THE FERTILIZER INSTITUTE

Environmental & Economic Benefits of Precision Ag Linked to 4R Nutrient Stewardship

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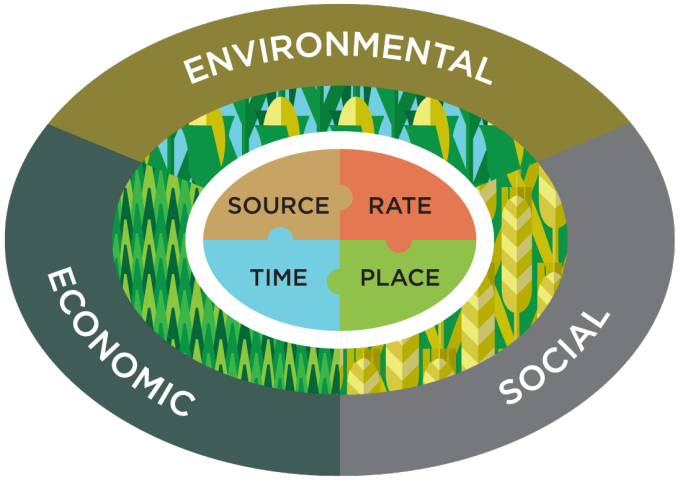
4R Nutrient Stewardship

- **Improve agricultural production while contributing to social well being and minimizing environmental impacts (benefits water and air quality)**



RIGHT SOURCE
Matches fertilizer type to crop needs.

RIGHT RATE
Matches amount of fertilizer to crop needs.

RIGHT TIME
Makes nutrients available when crops need them.

RIGHT PLACE
Keeps nutrients where crops can use them.

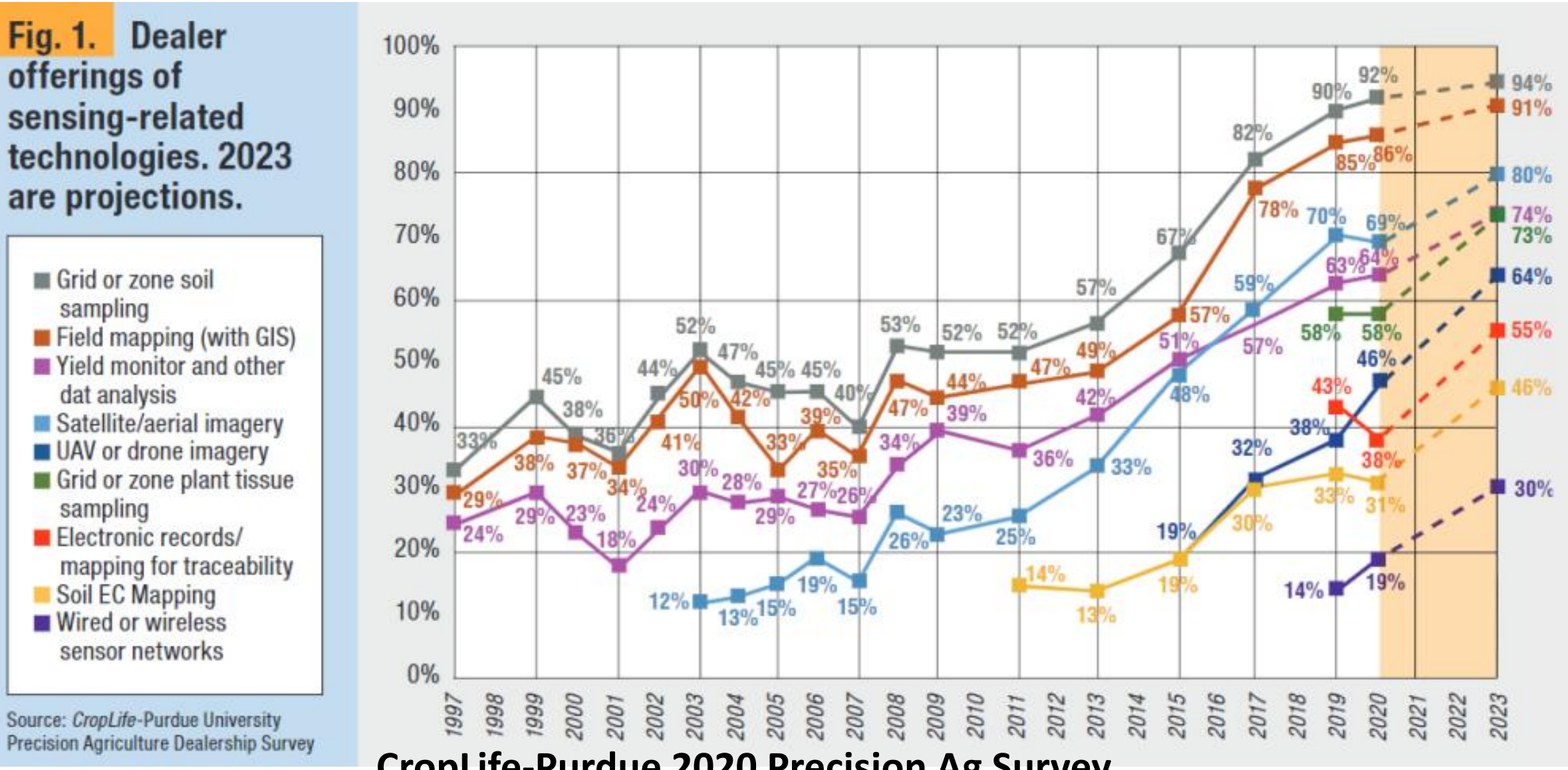
4R on the Farm

- Spring soil sample, 2.5 acre grid
- Spring apply stabilized N, 70% side dressed in-season at V10
- VRT apply P & K per soil maps
- All equipment has GPS, yield monitors, VRT & auto shutoff
- Determine N rate using yield & soils data integrated with in-season assessment

- Of farm research trials to test new products & practices
- 80% of acres are no-till
- Buffer strips, dry dams and grassed waterways in place as needed

Increase in Service Offerings

Fig. 1. Dealer offerings of sensing-related technologies. 2023 are projections.



Source: *CropLife*-Purdue University Precision Agriculture Dealership Survey

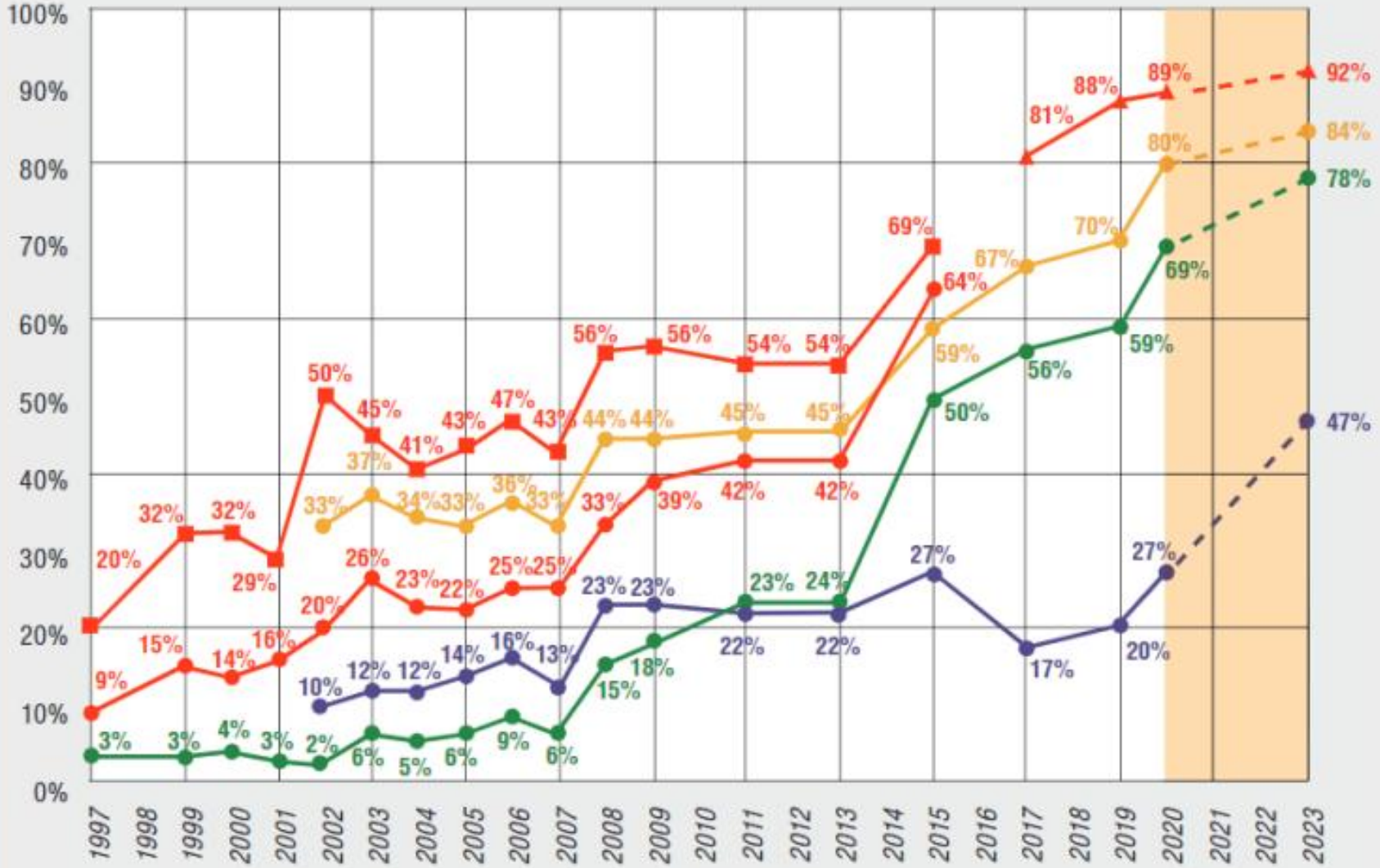
CropLife-Purdue 2020 Precision Ag Survey

Increase in Service Offerings

Fig. 2. Dealer offerings of variable-rate technologies. 2023 are projections.

- ▲ VRT Fertilizer Application
- ■ VRT Fertilizer, Single Nutrient
- ● VRT Fertilizer, Multiple Nutrient
- ● VRT lime application
- ● VRT pesticide application
- ● VRT seeding prescriptions

Source: *CropLife*-Purdue University Precision Agriculture Dealership Survey



CropLife-Purdue 2020 Precision Ag Survey

Case Study Data Collection

- 3 - 4 years of data at whole farm average level
  - OR 4 individual fields over 3 - 4 years
- Cost & equipment associated w/ fertilizer application
- Equipment cost, time & fuel use based on national databases
- Fertilizer price based on reported prices to USDA

Non-irrigated Corn-Soybean – Eastern US

Practice Level	Right Source	Right Rate	Right Time	Right Place
Basic - adopted by approximately 50% of growers	• Guaranteed or book value for all sources applied • Urea, UAN, Anhydrous Ammonia, Manure	• Rate based on evidence recognized by regional soil fertility extension • Properly accounting for legume & Manure N	• Spring; not on frozen soil • Apply manure according to a manure management plan	• Broadcast and incorporated, injected or subsurface band • **If broadcasted Urea accompanied by an inhibitor** • UAN w/herbicide no more than 40 Lbs
Intermediate - adopted by approximately 20% of growers	• Guaranteed or known analysis for all sources applied; **with nitrification inhibitor or controlled release if preplant;** with **urease inhibitor for urea/UAN surface applied sidedress**	• Rate based on evidence recognized by regional soil fertility extension, including results of local adaptive management research. • Manure analysis required to determine rate	• Some or all applied nitrogen in season or if pre-plant used with **NI or polymer coated Urea**	• Broadcast and incorporated, injected or subsurface band, **surface application only for sidedress urea with UI or dribbled UAN**
Advanced - adopted by approximately 5% of growers	• Guaranteed or known analysis; **with nitrification inhibitor or controlled release if preplant; with urease inhibitor for urea/UAN sidedress**	• Rate based on evidence recognized by regional soil fertility extension, or results of **local adaptive management research**, AND, in addition, addressing within-field and weather-specific variability using tools such as crop sensors, PSNT, models that allow adjustment of in-season N rates	• Some or all N applied in-season	• Broadcast and incorporated, injected or subsurface band, **surface application only for sidedress urea with UI or dribbled UAN**

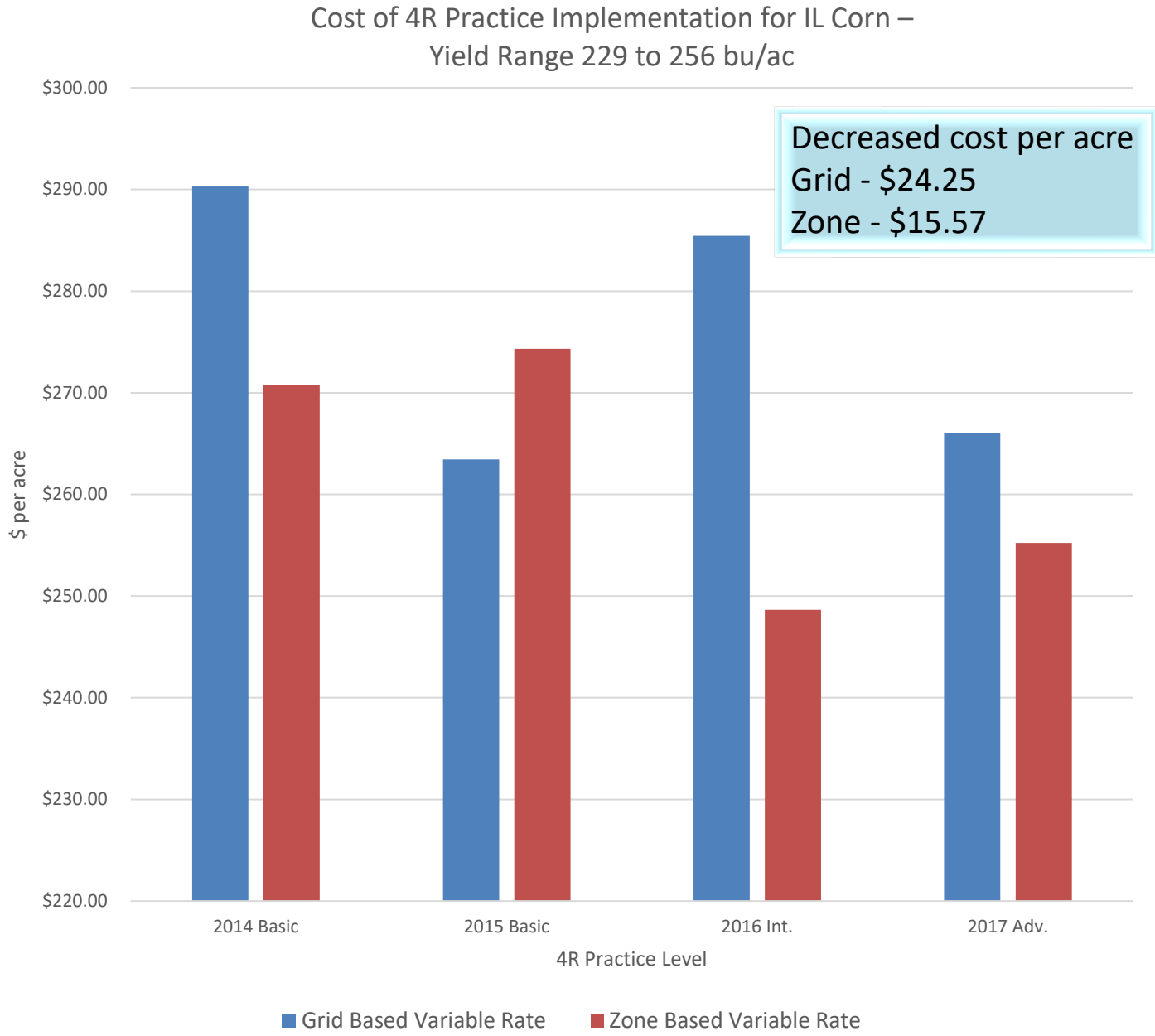
Field to Market – GHG Assessment

- **Quantification Components**
  - Land Resource Region (Climate, Geography, Soil)
  - Surface Soil Texture
  - Nitrogen Application Rate
  - Level of 4R Management
    - Basic, Intermediate, or Advanced

Illinois 4R, no-till

All Fields: Fall variable rate application of MAP and potash based on grid soil sampling and yield data; Variable rate seeding based on zones and incorporating use of software for in-season decision; auto guidance in use

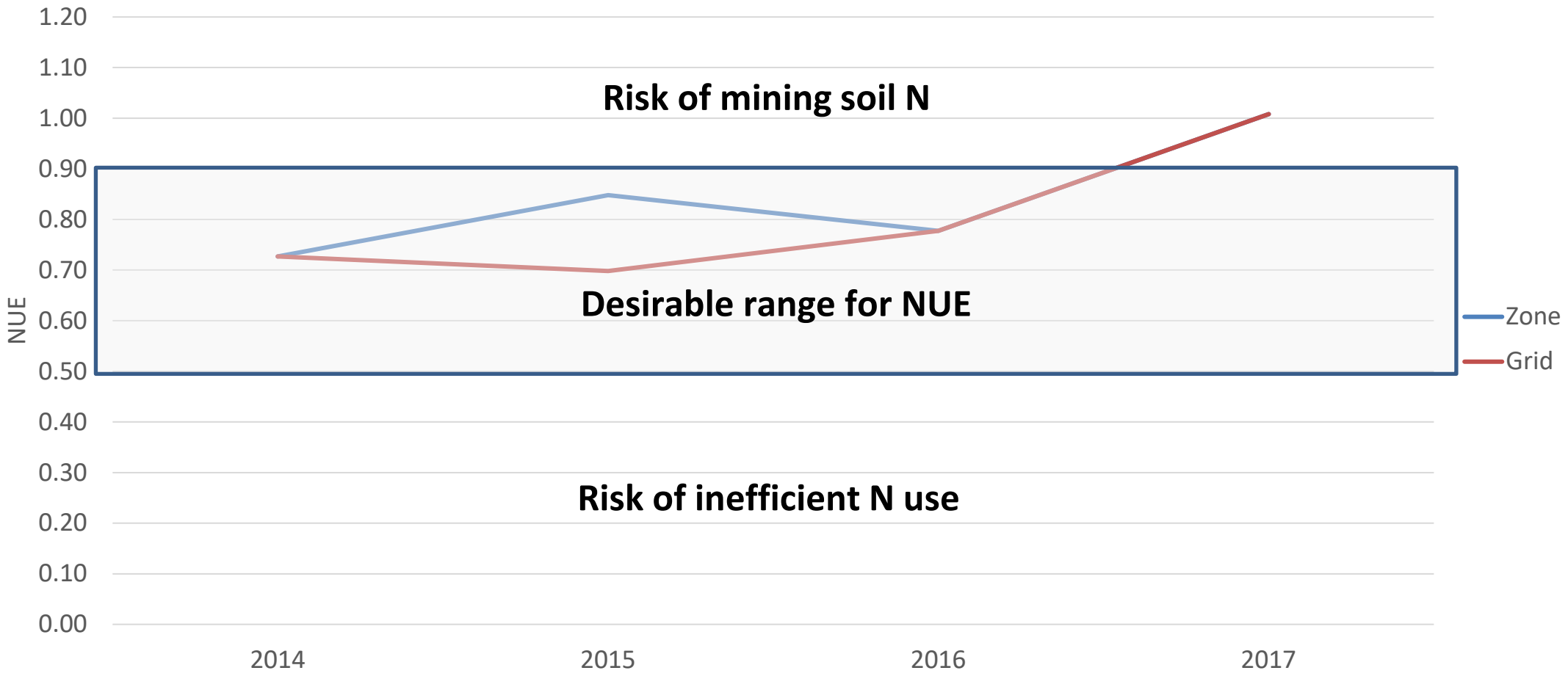
- Basic: spring pre-plant anhydrous ammonia w/ inhibitor, liquid starter w/ seed, early post-plant w/ herbicide, liquid N side-dress with Y-drop
- Intermediate: Liquid starter w/ seed, early post-plant w/ herbicide, side-dress anhydrous ammonia with inhibitor
- Advanced: Liquid starter w/ seed, early post-plant w/ herbicide, side-dress anhydrous ammonia w/ inhibitor, liquid side-dress w/ Y-drop (V10)



Environmental Metrics– IL Corn

	2014	2015	2016	2017
4R Practice Level	Basic	Basic	Intermediate	Advanced
Corn Grain Yield (bu/ac)	229	220	246	256
N Application Rate (lbs/ac)	253	208	253	204
Nitrogen Use Efficiency (lb N applied/bu corn grain)	1.11	0.95	1.03	0.80
N Balance (lb N applied – lb N harvested)	69.5	31.9	56.6	-1.14
CO2e Emissions per bu	9.4	8.43	8.17	6.14
Percent reduction	-	10.3	13.1	34.7

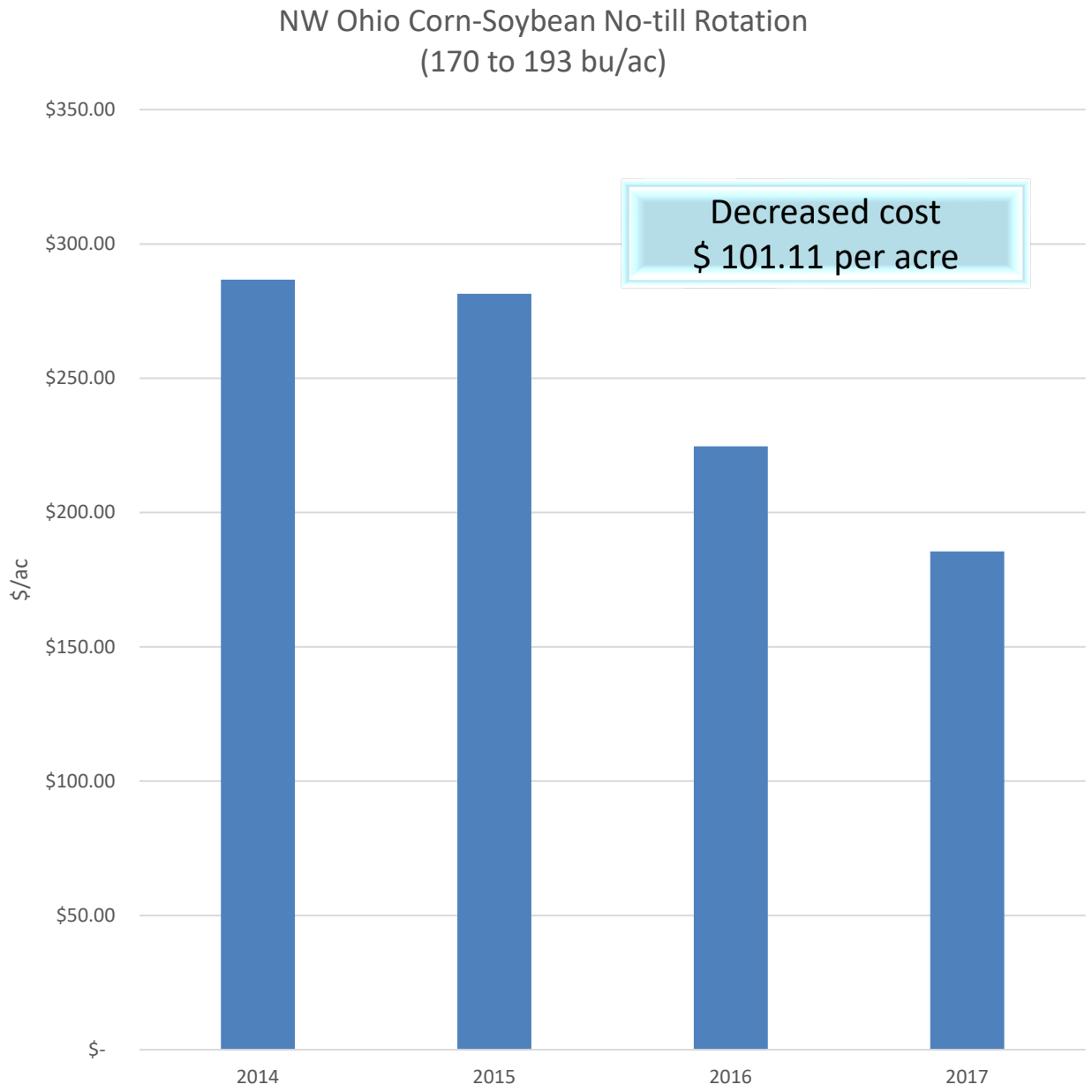
NUE (N removed / N applied)



International Nitrogen Expert Panel Recommendations

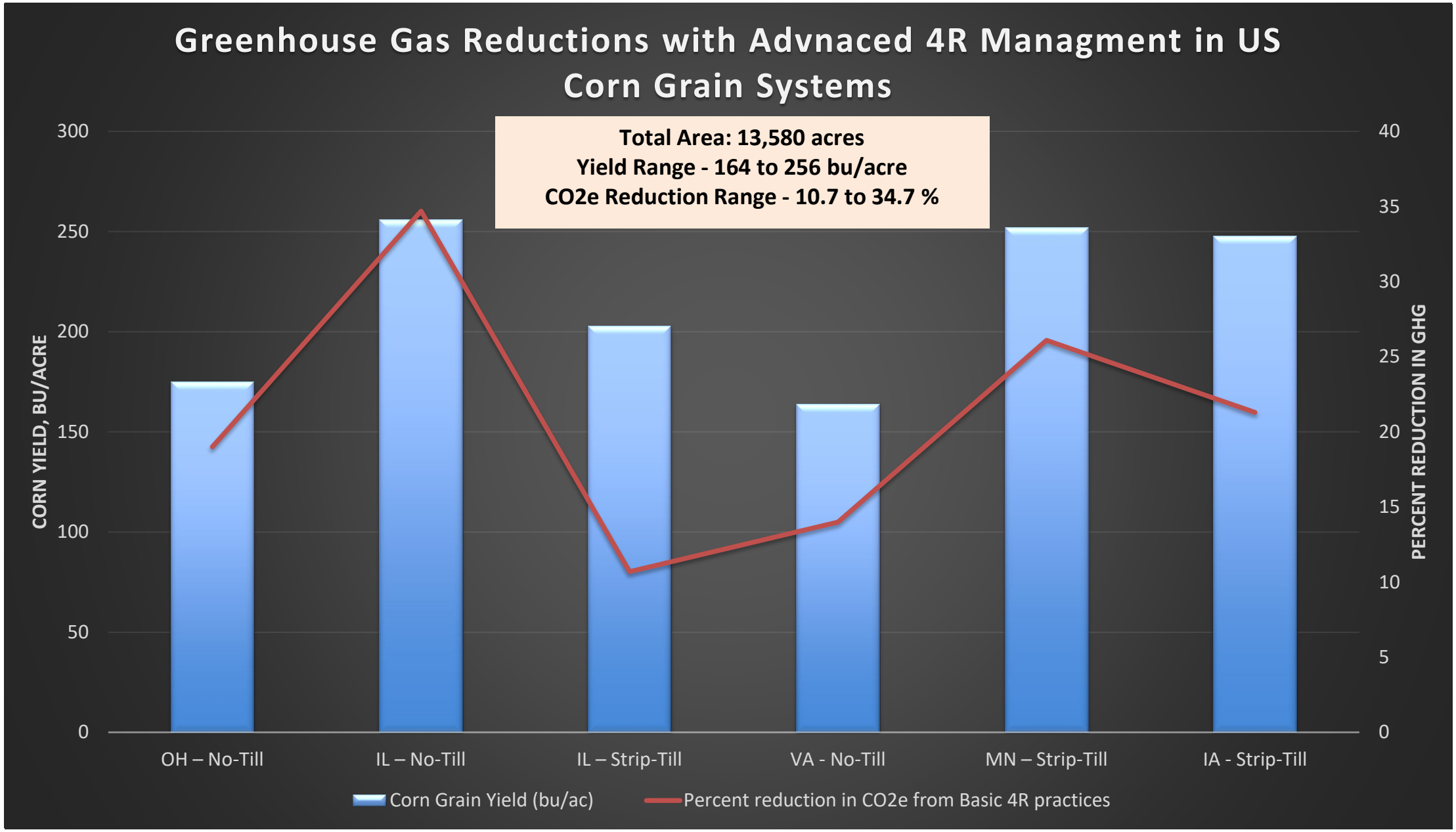
No-Till Corn Ohio

- Practices Changed from Basic to Advanced*:*
  - Removed ammonia sulfate from fall strip-till application
  - Variable rate seeding and starter fertilizer application
  - Side dress N with inhibitors applied at a variable rate and knifed-in
    - Working with NRCS to test variable rate nitrogen applications
  - Phosphorus and potassium applications with strip-till and variable rate

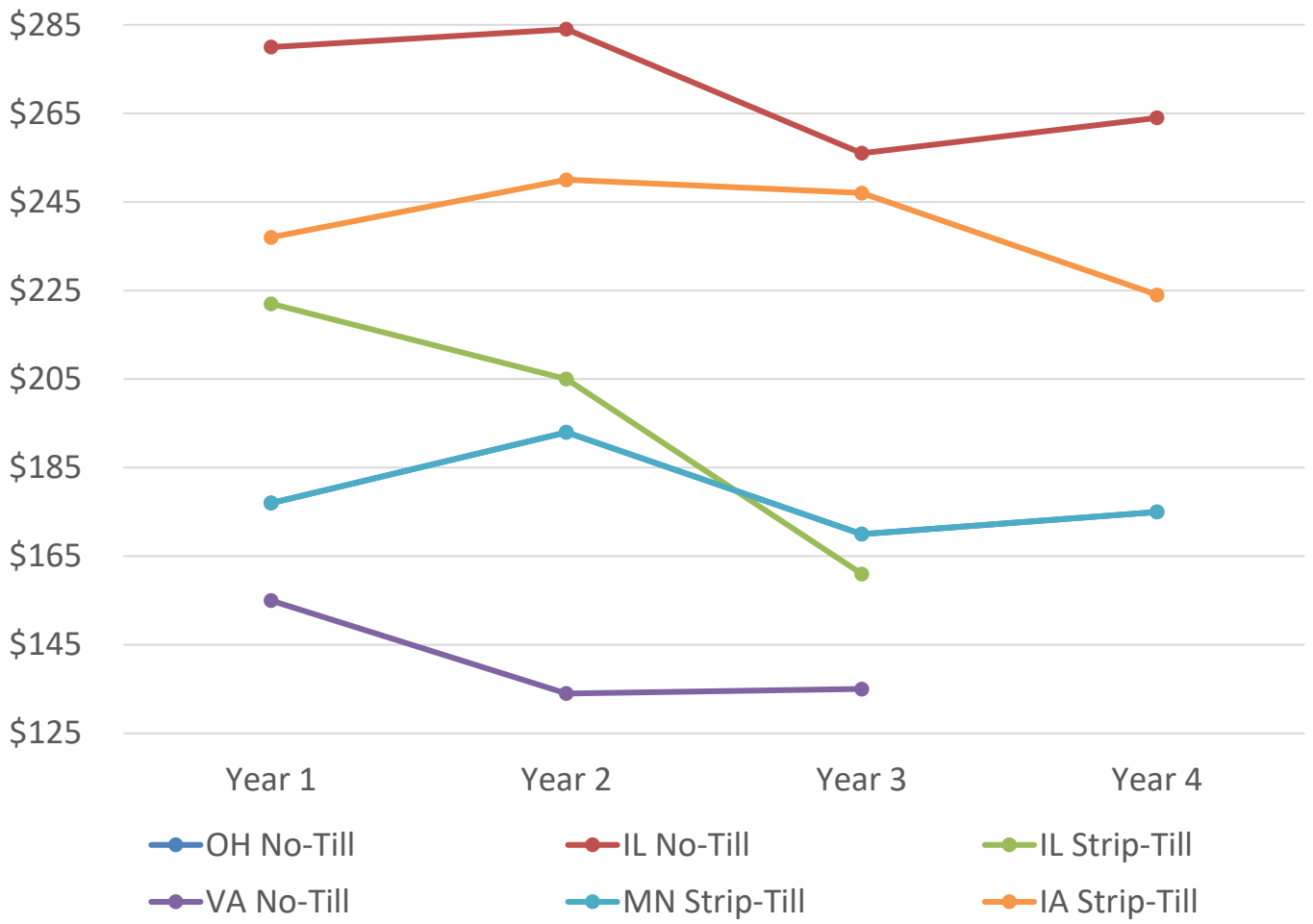


OH Corn – Efficiency and Environment

	2014	2015	2016	2017
4R Practice Level	Basic	Basic	Intermediate	Advanced
Corn Grain Yield (bu/ac)	178	193	170	175
N Application Rate (lbs/ac)	204	224	195	184
Nitrogen Use Efficiency (lb N applied/bu corn grain)	1.14	1.16	1.14	1.05
N Balance (lb N applied – lb N harvested)	61.3	68.6	58.4	43.4
CO2e Emissions per bu	10.3	10.2	9.67	8.34
Percent reduction	-	-	6.12	19.0


Greenhouse Gas Reductions with Advnaced 4R Managment in US Corn Grain Systems
Total Area: 13,580 acres
Yield Range - 164 to 256 bu/acre
CO2e Reduction Range - 10.7 to 34.7 %
CORN YIELD, BU/ACRE
PERCENT REDUCTION IN GHG
300
250
200
150
100
50
0
40
35
30
25
20
15
10
5
0
OH – No-Till
IL – No-Till
IL – Strip-Till
VA - No-Till
MN – Strip-Till
IA - Strip-Till
Corn Grain Yield (bu/ac)
Percent reduction in CO2e from Basic 4R practices

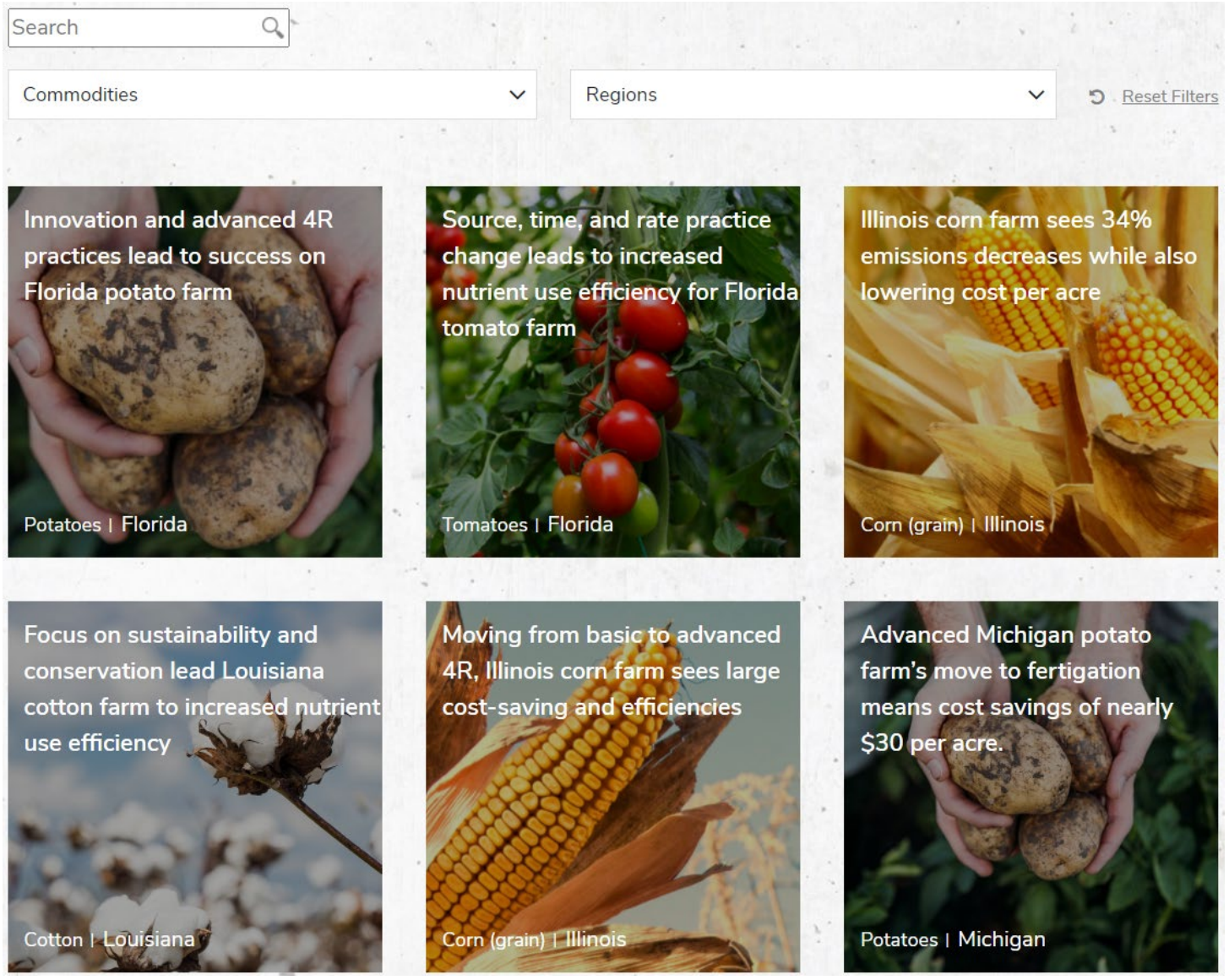
4R Implementation Costs



Year 1 through Year 4 represent progress from basic to advanced level of 4R practice adoption.

nutrient stewardship

4R Case Studies: 4RFarming.org



One Final Thought

Nutrient Use Efficiency (ratio removal / input)	
World	0.585
EU (central)	0.559
USA	0.740
4R Advocates	1.116

Corn Yield (bu/ac)	
World	90
EU (central)	152
USA	173
4R Advocates	203

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Questions

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