

# Managing Agricultural Land for Greenhouse Gas Mitigation within the United States

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Conference

*Session 8: Carbon and Greenhouse Gas*

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# Agenda

- **Basic Approach**
- **Crop Production Systems**
- **Manure Management Systems**
- **Land Retirement**
- **Summary Marginal Abatement Cost Curve (MACC)**

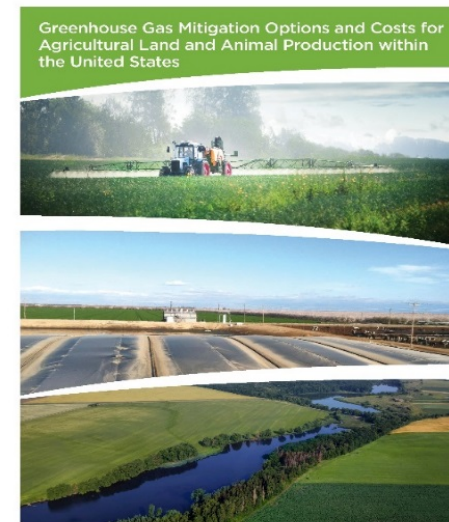
# Basic Approach

## 2013 report determined break-even prices for set of 20 potential farm-level GHG mitigation technologies and practices (T/P):

1. Representative farm-level costs of adoption of each T/P
2. Representative farm-level GHG mitigation that would result from adoption
3. Calculate the CO<sub>2</sub> prices that would make adoption a break-even action for a set of “representative” farms

## 2016 report developed MACC analysis:

1. Assess the applicability (i.e., potential adoption) of each T/P by USDA production region, commodity, and farm size
2. Develop a methodology that describes when potential adopters of each T/P decide to adopt
3. Aggregate the adoption decisions into MACCs for GHG mitigation



# Crop Production Systems



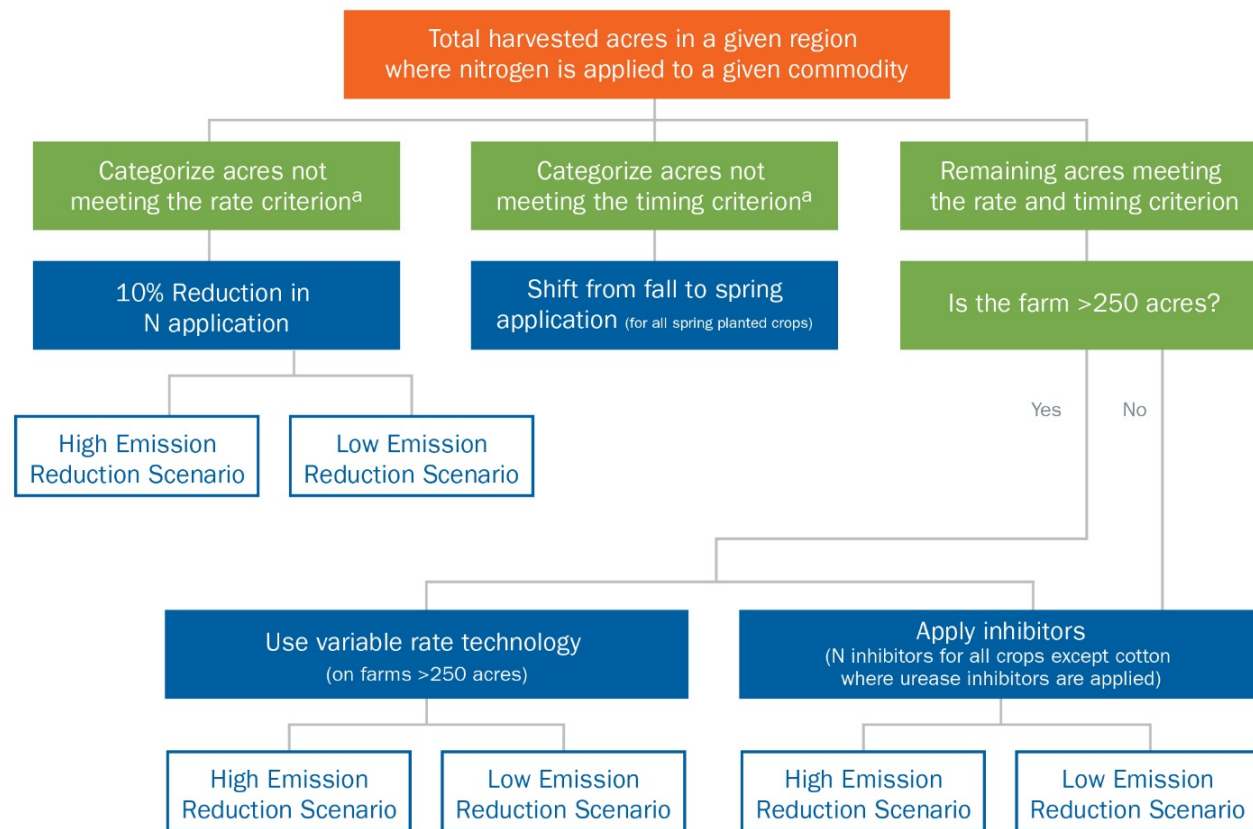
# GHG Mitigation Options

- Reduce Application of N Fertilizers (10%)
- Nitrification Inhibitors
- Fall to Spring N Applications
- Variable Rate Technology
- Reduced Tillage (Three options)
  - ❑ Conventional to No-till
  - ❑ Conventional to Reduced Till
  - ❑ Reduced to No-till



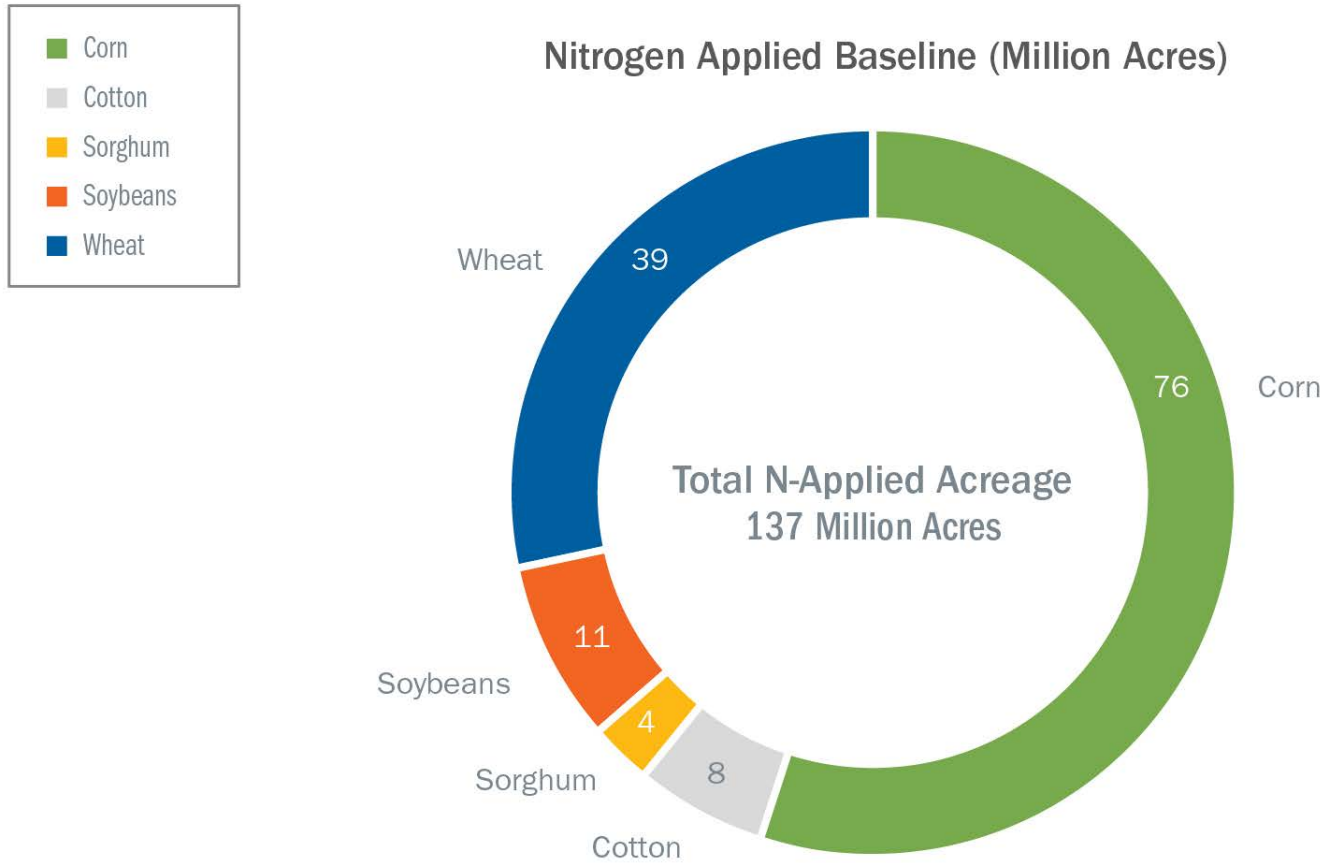
# Assumptions and Applicability Flow Diagram

- Starting Point: Acres where N is applied
- Assume that options are not applicable for farms smaller than 100 acres
- Assume that acres not meeting the timing criteria were meeting the rate criteria and visa versa (i.e., the two are mutually exclusive)

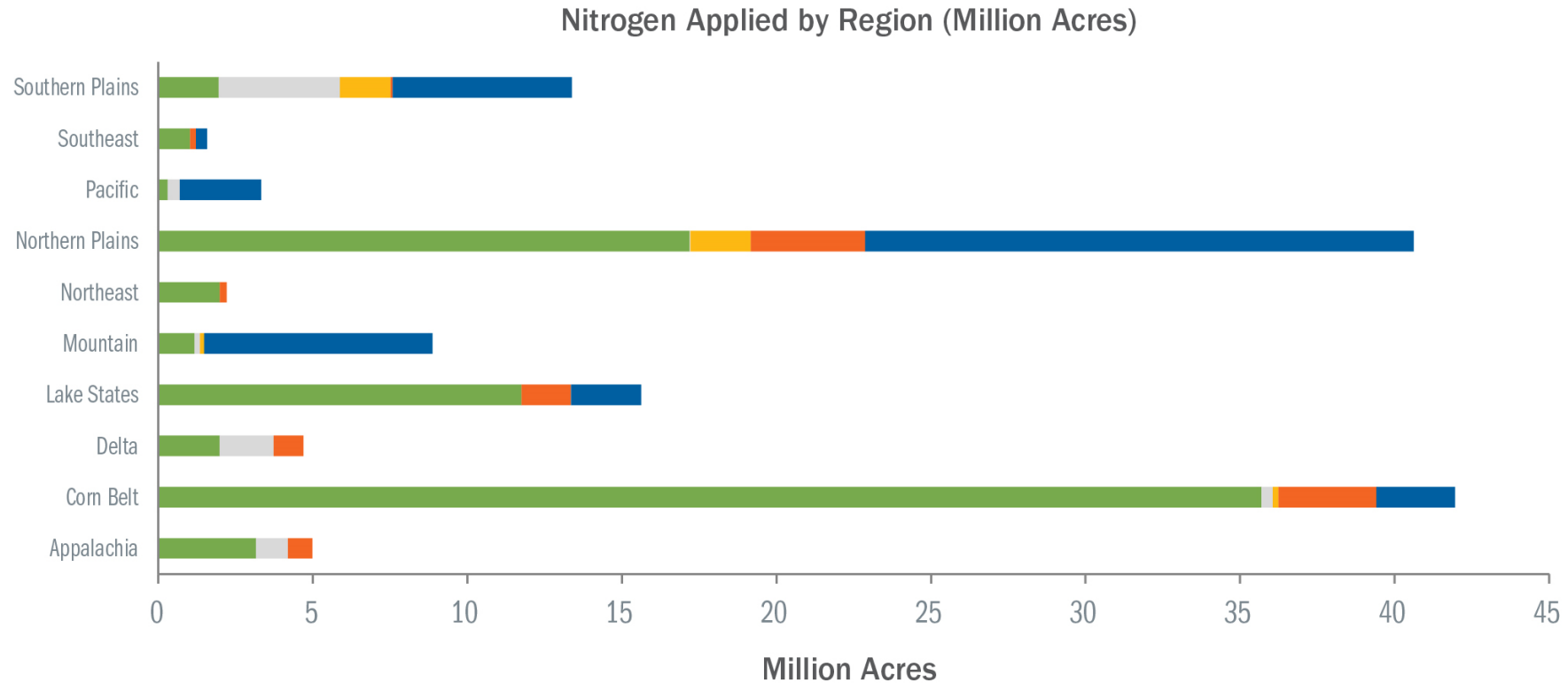


<sup>1</sup> Based on Ribaud et al. 2011 criteria

# Acres Treated with Nitrogen by Crop

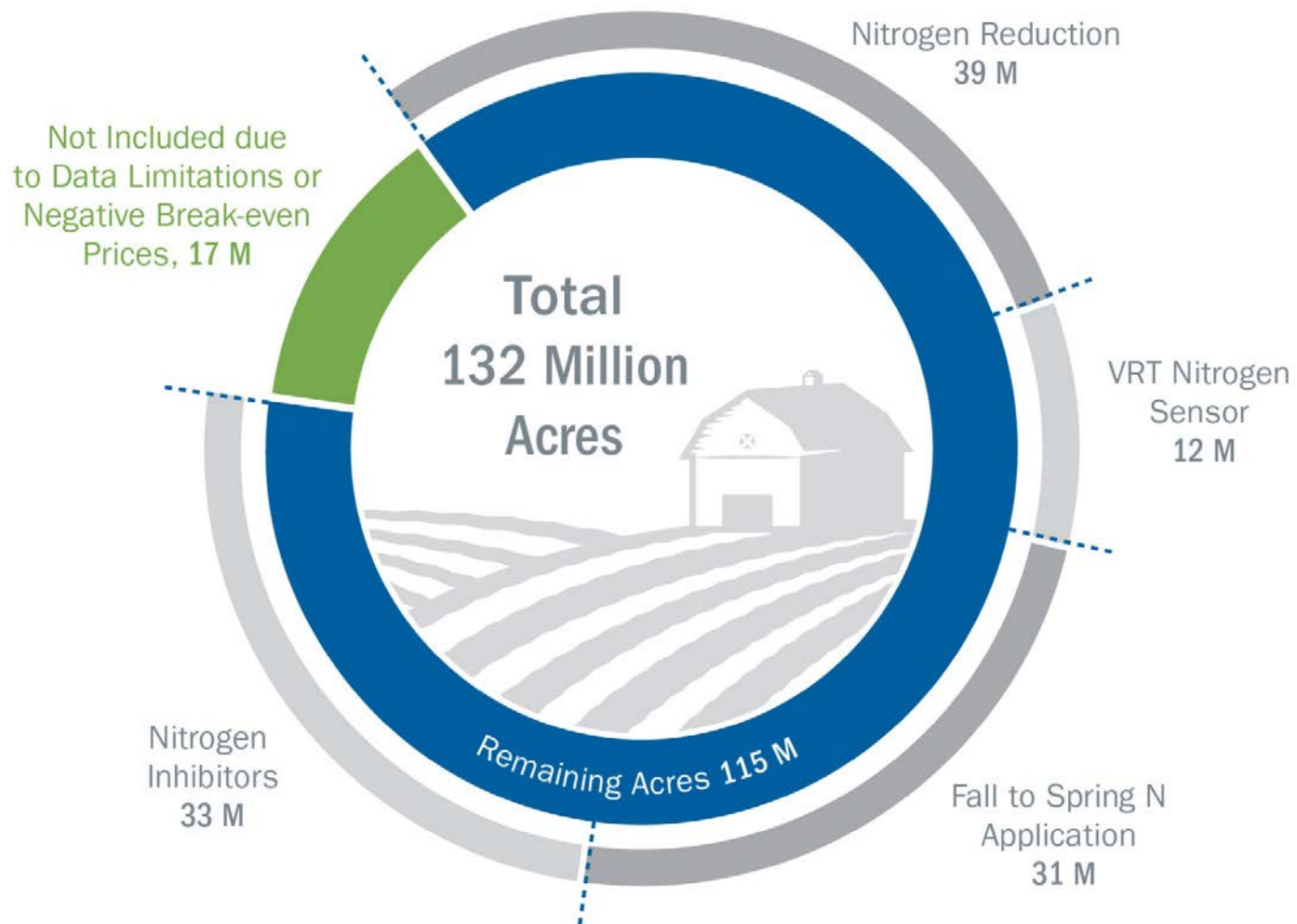


# Acres Treated with Nitrogen by Crop and Region

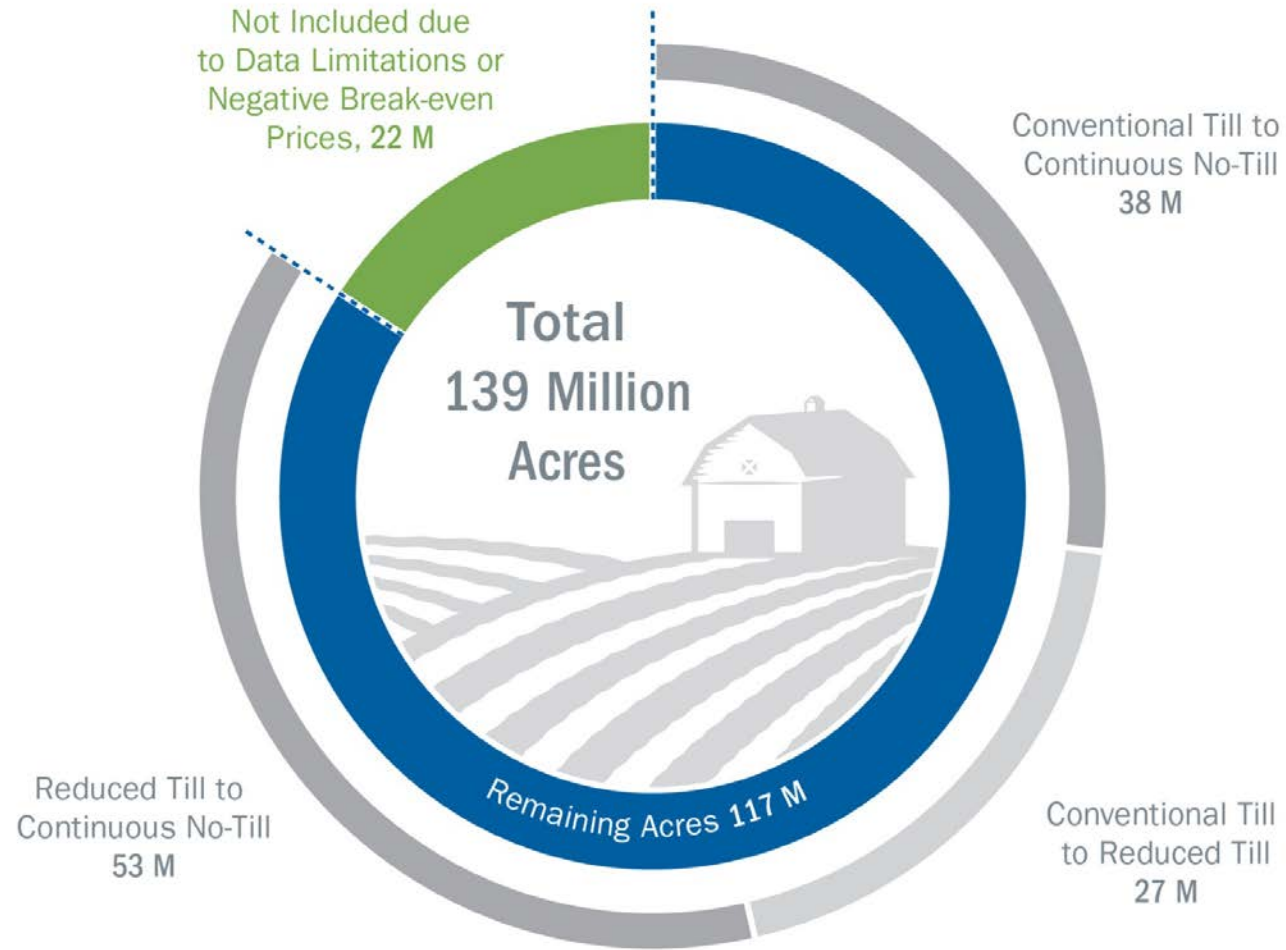




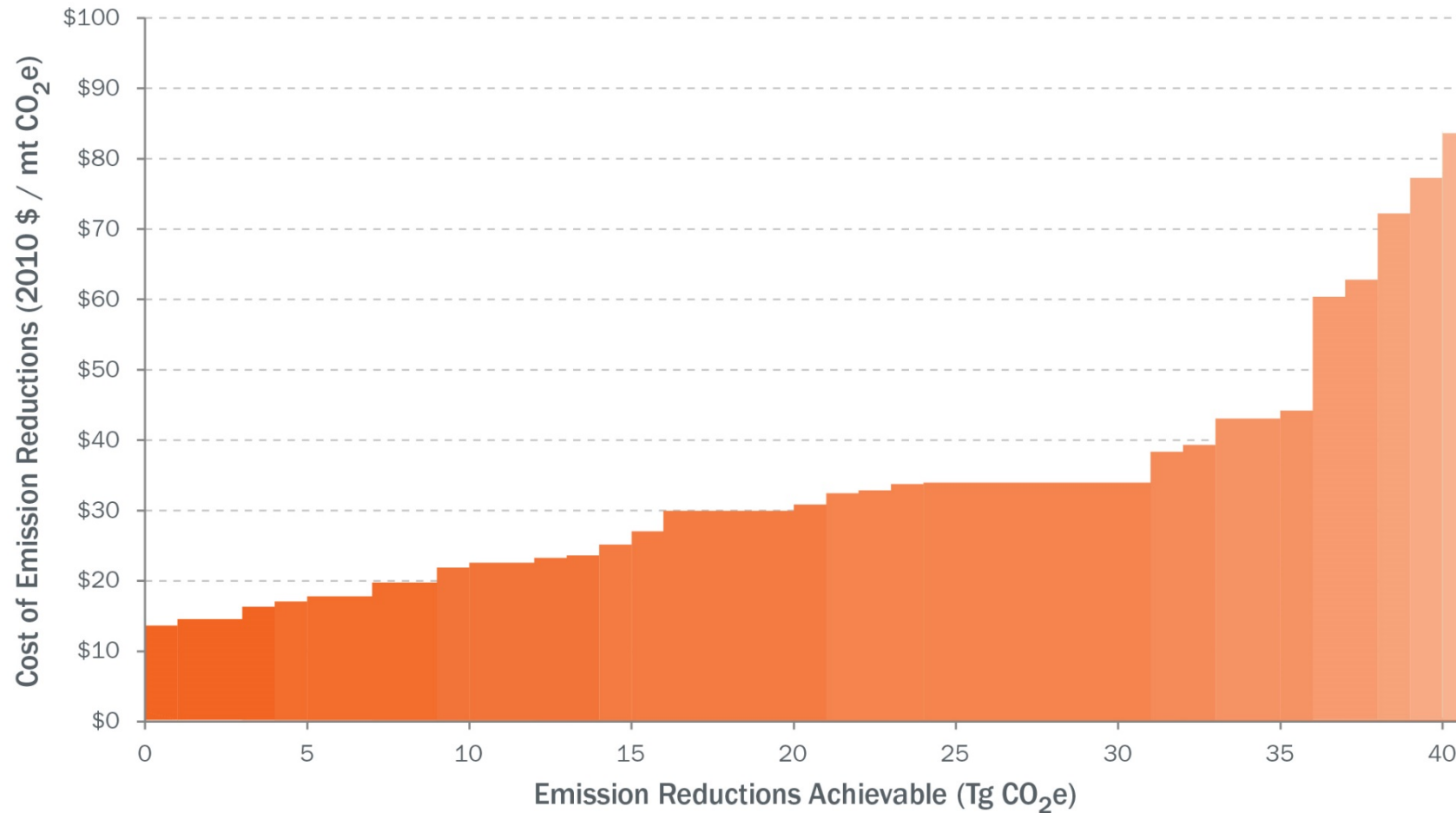
# Total Eligible Acres for the MACC (Million Acres)



# Total Eligible Acres for Tillage Intensity Reduction (Million Acres)



# MAC Curve for Nutrient and Tillage Management (Below \$100 per mt CO<sub>2</sub>e)



# Top Crop Production GHG Mitigation Sources at \$30 per mt CO<sub>2</sub>e by Region, Mitigation Option, and Farm Type

Region	Share of Total Mitigation	Mitigation Option	Share of Total Mitigation	Farm Type	Share of Total Mitigation
Northern Plains	30%	Reduced Till to Continuous No-Till	56%	Corn	77%
Lake States	28%	Conventional Till to Continuous No-Till	36%	Wheat	13%
Corn Belt	20%	Conventional Till to Reduced Till	3%	Soybeans	7%
Delta	8%	Nitrogen Reduction	3%	Sorghum	3%

# Manure Management Systems



# GHG Mitigation Options

- Anaerobic Digesters (four options)
  - Covered Lagoon with Electricity Generation
  - Covered Lagoon with Flare
  - Complete Mix with Electricity Generation
  - Plug Flow with Electricity Generation
- Cover Existing Tank, Pond, or Lagoon
- Solids Separation
- Nitrification/Denitrification System



# Applicability of Manure Mitigation Options

Baseline Manure Management Practice	Mitigation Option						
	Covered Lagoon Digester with EG <sup>b</sup>	Covered Lagoon Digester with Flaring	Complete Mix Digester with EG	Plug Flow Digester with EG	Covering Existing Tank, Pond, or Lagoon	Solids Separator	Nitrification / Denitrification System <sup>c</sup>
Dairy Anaerobic Lagoon	●	●	●		●	●	
Swine Anaerobic Lagoon	●	●	●		●	● <sup>d</sup>	●
Dairy Deep Pit	●	●	●				
Swine Deep Pit	●	●	●				
Dairy Liquid/Slurry	●	●	●	●	●		
Swine Liquid/Slurry	●	●	●	●	●		

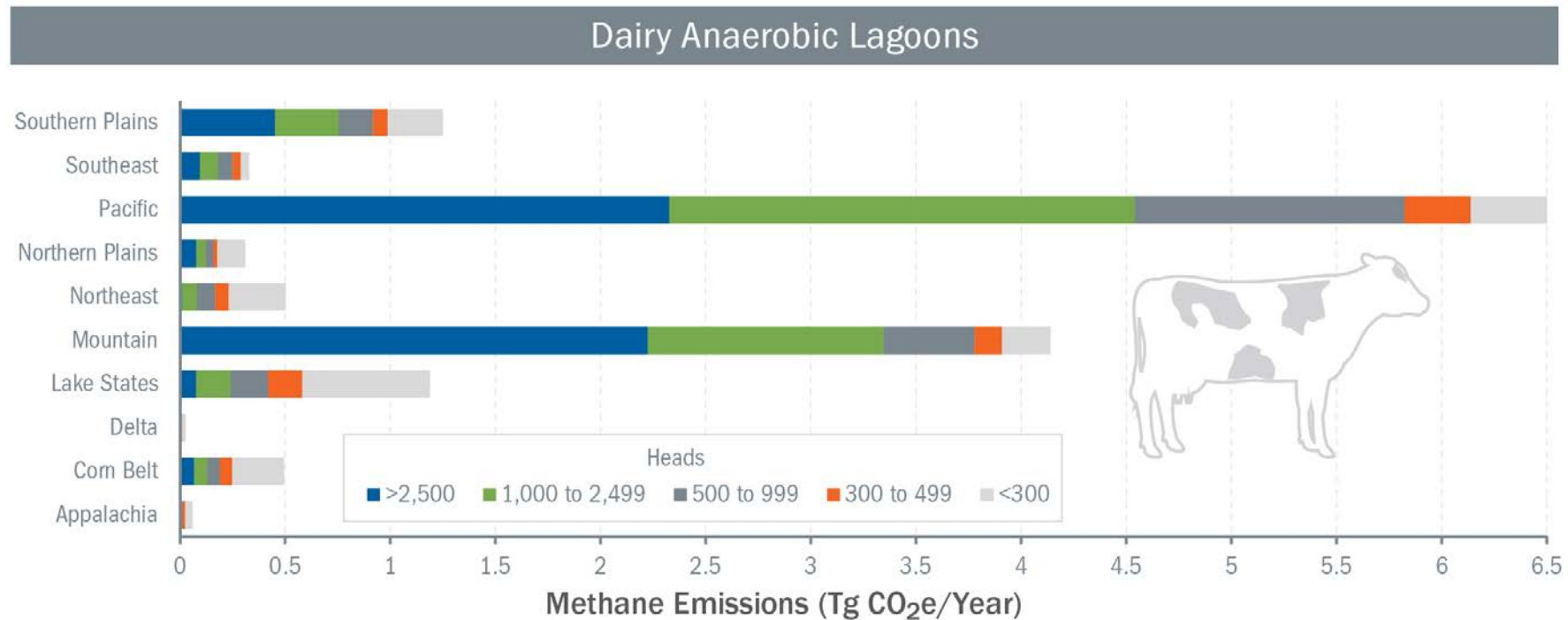
<sup>b</sup> Electricity Generation (EG)

<sup>c</sup> The nitrification/denitrification technology reflects a demonstration project in use on a 5,000+ hog feeder-to-finish operation in North Carolina.

<sup>d</sup> Solids separator mitigation option for swine farms is limited to those operations that adopt the nitrification/denitrification system.

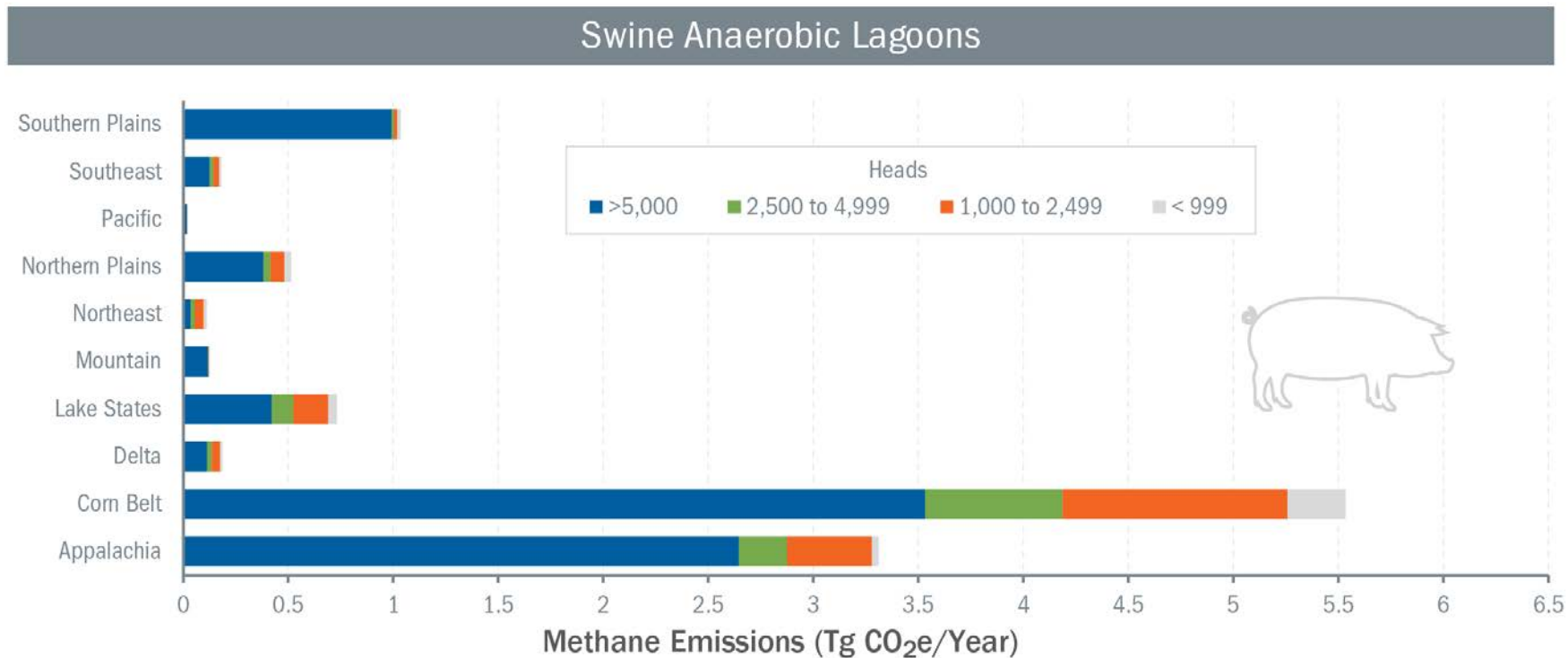


# Distribution of GHG Emissions Across Baseline Management Practices and Farm Sizes - Dairy Anaerobic Lagoons

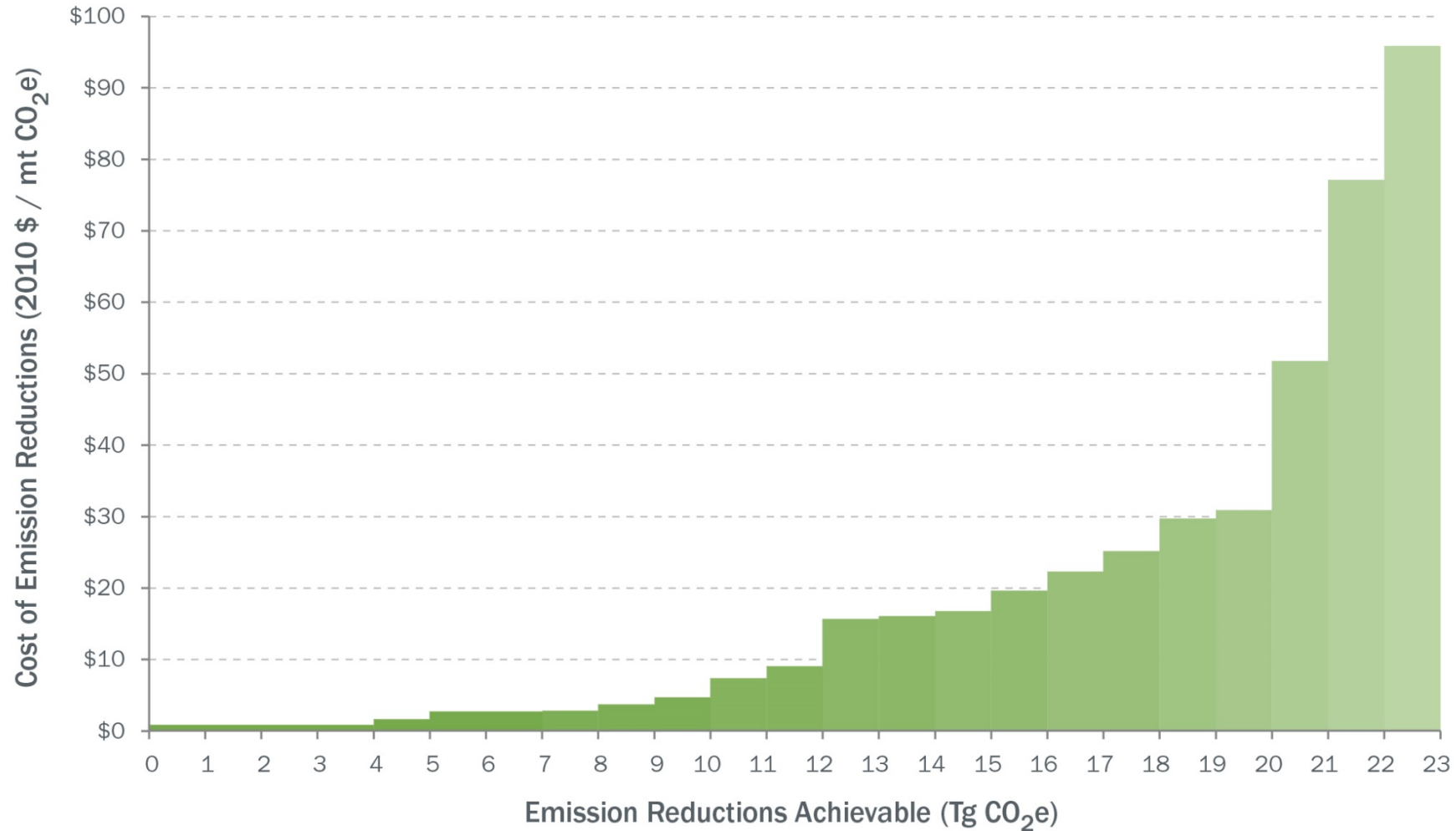




# Distribution of GHG Emissions Across Baseline Management Practices and Farm Sizes – Swine Anaerobic Lagoons



# MAC Curve for Manure Management Systems (Below \$100 per mt CO<sub>2</sub>e)



# Top Livestock Sector GHG Mitigation Sources at \$30 per mt CO<sub>2</sub>e by Region, Mitigation Option, and Farm Type

Region	Share of Total Mitigation	Mitigation Option	Share of Total Mitigation	Farm Type	Share of Total Mitigation
Corn Belt	26%	Complete mix digester with electricity generation (EG)	51%	Swine (> 5,000 head)	50%
Pacific	24%	Covered lagoon digester with EG or flaring	21%	Dairy (> 2,500 head)	22%
Appalachia	14%	Cover existing tank, pond, and lagoon with flaring	16%	Dairy (1,000–2,499 head)	17%
Mountain	14%	Solids separation	9%	Dairy (500–999 head)	6%

# Land Retirement Systems



# GHG Mitigation Options

- Retire Organic Soils and Establish Grassy Conservation Cover
- Retire Marginal Soils
  - Establish Grassy Conservation Cover
  - Establish Windbreaks
  - Restore Riparian Forest Buffers
  - Restore Wetlands (Grassy and Forested)

Organic Soils in the United States



## Potentially Available Land

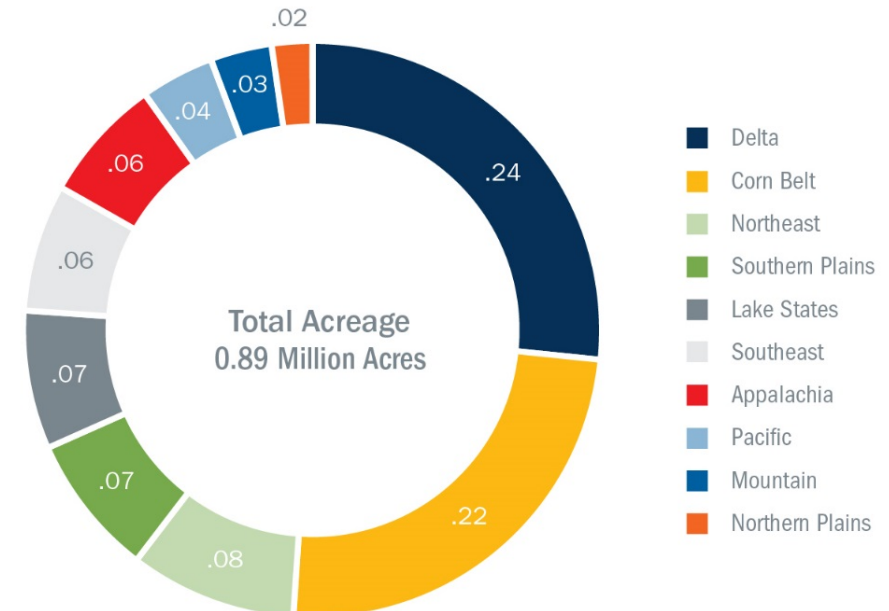
- **Conservation Reserve Program (CRP) will have 24 million acres enrolled in 2017**
- **CRP at peak enrollment was 36.8 million acres**
- **Taking peak CRP enrollment as society's demonstrated maximum willingness to retire cropland for conservation purposes, we cap new land retirements at 12.5 million acres (i.e.,  $24 + 12.5 = 36.5$ ). These acres are allocated to:**
  - ❑ Retire Organic Soils to Establish Grassy Conservation Cover (~1.6 million acres)
  - ❑ Retire Marginal Soils:
    - Restore Riparian Forest Buffers (~0.9 million acres)
    - Establish Windbreaks (2.2 million acres)
    - Restore Wetlands (Using Wetlands Reserve Program (WRP) enrollment data, assume 2.5 million acres are available to restore wetlands, which nearly doubles enrollment (2.6 million acres as of 2012))
    - Establish Grassy Conservation Cover (~5.3 million acres)

# Potential Adoption for Retiring Marginal Soils and Establishing Riparian Forest Buffers

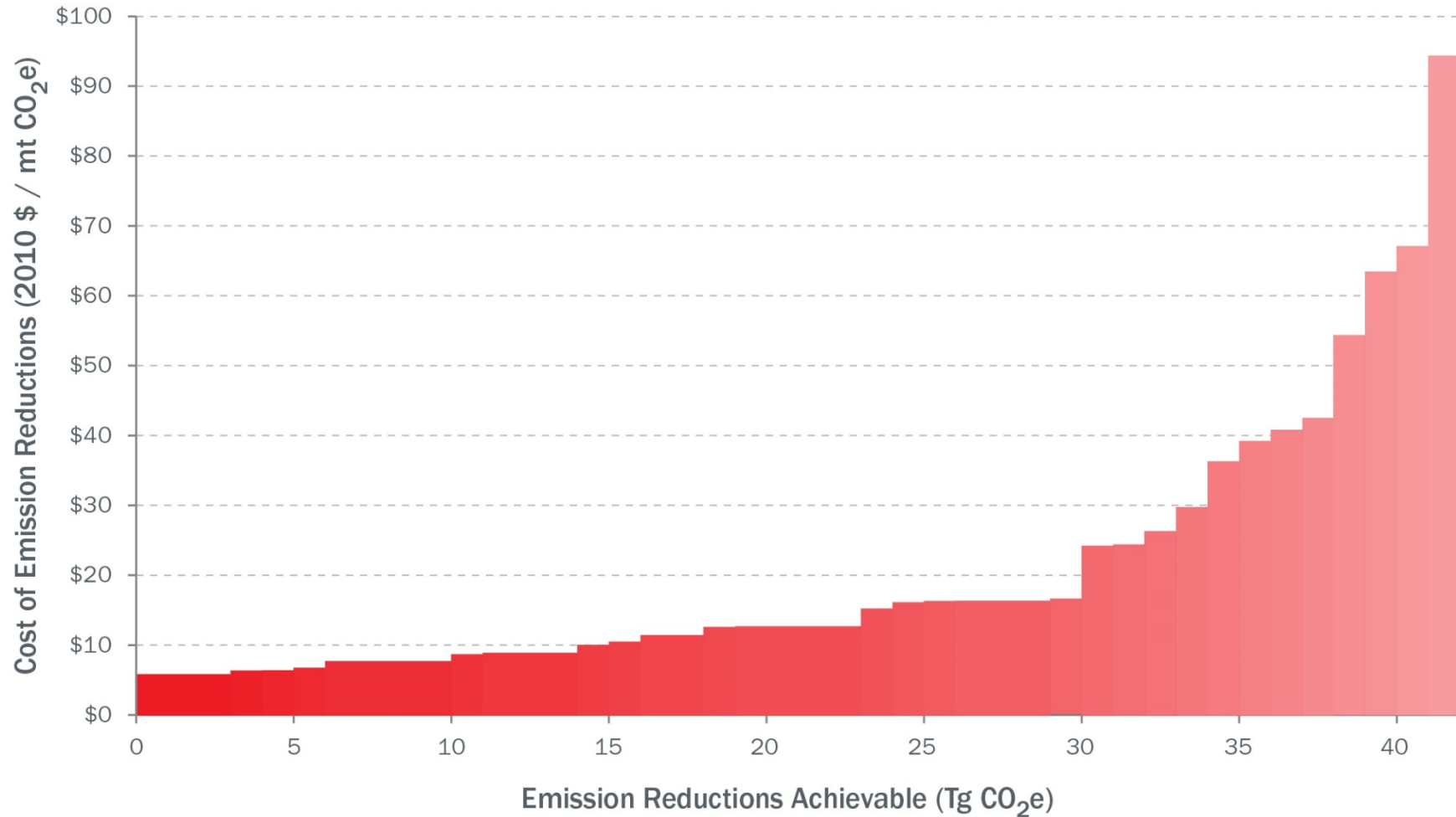
USDA Farm Production Region	Potential Acres for Restoring Riparian Buffers
Delta	237,125
Corn Belt	217,924
Northeast	83,031
Southern Plains	70,716
Lake States	69,196
Southeast	63,506
Appalachia	61,862
Pacific	36,566
Mountain	30,696
Northern Plains	20,286
<b>Total</b>	<b>890,909</b>

Estimated 890,909 acres available for restoration/establishment. Based on assumption that all river miles adjacent to farmland (210,000 miles) could improve riparian buffer with 35 foot buffer on one bank.

Potential Acres for Restoring Riparian Buffers (acres) (in millions)



# MAC Curve for Land Retirement (Below \$100 per mt CO<sub>2</sub>e)





# Top Land Retirement GHG Mitigation Sources at \$30 per mt CO<sub>2</sub>e by Region and Mitigation Option

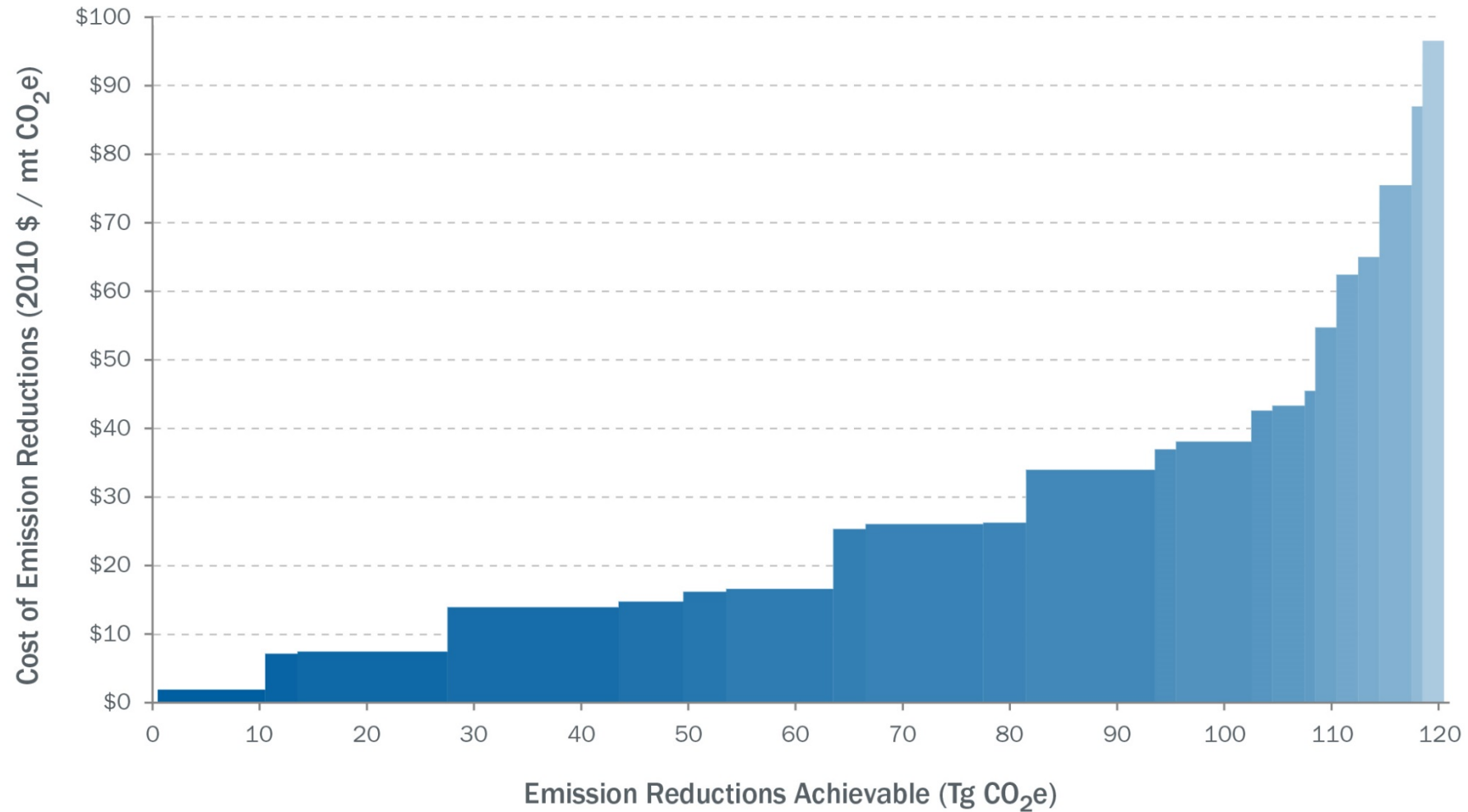
Region	Share of Total Mitigation
Lake States	25%
Southeast	23%
Corn Belt	15%
Northern Plains	8%

Mitigation Option	Share of Total Mitigation
Retire Organic Soils	67%
Restore Forested Wetlands	20%
Retire Marginal Soils	8%
Establish Windbreaks/Shelterbelts	3%

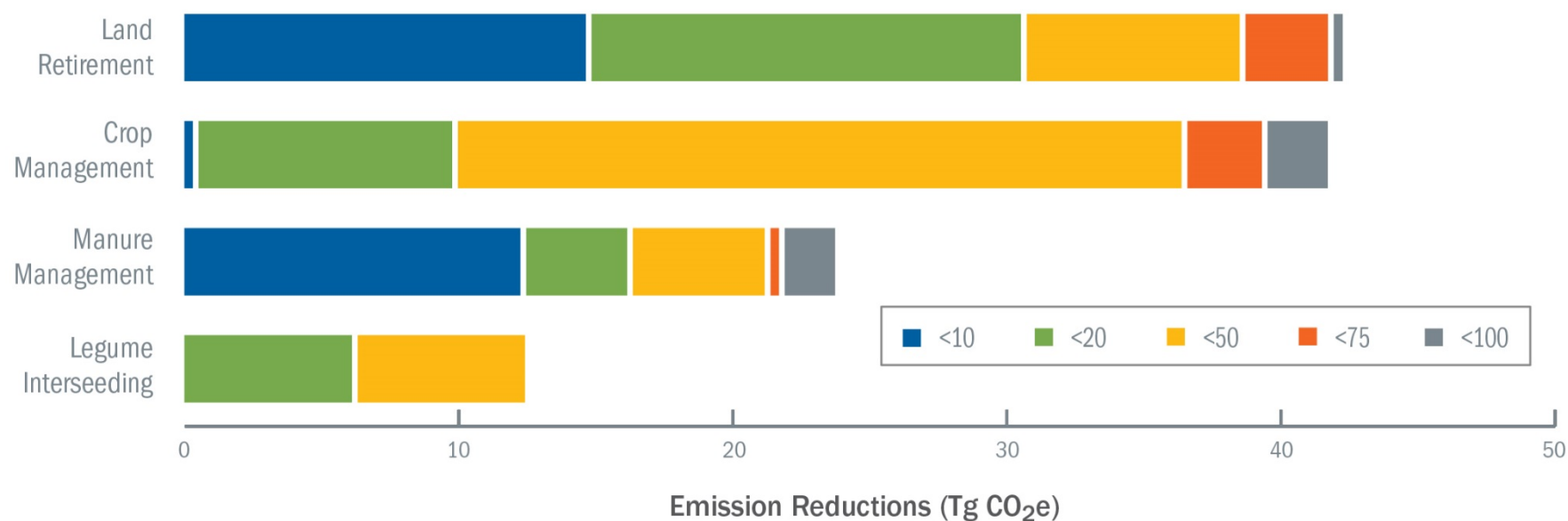
## Summary of MAC Curves



# National MAC Curve for all Mitigation Options (Below \$100 per mt CO<sub>2</sub>e)



# Potential Mitigation by Agricultural Source Area and CO<sub>2</sub> Price Level (\$ per mt CO<sub>2</sub>e)



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***Managing Agricultural Land  
for Greenhouse Gas  
Mitigation within the United  
States (2016) paper***

Available at:

[http://www.usda.gov/oce/climate\\_change/White\\_Paper\\_WEB71816.pdf](http://www.usda.gov/oce/climate_change/White_Paper_WEB71816.pdf)