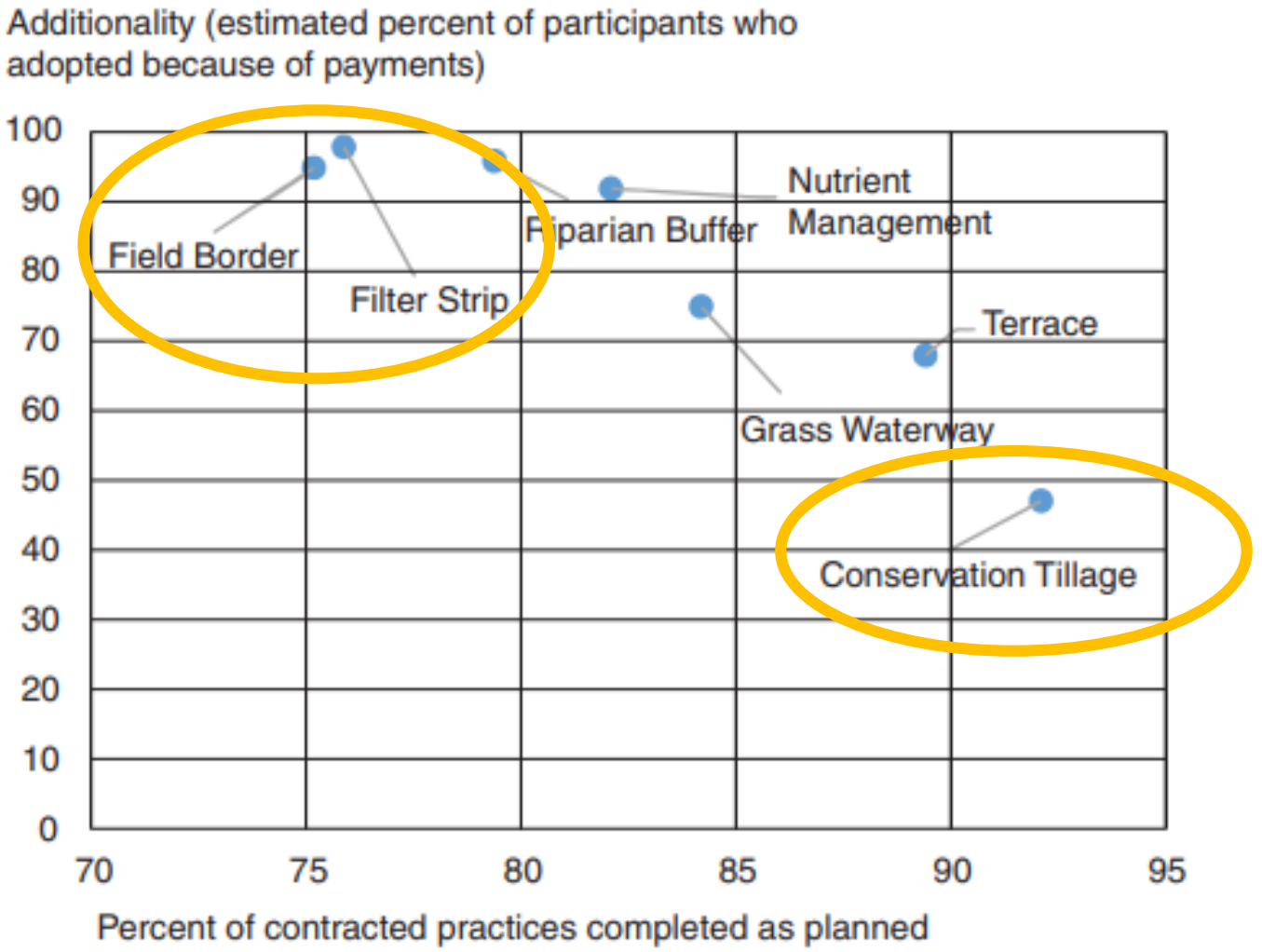
Comparing successful EQIP participation to additionality



Source: ERS, Working Lands Conservation Contract Modifications: Patterns in Dropped Practices

Comparing successful EQIP participation to additionality

Structural practices are additional, but less likely to be completed as planned



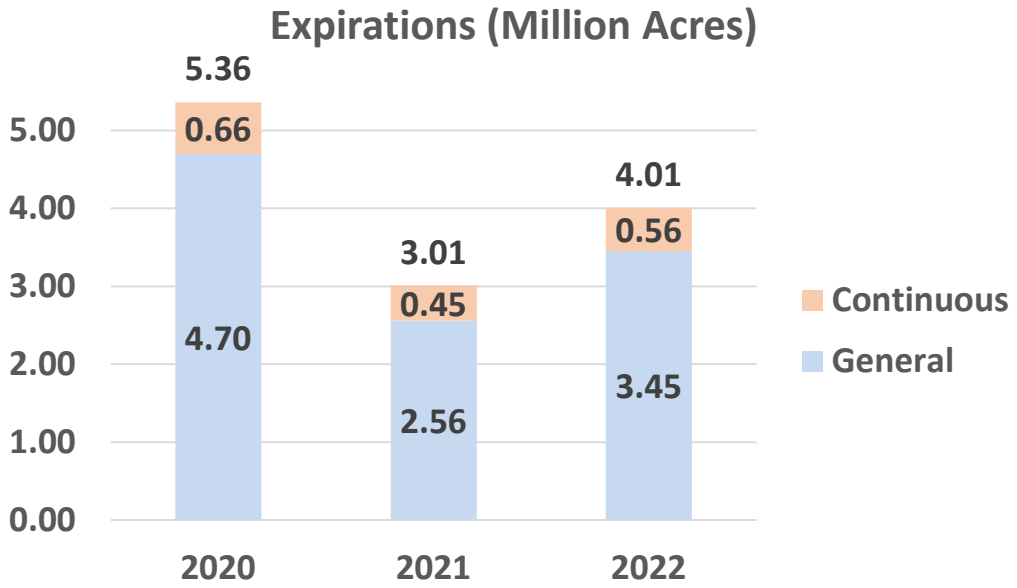
Conservation tillage is not as additional, but very likely to be completed as planned

→ Conservation tillage probably pencils out for farmers

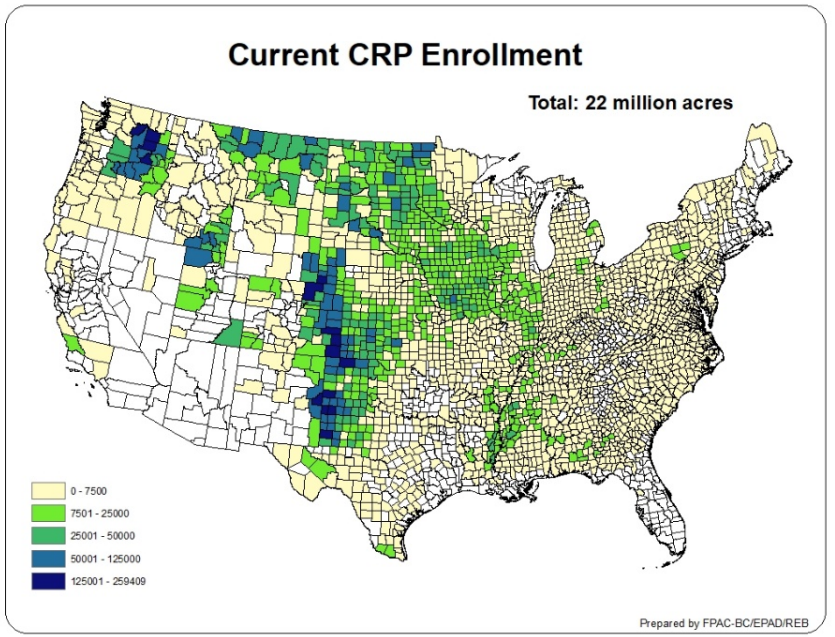
Source: ERS, Working Lands Conservation Contract Modifications: Patterns in Dropped Practices

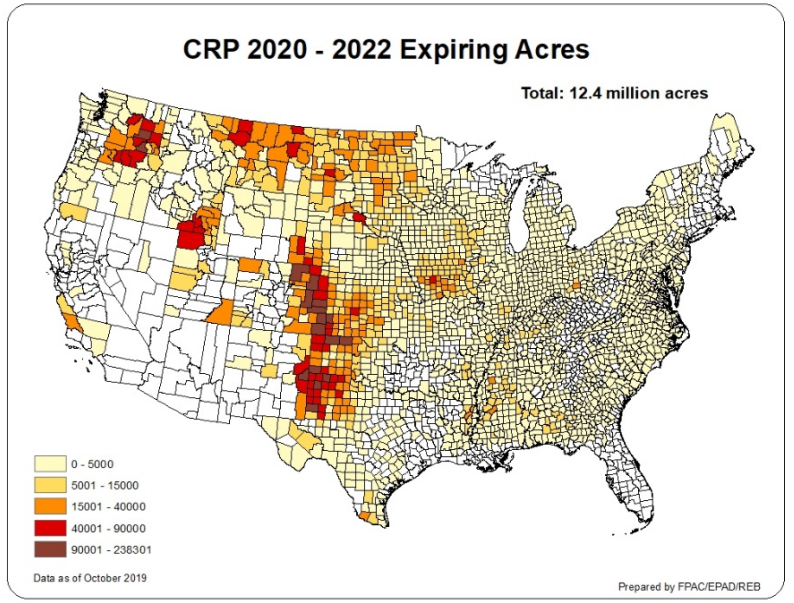
Current CRP Enrollment and Expirations

- Current CRP enrollment is at 22 million acres. The 2018 Farm Bill increased the cap to 27 million acres by 2023.
- Expiring CRP Acres
  - 5.36 million acres in FY 2020
  - 3.01 million acres in FY 2021
  - 4.01 million acres in FY 2022

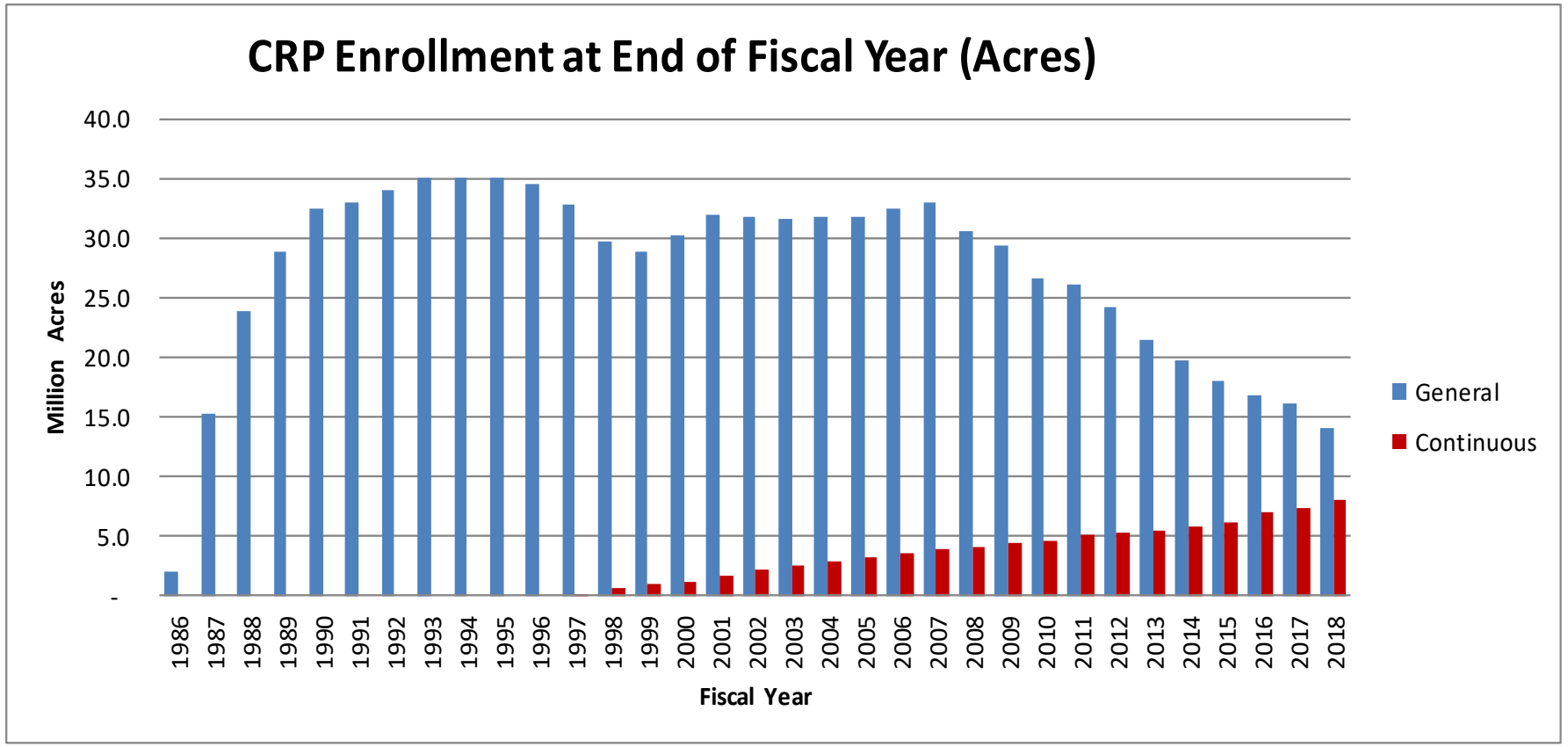


Source: USDA.





Continuous Enrollment Has Expanded Relative to General Enrollment



Source: USDA.

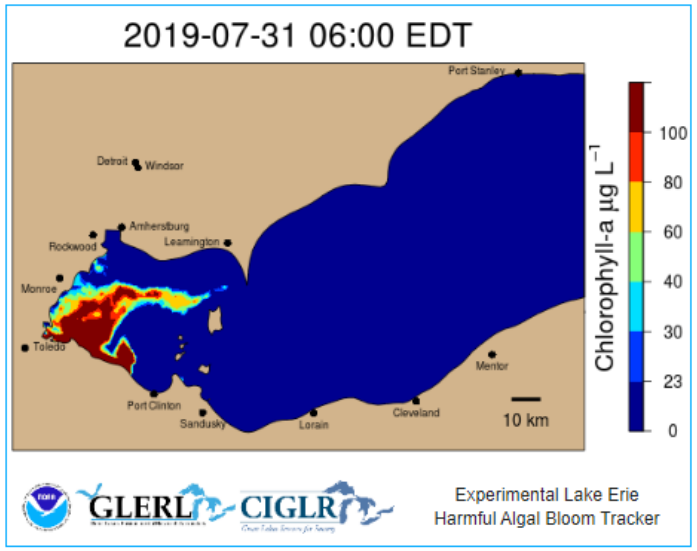
Outcomes from CRP investments:

- 34 million metric tons CO_2e stored
- Habitat for over 42 million ducks since 1992
- Over 9 billion tons of soil erosion reduced since 1986
- In 2017, CRP reduced Phosphorus reaching streams by over 100 million pounds, Nitrogen by over ½ billion pounds, and sediment by nearly 200 million tons

Source: USDA.

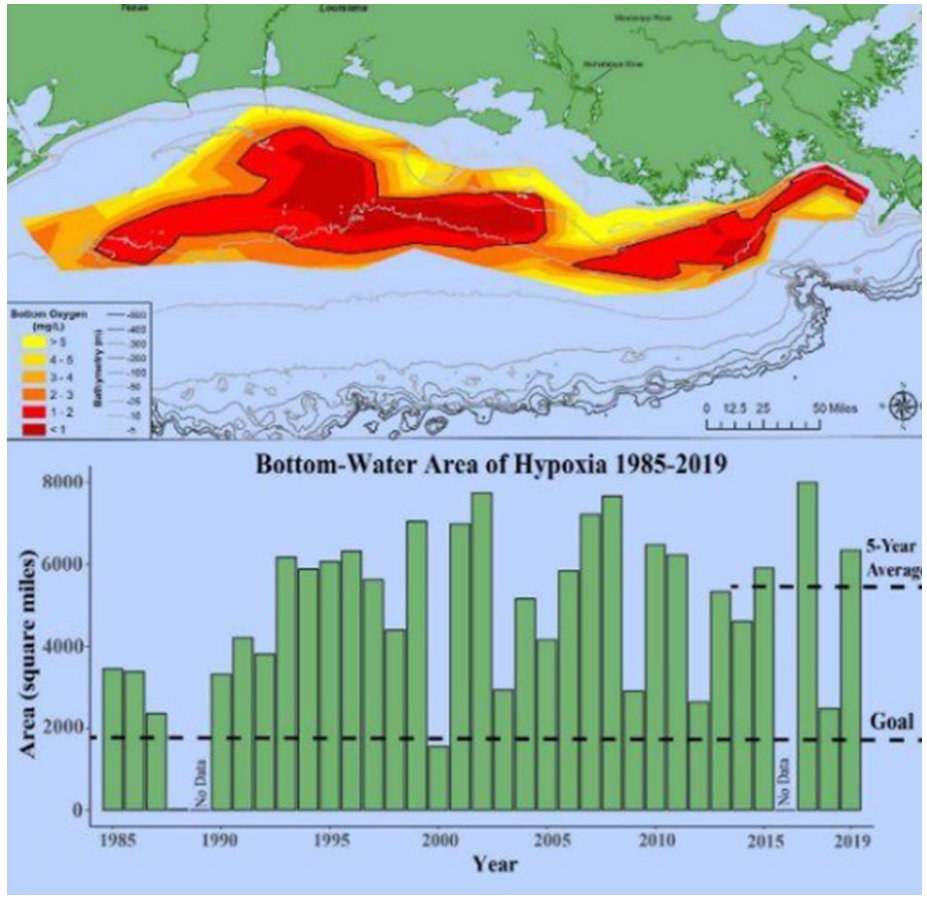
Despite these investments and improvements in efficiency, we still have externalities

Lake Erie Harmful Algal Bloom Tracker



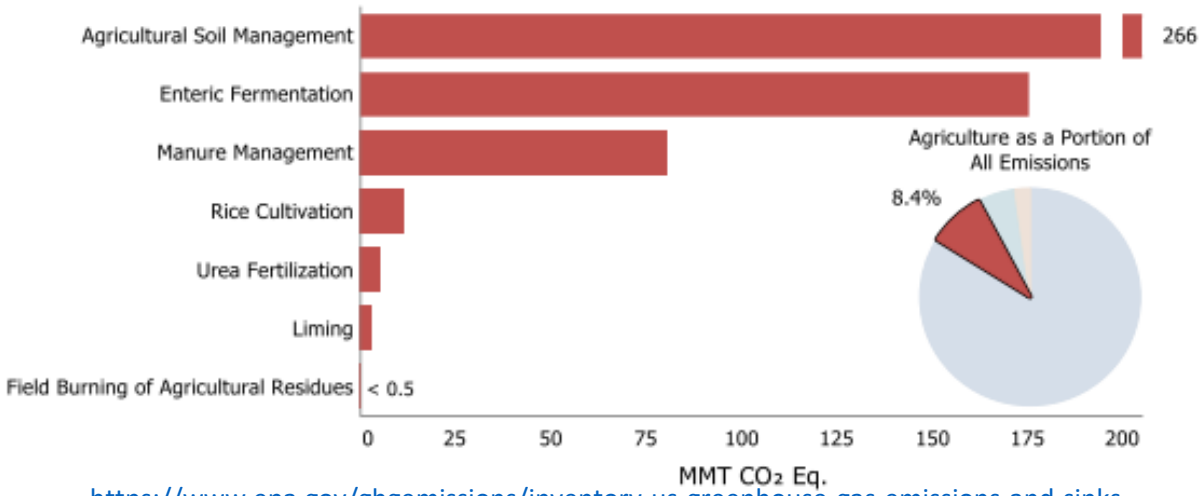
https://www.glerl.noaa.gov/res/HABs_and_Hypoxia/habTracker.html

MRB Hypoxic Zone



https://www.nola.com/news/article_98aed114-b492-11e9-b48d-2ba5b81fd692.html

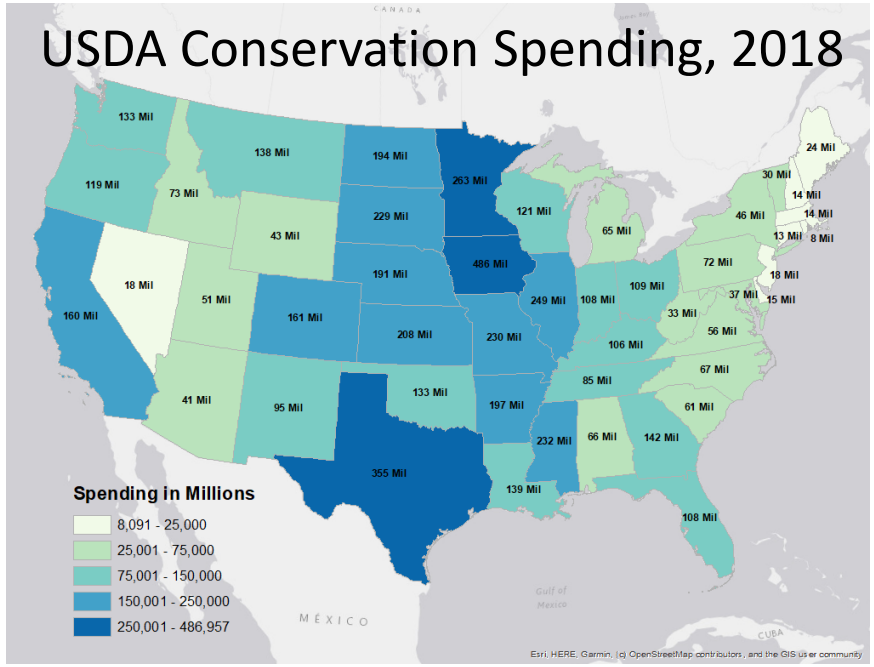
Figure 5-1: 2017 Agriculture Chapter Greenhouse Gas Emission Sources (MMT CO_2 Eq.)



https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks

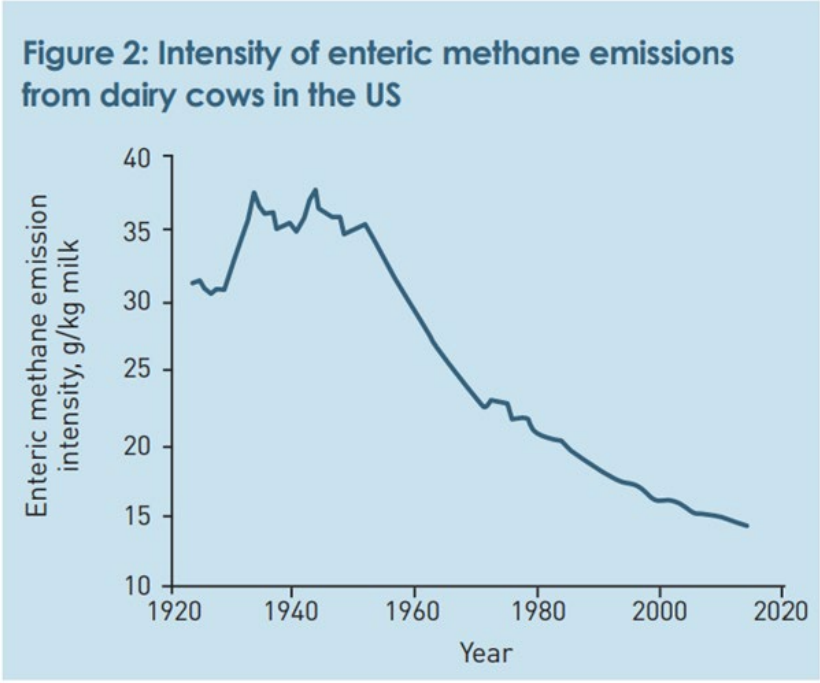
Summary: U.S. agriculture must continue to be productive, while addressing environmental challenges

USDA has a role in continuing to incentivize conservation adoption.



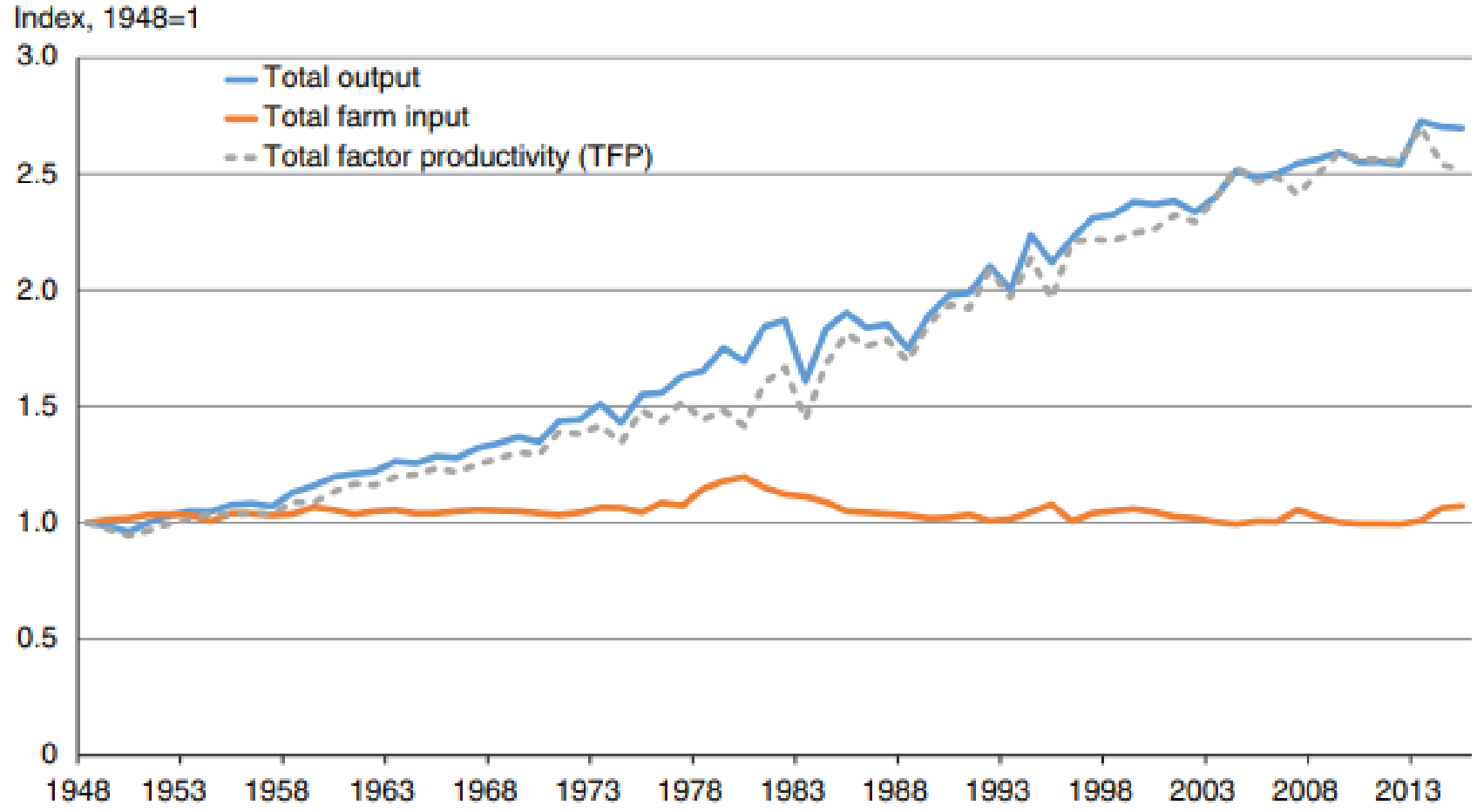
Source: NRCS RCA Reports

Thinking about this in an "intensity" context can help achieve productivity and environmental improvements.



Global Research Alliance: https://globalresearchalliance.org/wp-content/uploads/2015/11/USA-national-dairy-CH4.pdf

Continuing to innovate, improve efficiency, and enhance bottom lines will help meet demand and improve the environment

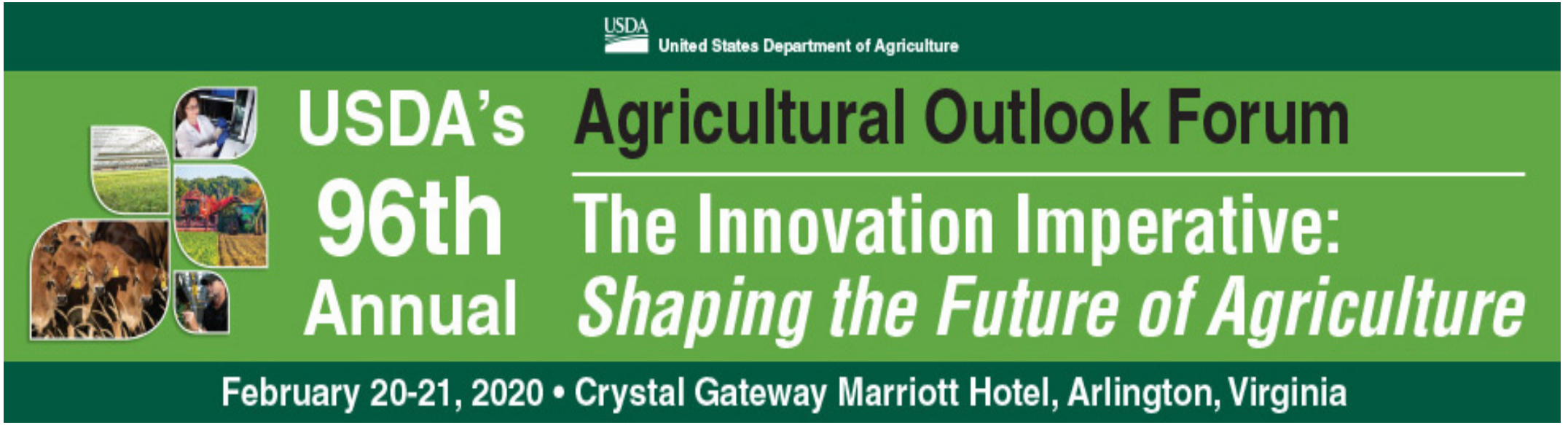


Source: USDA, Economic Research Service, "Agricultural Productivity in the U.S." series.

Total Factor Productivity grew 170% from 1948-2015. This trend must continue to meet global demand.

Total inputs only grew 7% during this time period. This efficiency is necessary to protect the environment.

Join us on February 20-21, 2020 for USDA's 96th annual Agricultural Outlook Forum



Registration is now open

https://www.usda.gov/oce/forum/