# The Benefits of Precision Ag in the United States

## Executive Summary and Targeted Spray Application Case Study

August 2025

AEM
Association of Equipment Manufacturers

KEARNEY

# Background

This study is an update and expansion of the 2020 Benefits of Precision Agriculture study that focused on the larger benefits of precision agriculture beyond the positive economic impact to individual farmers. The initial study, and its various follow-up studies facilitated by AEM, work together to tell the story of innovation to all industry stakeholders, policy makers, and the general public. The 2025 Benefits of Precision Agriculture for the first time in one single consolidated study, showcases the potential impact of emerging targeted spray application technologies.

This study represents cooperation and alignment of the agriculture industry around the benefits of precision agriculture. Each partner, Association of Equipment Manufacturers, American Farm Bureau Federation, American Soybean Association, Crop Life America and National Corn Growers Association has a unique perspective to bring to this conversation. All partners agree that innovation in agriculture points to a positive future in food production.

AEM Association of Equipment Manufacturers
CropLife AMERICA
NCGA
ASA American Soybean Association
American Farm Bureau Federation®

# Executive Summary

The Benefits of Precision Ag in the United States study quantifies the on-farm efficiencies that farmers have seen and can still achieve through the use of precision agriculture technologies.

Today's precision ag technology on equipment can have an enormous positive impact on farmers and the environment, ultimately enhancing productivity through more efficient use of critical inputs, such as land, water, fuel, fertilizer, and herbicides. In short, farmers who use precision ag equipment use less to grow more.

The study's findings show that, with increased adoption of precision ag technologies, the following notable and impactful benefits can be achieved:

- Widespread use of resource-efficient production practices that positively impact producers' bottom line
- Improved societal outcomes
- Long-term soil and water stewardship

# Study Objective and Scope

## Study Objective

**The objective of this study is to quantify the benefits of precision agriculture (P.A.) technologies in the U.S. and demonstrate how adoption can contribute to:**

- **Promotion of resource-efficient production practices that can impact producers bottom line**
- **Improving societal outcomes and long-term soil and water stewardship**

## Study Scope

**Geography**:
*United States*

### Crops

**Row**
*Corn, Soybeans*
*Cotton, Peanuts*

**Broad Acre**
*Wheat, Sorghum*

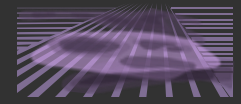
**Roots & Tubers**
*Potatoes, Sugarbeets*

**Forage**
*Hay, Alfalfa*

### Precision Ag Technologies

**Auto Guidance**

**Machine Section Control**

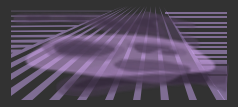


**Variable Rate Application**

**Fleet Analytics & Telematics**

**Precision Irrigation**

# Five key precision agriculture technologies were identified as focus areas for this study

| Precision Ag Technology | Definition | How Environmental Benefit is Achieved | Technologies Analyzed |
|---|---|---|---|
|  **Auto Guidance** | Auto-steer uses GPS signals to automatically control the tractor in seeding, spraying, fertilizer application and harvesting | – Reduced overlap of farming operations leads to fuel savings<br>– Avoided skips for field passes with tillage, planters, sprayers, and harvesters | – Auto Steering |
|  **Machine Section Control** | Machine section control technology automatically turns planter, fertilizer or sprayer sections on or off in rows that have been previously been seeded or sprayed, or at headland turns, point rows and waterways | – Optimized placement of seed / fertilizer / pesticides.<br>– Optimized down pressure + depth control to gain machine + fuel efficiencies | – Tillage drag / depth control<br>– Planting row, depth, down pressure control<br>– Fertilizer row control<br>– Spraying row control |
|  **Variable Rate** | Variable rate technology uses sensors or preprogrammed maps to determine seeding, fertilizer, and/or pesticide application rates. Technologies include variable rate controllers, GPS, yield monitors, crop and soil sensors | – Optimized rate of seed / fertilizer / pesticides applications | – Variable rate planting<br>– Variable rate fertilization<br>– Variable rate spraying* |
|  **Fleet Analytics & Telematics** | Real time monitoring of equipment, providing information like GPS location, equipment idling, traffic control and route suggestions | – Improved fuel efficiency from machine optimization | – Fleet analytics<br>– Telematics |
|  **Precision Irrigation*** | Ability to switch on/off apply and different amounts of water to different areas of the field | – Improved water use efficiency | – Sensor-driven center pivots<br>– Lower energy precision application |

*This report focused on center pivots

Note: Variable rate spray does not include targeted spray application technology

# Precision agriculture technology is built on a foundation of enabling technologies

## Enabling Technologies

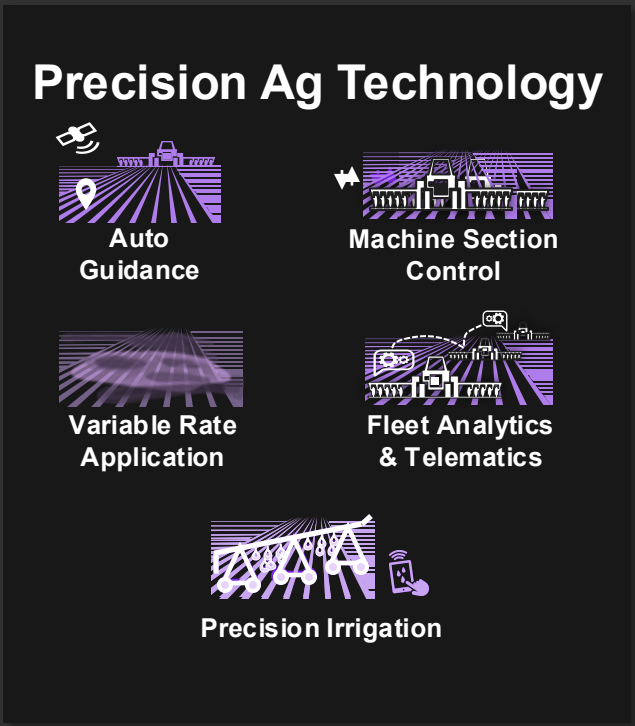
*Field level enablers*

- Remote sensing
- GPS tracking
- Yield monitors
- Satellite imagery
- Sensors

*Digital enablers*

- Cloud storage
- AI/ML analytics
- Edge computing
- 5G connectivity

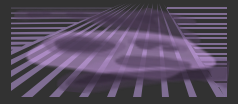
## Precision Ag Technologies



# Five measurable benefits of precision agriculture technology adoption

| Benefits | Direct Outcomes | Indirect Outcomes |
|---|---|---|
| **Productivity** | – Yield benefit from accurate spacing (pass-to-pass, end/point rows) and population rate | – Reduce land needs through more efficient use of productive acres<br>– Reduced soil compaction |
| **Fertilizer Use** | – Optimization of fertilizer applications (reduced overlap, avoid skips, best placement and rate of inputs) | – Improved water quality (reduced nutrient runoff)<br>– Improved soil health<br>– Net GHG reduction (including in production of inputs) |
| **Herbicide Use** | – Optimization of herbicide applications (reduced overlap, avoid skips, best placement and rate of inputs) | – Improved soil health, and reduced erosion through less overlap<br>– Net GHG reduction (including in production of inputs)<br>– Improved water quality<br>– Reduced weed resistance |
| **Fuel Use** | – Fuel savings from fewer field passes, variable depth of tillage and/or more efficient harvest | – Net GHG reduction<br>– Improved soil health through reduced compaction |
| **Water Use** | – Water waste avoided through remote shutoff of center pivots and selective application | – Improved use of water through ideal soil moisture levels<br>– Less energy use by running pumps fewer hours |

# Precision ag technologies reduce compaction and nutrient losses, improving soil structure, biology, water infiltration and long-term resilience

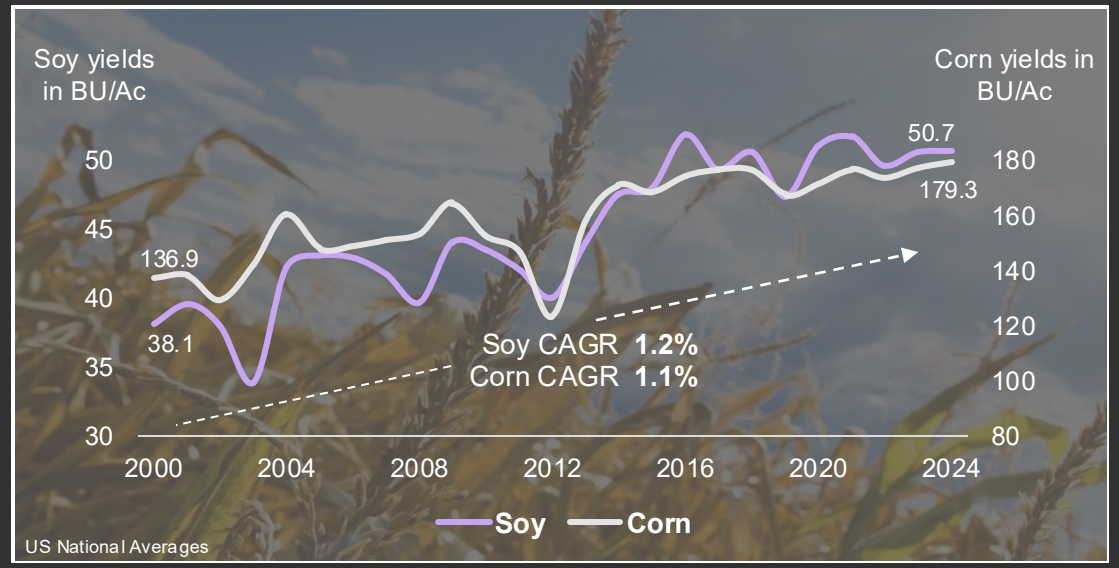
| Precision Ag Technology | What it changes in the field | What it changes in the soil |
|---|---|---|
|  **Auto Guidance** | Keeps wheels on repeatable tramlines; reduces overlap and wandering passes | Less random compaction; better infiltration & root growth; fewer ruts/erosion scars |
|  **Machine Section Control** | Shuts off sections at overlaps/headlands/wedges | Avoids double dosing of fertilizer/chemicals → less salt burn, pH hotspots and runoff at field edges |
|  **Variable Rate** | Matches nutrients to soil/yield potential zones | More even nutrient balance; lower leaching (N) and P loading; slower acidification/salinization; supports microbial activity by avoiding excesses |
|  **Fleet Analytics & Telematics** | Optimizes timing/routes; geofences wet zones; monitors slip/axle load | Fewer passes on wet soil (less compaction & smearing); reduced rutting/erosion; lower spill/leak risk via maintenance alerts |
|  **Precision Irrigation** | Applies water by zone & schedule (ET/soil-moisture driven) | Prevents waterlogging and dry-soil crusting; minimizes leaching; manages salinity; protects structure vs. flood events |

Precision ag improves soil health by:
- Reducing compaction
- Optimizing inputs
- Boosting resilience
- Reducing erosion and runoff

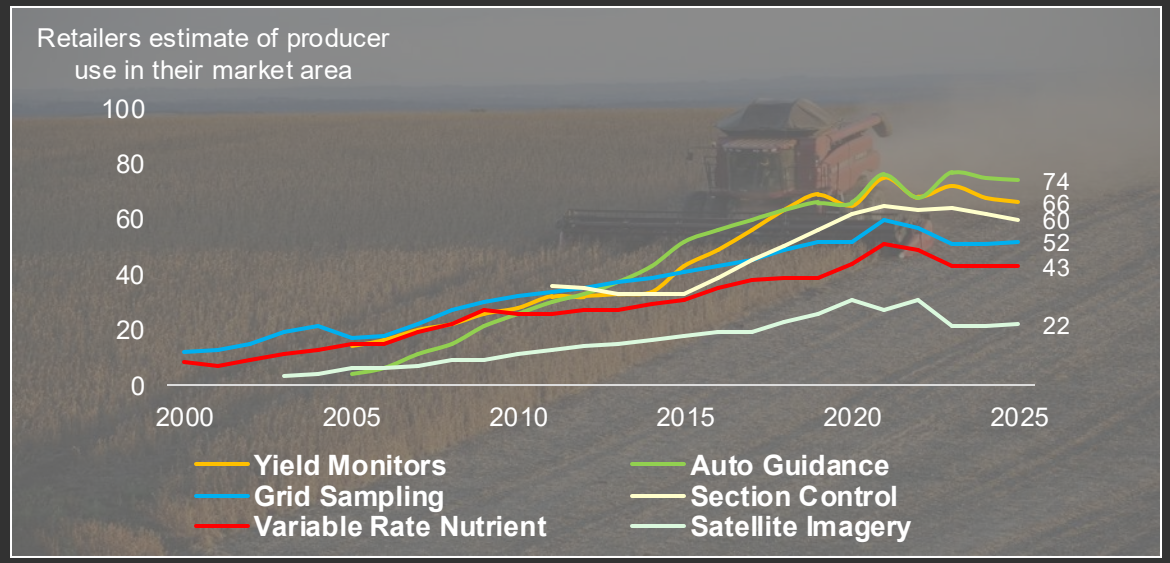
Note: Quantifying soil health benefits was not part of the study's scope

# Precision agriculture has fueled two decades of growth in U.S. corn and soybean yields

## Corn & Soybean Yields (2000 – 2024)




## Producer Use of Precision Technologies (2000 – 2025)



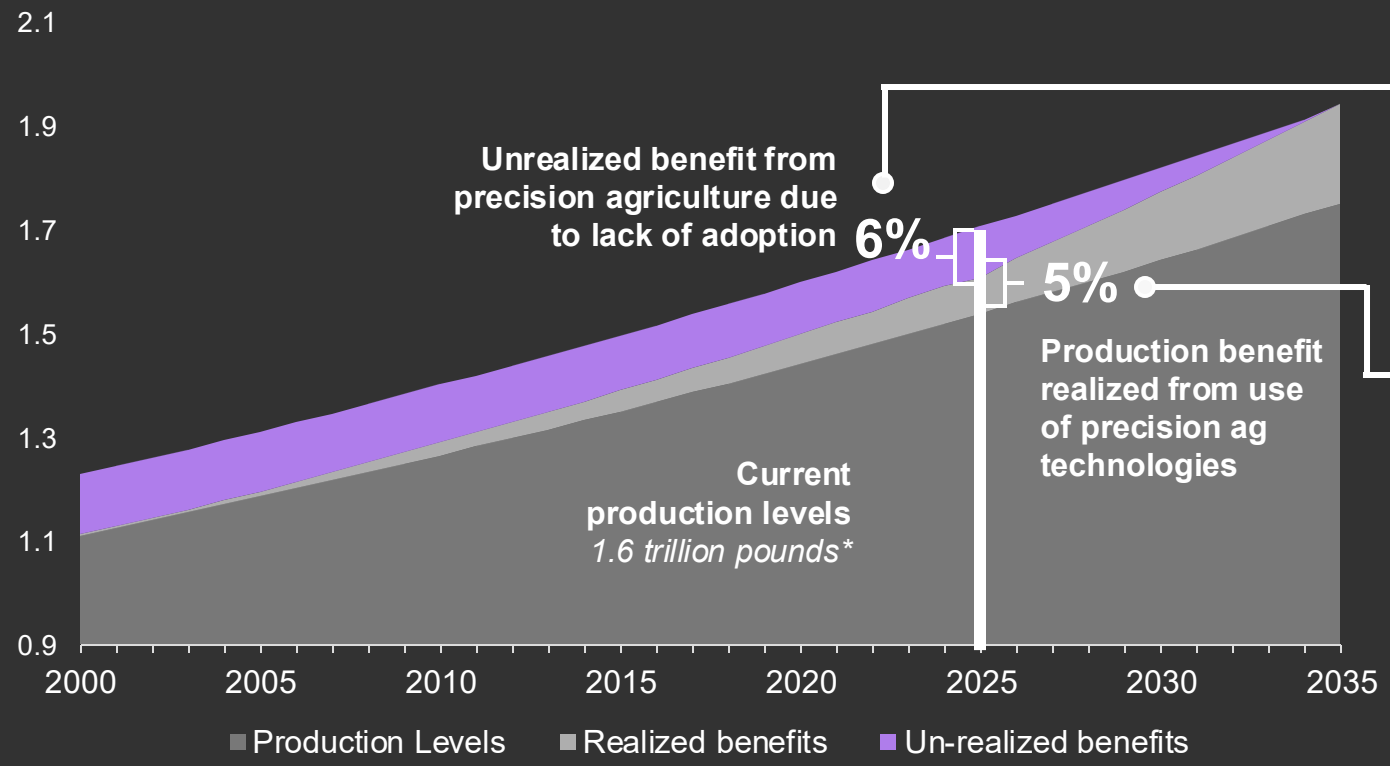

**Reasons for rising yields include improved:**

1. **Seed genetics & traits**
2. **Crop inputs & management practices**
3. **On-farm technology**

Source: USDA NASS, Purdue 2025 Precision Ag Dealership Survey

# Precision agriculture has boosted annual crop production by 5%, with potential for an additional 6% gain through wider adoption

## Access to rural broadband, improved financing, and demonstrating ROI will help accelerate precision agriculture adoption on U.S. farms driving higher yields and increasing farm incomes




### In the future, this could be achieved with…

- 20% less water used
- 7% less fuel used
- 14% optimization of fertilizer use
- 12% optimization of herbicide use

### Today, this has been achieved with…

- 5% less water used
- 7% less fuel used
- 8% optimization of fertilizer use
- 9% optimization of herbicide use

*Pounds of corn, soybeans, cotton, peanuts, wheat, sorghum, tubers, sugarbeets, hay, and alfalfa combined
Note: Reduction in herbicide use does not include targeted spray technology

Source: Kearney Analysis based on USDA NASS, USDA ERS, Purdue Precision Ag Dealership Survey, Iowa State University, North Dakota State University, South Dakota University, The Ohio State University, University of California (Davis), University of Illinois, University of Kentucky

# Current Realized Benefits:
# Precision agriculture technologies helps farmers do more with less

*Each 1,000 acres of row crops farmed generates $118,000 in annual economic value from precision agriculture ($118 per acre).*

Precision ag adoption has driven an additional **5% increase** in annual crop production

*Each 1,000 acres of row crops* farmed generates ~$66,000 a year in additional revenue from yield benefits*

+

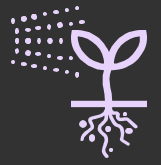
## Optimization of fertilizer use

**8%**

*Each 1,000 acres of row crops farmed avoids as much as ~$20,000 in additional expenses through fertilizer use efficiency*

## Optimization of herbicide use

**9%**



*Each 1,000 acres of row crops farmed avoids ~$12,000 in additional expenses through herbicide use efficiency*

## Less fuel used

**7%**

*Each 1,000 acres of row crops farmed avoids ~$4,000 in additional expenses through fuel use efficiency*

## Less water used

**5%**


*Each 1,000 acres of row crops farmed avoids ~$16,000 in additional expenses through water use efficiency*



*For this analysis, we considered a 1,000-acre row crop farm with 50% corn and 50% soybeans

Source: Kearney Analysis based on USDA NASS, USDA ERS, Purdue Precision Ag Dealership Survey, Iowa State University, North Dakota State University, South Dakota University, The Ohio State University, University of California (Davis), University of Illinois, University of Kentucky

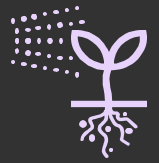
# Unrealized Benefits:
# Greater adoption of precision agriculture technologies unlocks continued yield gains and input savings

Precision ag adoption could drive an additional **6% increase** in annual crop production

+

**14%** Optimization of fertilizer use

**12%** Optimization of herbicide use



**7%** Less fuel used

**20%** Less water used




Source: Kearney Analysis based on USDA NASS, USDA ERS, Purdue Precision Ag Dealership Survey, Iowa State University, North Dakota State University, South Dakota University, The Ohio State University, University of California (Davis), University of Illinois, University of Kentucky

# Detailed Findings

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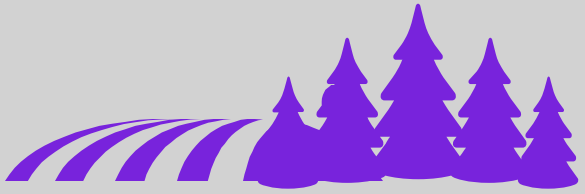
# Productivity has increased an estimated 5% as a result of current P.A. adoption, and has the potential to further increase 6% with broader P.A. adoption



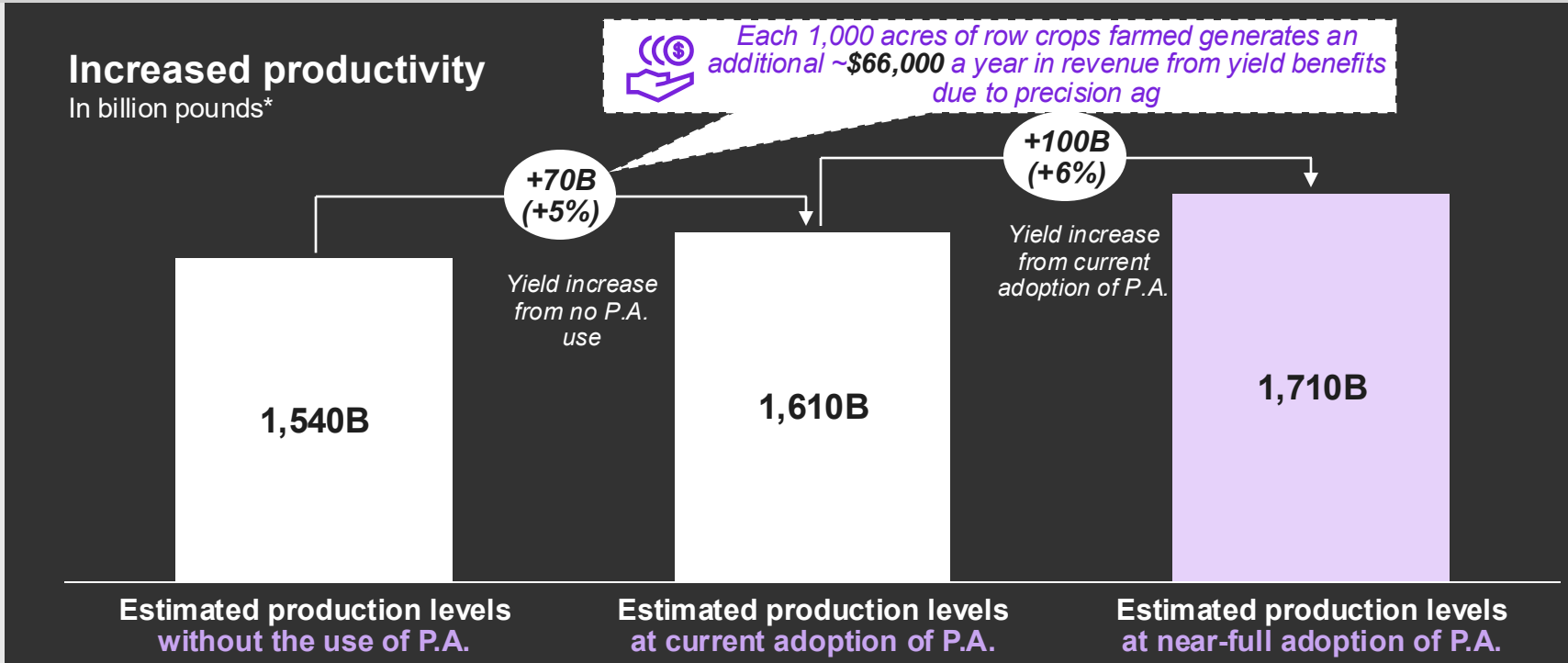
Cultivating an estimated **11.4 million acres** of cropland was avoided due to more efficient use of existing land. This is an area equivalent to **5 Yellowstone National Parks.**

## Precision Technologies Analyzed

Auto Guidance

Variable Rate

Section Control




*Production of each crop in scope were normalized for the purposes of aggregation and comparison

# An estimated 8% additional fertilizer would be needed to produce the same amount of food without current P.A. practices, and with broader P.A. adoption there is the potential for an additional 14% less fertilizer than used today

The application of an estimated **4 billion pounds** of fertilizer was avoided due to adoption of P.A. technologies. With an estimated **7 billion pounds** of additional fertilizer that could be avoided with broader adoption.

## Precision Technologies Analyzed

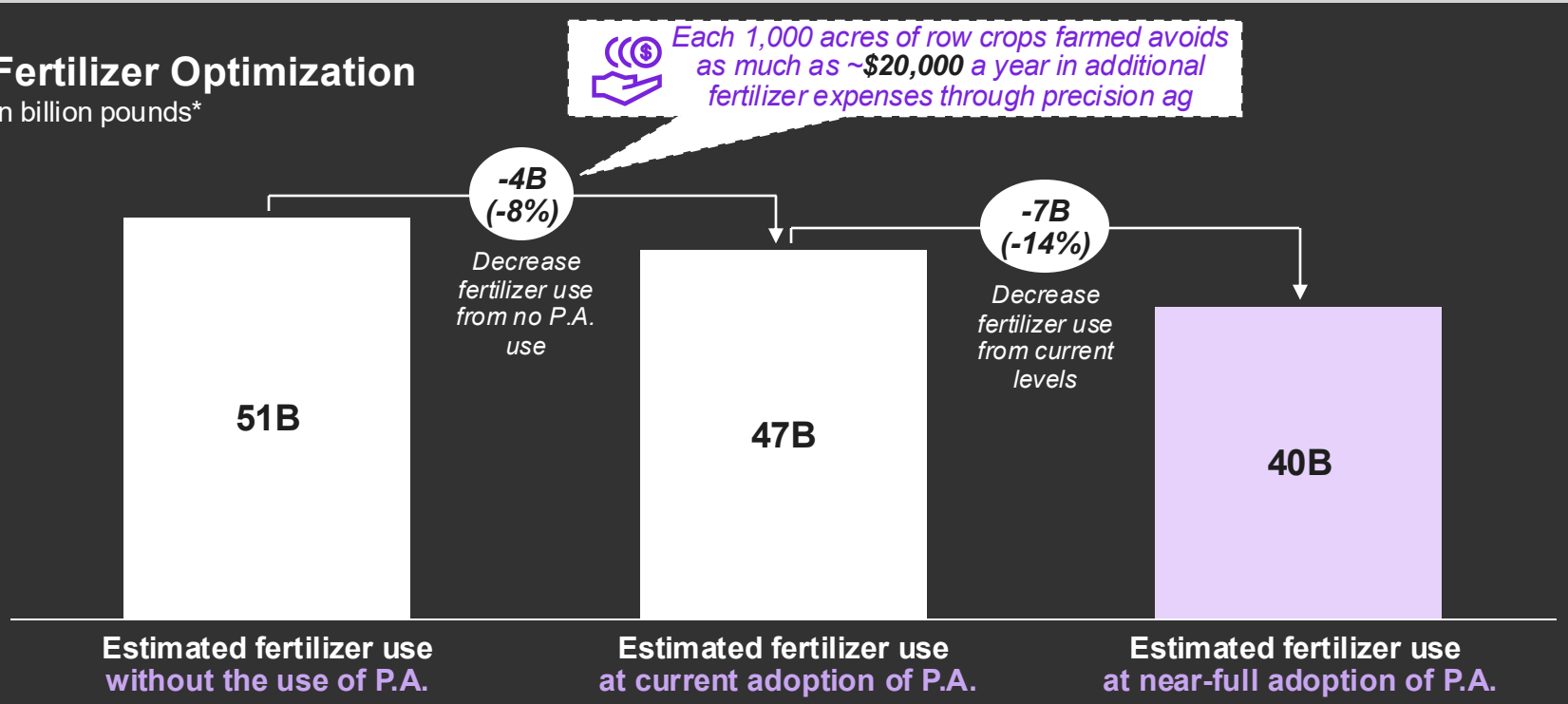
Auto Guidance

Variable Rate

Section Control

## Fertilizer Optimization

In billion pounds*




*Materials pounds of fertilizer, not nutrient pounds

# An estimated 9% of herbicide was avoided as a result of current P.A. application practices, and there is the potential for an additional 12% with broader P.A. adoption

The application of an estimated **54 million pounds** of herbicide was avoided due to adoption of P.A. technologies. With an estimated **66 million pounds** of additional herbicide that could be avoided with broader adoption.

## Precision Technologies Analyzed

Auto Guidance

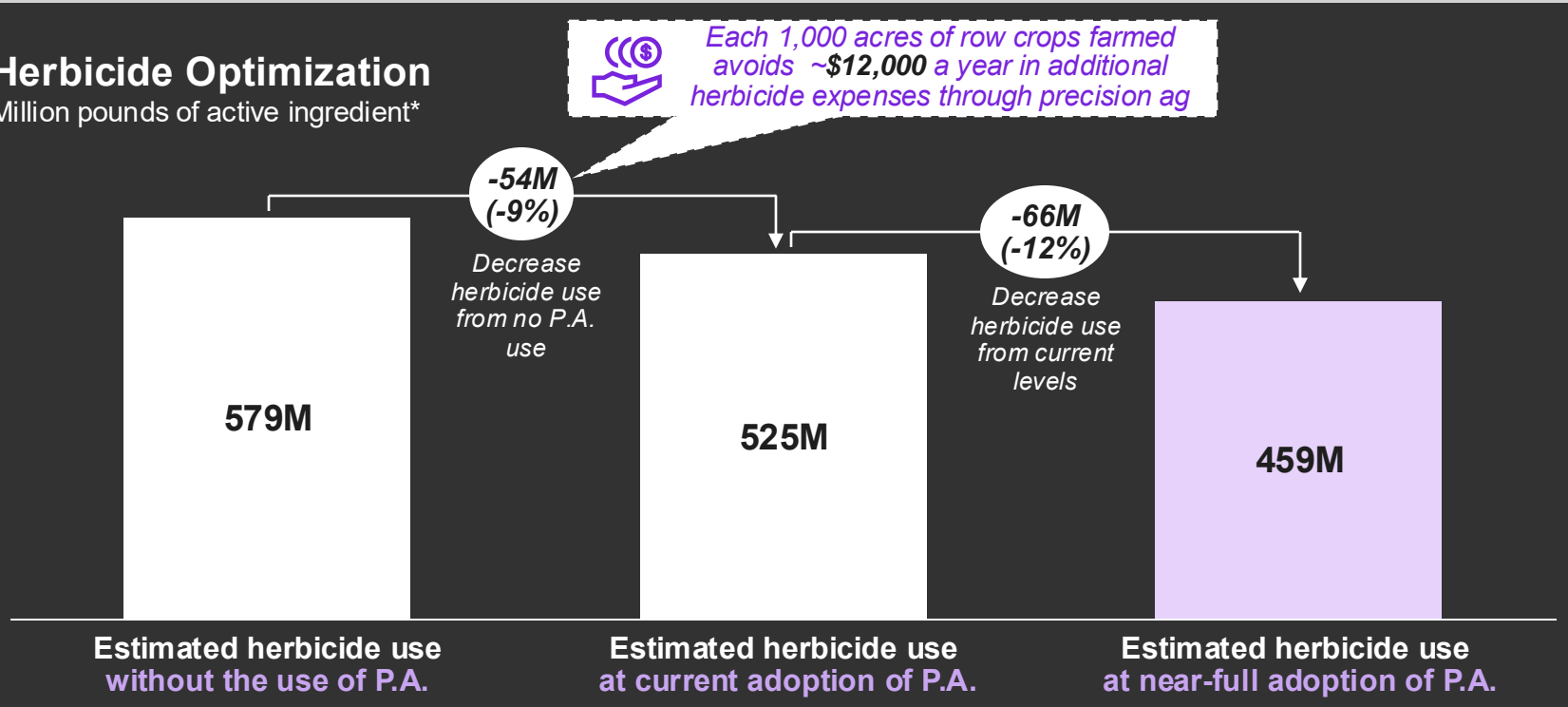
Variable Rate

Section Control

## Herbicide Optimization

Million pounds of active ingredient*

*Each 1,000 acres of row crops farmed avoids ~**$12,000** a year in additional herbicide expenses through precision ag*




*Note: Reduction in herbicide use does not include targeted spray technology

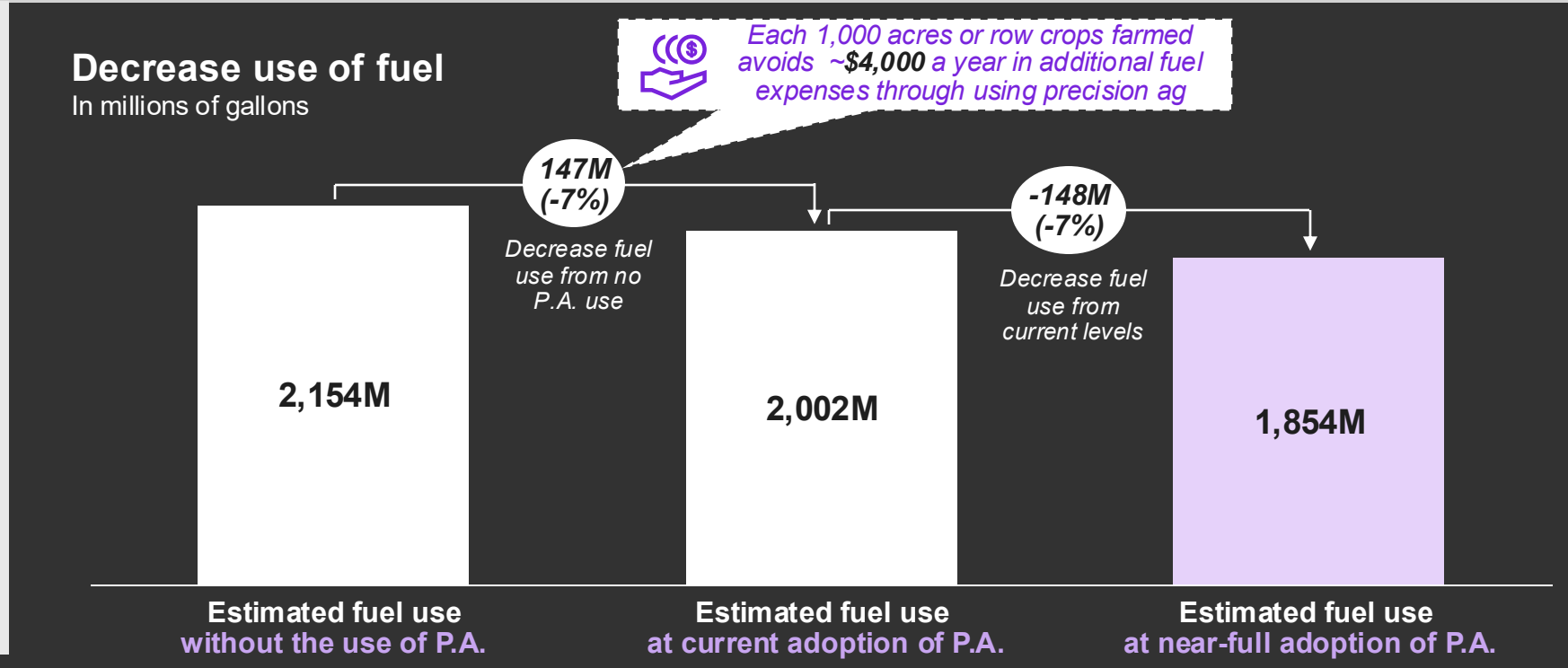
# Fuel use has decreased an estimated 7% as a result of current P.A. adoption, and there is the potential to further decrease 7% with broader P.A. adoption

The use of an estimated **147 million gallons** of fuel was avoided due to adoption of P.A. technologies. That is equivalent to an estimated **283,000 cars** off the road annually or **26,000** average **flights.**

## Precision Technologies Analyzed

Auto Guidance

Fleet Analytics & Telematics



# Water use and associated runoff has decreased an estimated 5% as a result of current P.A. adoption, and there is the potential to further decrease 20% with broader P.A. adoption

The application of an estimated **824,000 Olympic swimming pools** worth of water was avoided due to adoption of P.A. technologies.

## Precision Technologies Analyzed

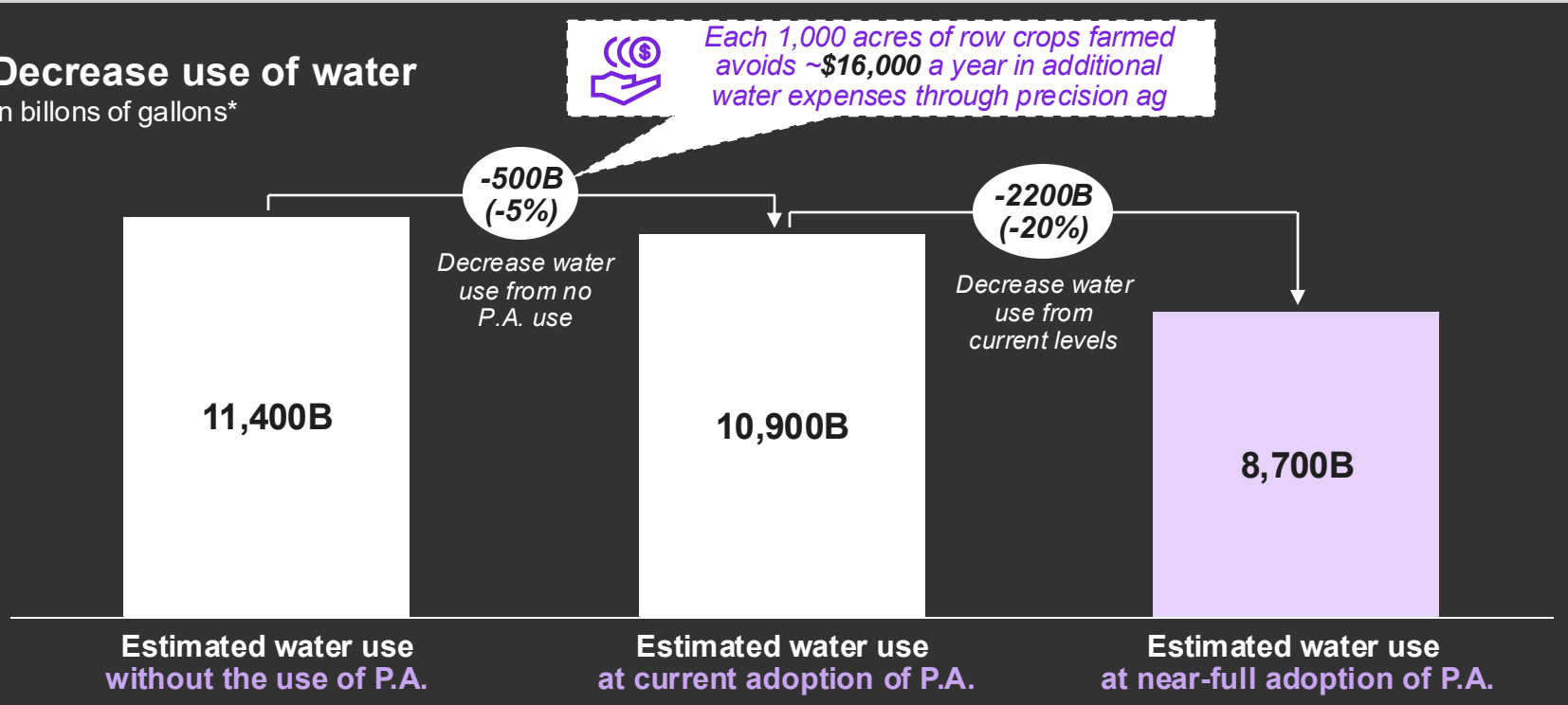
**Variable Rate Precision Irrigation**

**Soil Moisture Sensors**

## Decrease use of water

In billons of gallons*

*Each 1,000 acres of row crops farmed avoids ~**$16,000** a year in additional water expenses through precision ag*




*The model only measures the benefits of sensor-driven precision pivots that have seen sizable adoption across the crops within scope. Drip and other methods of irrigation provide water savings but are not widely adopted enough in the crops within scope of the analysis.

# Targeted Spray Application Case Study

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# Targeted spray application systems aim to optimize herbicide application in fields

## Pesticides mainly fall into three categories herbicides, fungicides & insecticides

### Herbicides

- Designed to kill or inhibit the growth of **unwanted plants (e.g. weeds)**
- Helps protects crops from being overrun by **competing plants**
- Commonly applied by spraying onto soil or plant leaves
- Example: S-Metolachlor
- **#1 pesticide category** by volume applied

### Fungicides

- Designed to kill or inhibit **fungi** that cause plant diseases
- Helps protect crops from problems such as **mildew, rust, or blight**
- Commonly applied by spraying onto soil or plant leaves; or as a seed coating
- Example: Chlorothalonil

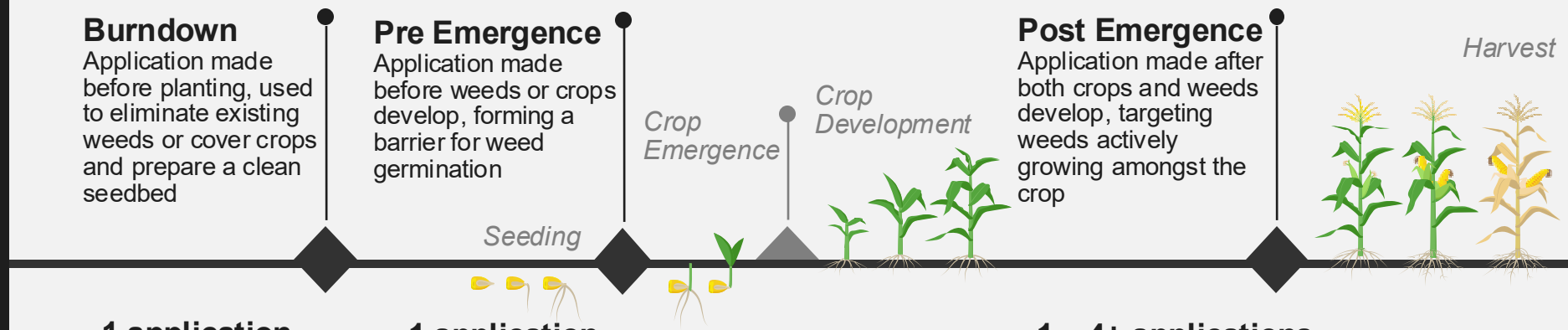
### Insecticides

- Designed to kill or inhibit **insects** that damage plants
- Helps protects crops from insect pests and the **spread of disease**
- Commonly applied by spraying onto soil or plant leaves; or as a seed coating
- Example: Imidacloprid

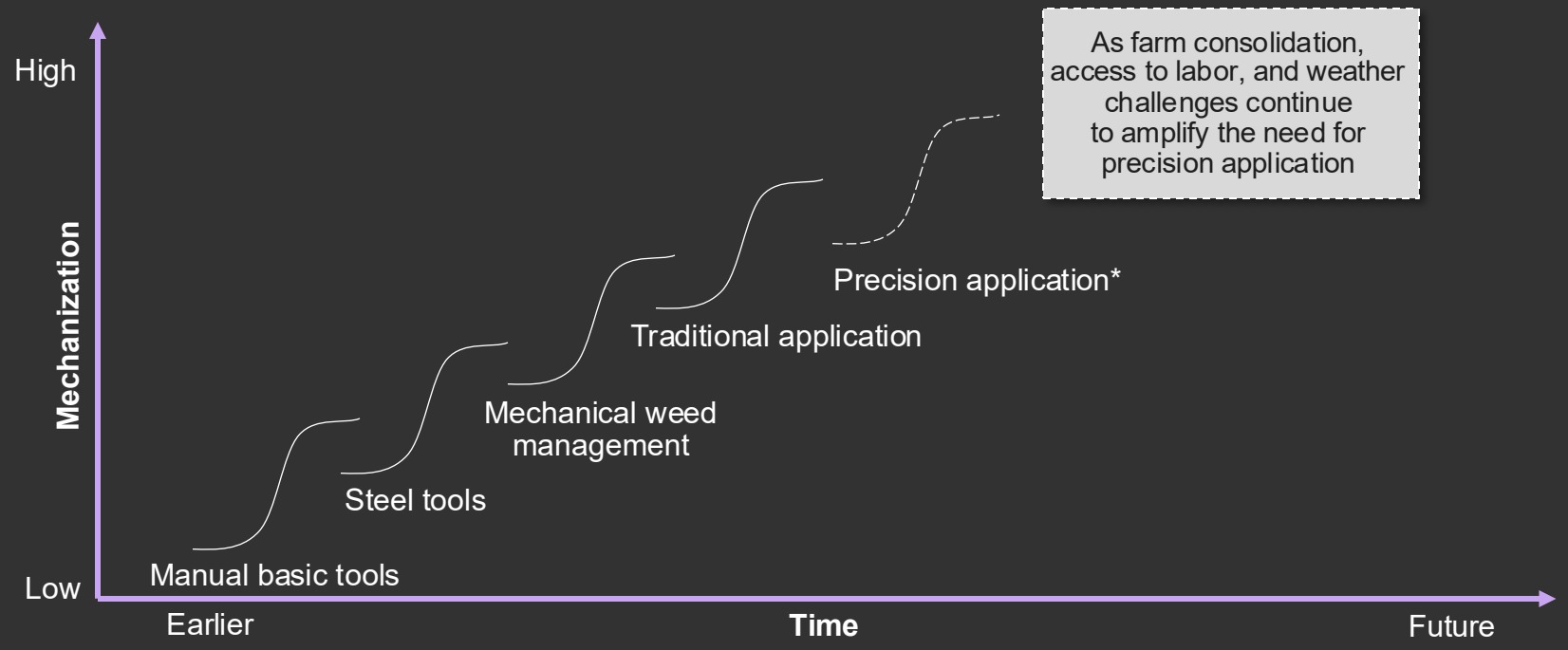
Targeted Spray Application Case Study Focus

### Herbicide Application Schedule

Overview of when herbicides are applied to control weeds effectively and safely



# The promise of precision application is compelling as the next s-curve of innovation in weed management




Targeted Spray Application Case Study Focus

## Change in Chemical Use

- More precise application:
  - Reduces chemical volume
  - Enables targeted applications that may adjust use or frequency based on field conditions
- New active ingredients (AIs) or formulations focused on maximizing technology
- Long-term reduction in weed seed bank creates less overall weed pressure

## Improved Yield through Optimization of Inputs

- Lower weed pressure reduces fertilizer and water needs, allowing more resources to go to the intended plant
- Additional passes with camera technology opens the doors for additional data for proactive decision making

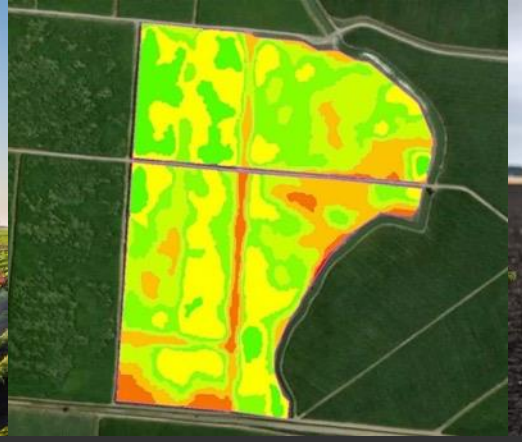
## Resistance Management

- Improves accuracy of chemical placement
- Ability to use multiple modes of action
- Early detection and application reduces likelihood of resistant gene expression and ability to kill more weeds prior to seeding

*Alongside targeted spray application, emerging technologies such as robotic weeding and laser-based weed control may further disrupt the herbicide market and reshape future crop protection strategies.

# From Broadcast to Targeted: The Future of Herbicide Application Methods is Here and Emerging

## Types of Herbicide Application Methods



| | Traditional (Broadcast) | Variable-Rate | Targeted Spray Application[1] |
|---|---|---|---|
| Granularity | **Entire Field**<br>*constant, uniform rate* | **Entire Field**<br>*rate changes by zone / section / nozzle* | **Plant by Plant**<br>*spray turns on where weeds are detected* |
| Objective | **Simple, full coverage** | **Optimize rate to field zones** | **Precise weed-level targeting** |
| Data Requirements | **Low**<br>*field maps & basic rates* | **Moderate**<br>*prescription maps & sensors* | **High**<br>*real-time vision/sensor detection* |
| Limitations | **Potential for higher rates of application[4]** | **Potential for higher rates of application**<br>*dependent on map/sensor quality* | **Operational sensitivity**<br>*Complex technology affected by lighting, speed, model accuracy, and optics maintenance* |
| Savings Potential[2] | **Baseline** | **Moderate**<br>*depends on rate variability* | **High**<br>*~50 – 90% savings in studies* |
| 2025 Est. Adoption[3] | **90%+** | **5%** | **~1%** |

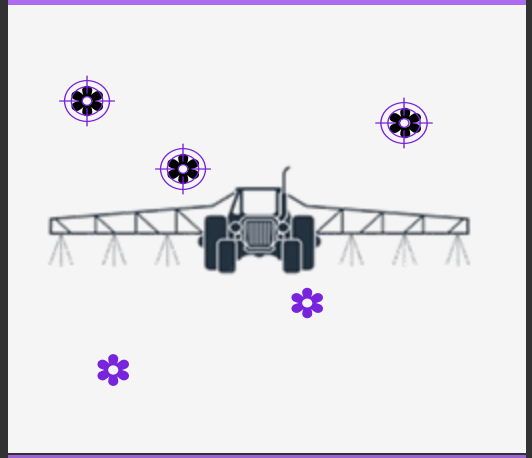
Source: Kearney Analysis

[1]Detailed analysis of targeted spray application in subsequent slides
[2]savings potential dependent on a number of factors; including weed pressure
[3]varies by crop, location, and application timing window
[4]this application is generally needed for burndown of cover crops used for conservation efforts

# The combination of sensors, equipment and AI are allowing for more targeted use and application of herbicides

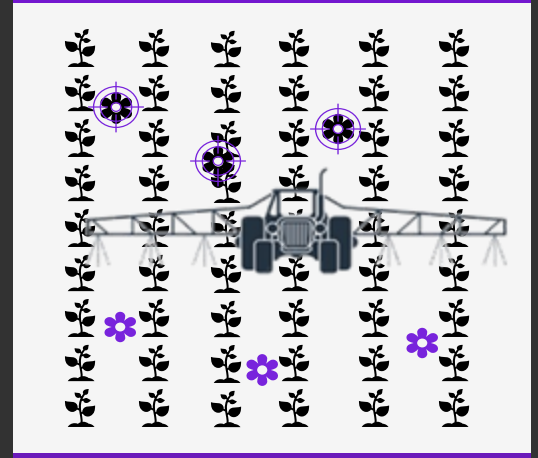
## Targeted Spray Application

### Green on Brown



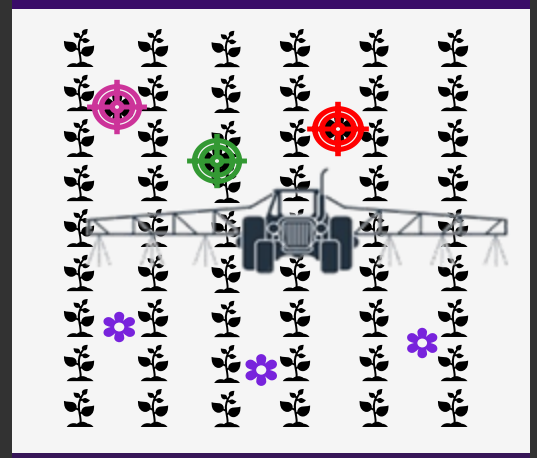
Target “green” in a field and spray the plant only (e.g., bare ground or stubble conditions)

### Green on Green



Target “weed” in a field and spray the weed only (e.g., with crop canopy)

### Selective Spot Spray



Detect “type of weed” in a field and spray the weed only and with the right chemical (e.g., with crop canopy)

***Today*** → ***Future***

***Less Complex*** → ***More Complex***

### U.S. Market Participants

John Deere, PTx Trimble, ONE SMART SPRAY, CNH, Greeneye TECHNOLOGY, AGCO

**Several other OEMs and startups have innovations in the pipeline*

### Notable Features

- Technology includes cameras and sensors integrated with artificial intelligence / machine learning (AI/ML) models
- Innovation focused on innovation in corn, soy, cotton
- Speed improvements up to 12-15mph
- Dual tank compatible
- Embedded in new equipment or retrofit aftermarket options

Note: Green on Brown is primarily used on burndown and pre-emergence application; Green on Green and Selective Spot Spray are primarily used on post emergence applications

## Stakeholders are evaluating the technology's value, viability and impact

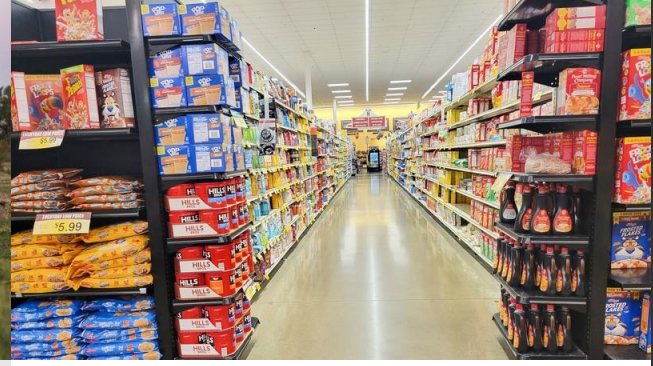
### Who are the stakeholders?

| | |
|---|---|
|  | Farmers |
|  | Equipment Company |
|  | Equipment Dealer |
|  | Crop Input Manufacturers |
|  | Ag Retailers / Co-ops / Custom Applicators |
|  | Regulators |
|  | Value Chain Partners |

### What are they trying to figure out?

- Value Proposition and Offer
- Commercial Terms
- Operational Realities
- Financial Impact
- Legal / Regulatory Issues

# Impact to key agricultural value chain stakeholders



## Farmers

- Less herbicide spend resulting in the potential for higher profitability
- Simplified logistics of spraying and time savings
- Increased yields and cleaner fields
- Improved soil health, biodiversity and structure

## Agribusiness
(Equipment + Crop Protection)

- New revenue streams via hardware, services and higher-value chemistries
- Shift toward service-oriented models
- Ongoing dealer and grower enablement needed (training, tools, incentives)
- Extended product lifecycle due to slow resistance development

## Consumers

- More resilient food supply chains
- Improved conservation outcomes that support long-term food availability (e.g., soil health, water efficiency, biodiversity)
- Potential for lower food prices if farm-level efficiencies reduce production costs

Source: Kearney, Farm Progress, University of Minnesota Extension, University of Arkansas Agricultural Experiment Station, Iowa State Extension

# Farmers share firsthand experiences with targeted spray application technology

## Kansas wheat, soybean, alfalfa farmer

“We’re spraying less chemical, [targeted spray application technology] is saving us money, and it’s better for the environment.”

“We ran through our herbicide costs we were going to have and dropped them by two-thirds. That is going to make our sprayer payment.”

## South Dakota corn & soybean farmer

“[Targeted spray application technology] is an investment, but with the amount of time, knowledge I’ve gained from [this technology] it seems to be well worth the value.”

“I wouldn’t own a sprayer without it.”

## North Dakota grain farmer

“When we went down to the dealer-customer product launch, I remember coming back thinking, ‘Boy, that’s going to be a tough sell in western North Dakota with no-till and everything we do.’ A year later, that skepticism died pretty quickly after I saw it in action.”

“[Targeted spray application technology] allows me to have effective weed control each year, especially in crops where we are starting to see some weed pressure or resistance to herbicide.”

## Minnesota corn & soybean farmer

“We looked at what we were spending on postemergence weed control and felt we could justify [targeted spray application technology] if we sprayed only 50% of our acres post.”

“In the end, we only sprayed 11% of our corn acres with postemergence herbicide and averaged only spraying 20% of our soybeans with both applications.”

## Texas cotton, wheat, corn, and milo farmer

“Upgrading our existing sprayer with [targeted spray application technology] will give us the flexibility to spray more frequently, including at night or in dusty conditions.”

“That’s critical for working around the storms we often face in June. Despite spraying more often, we expect to reduce our annual herbicide use by 25-40%, with our investment paying off within two to three seasons.”

Note: Technology brand names have been redacted in brackets
Source: CropLife, Successful Farming, Farm Progress

# Ag retailers and equipment dealers share experiences using targeted spray application technology for farmers

## Agronomy Quality Manager – Kansas Co-op

“We saved our customers $112,000 across 42,000 acres in 2024 with [targeted spray application technology]. That basically shoots to about $3 an acre with the fees or subscriptions of last year. That number will definitely increase for 2025 on savings.”

## VP of Agronomy Sales and Marketing – Iowa Co-Op

“Strip-till and no-till farming methods are not widely used in our part of the world, but they are becoming more common as our members seek to meet the needs of major food manufacturers and food service operators. These methods help to realize significant environmental benefits that can enable food companies to unlock carbon credits and meet their ESG objectives; however, they also create additional weed control challenges.”

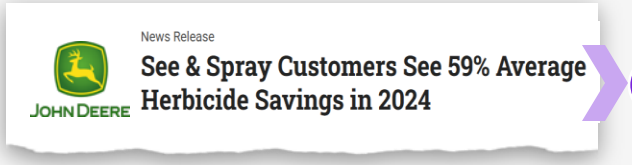
“It is our responsibility to ensure we provide our co-op members with the tools they need to take advantage of changing market dynamics. We believe the [targeted spray application technology] systems will prove invaluable in enabling farmers to pivot to more sustainable production while keeping weeds, and costs, firmly under control.”

## Application Technology Product Manager – Minnesota Equipment Dealer

“Our customers were able to cover over 35,000 acres in 2024. We saw, between our Midwest and Northwest territories, around a 67% savings in overall herbicide reduction. Our growers are stewards of the land, they care about their soil health, that's their land, and they want to take care of it. Any time we can implement a technology that allows for that while giving them a very good ROI, that's something that you get excited to represent.”

Source: Agriculture Technology with RDO Podcast, CropLife

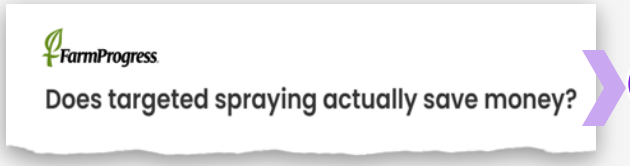
# Current research indicates 40–60% less herbicide volume applied with targeted spray application technology




**~59%** Reduction in herbicide volume over 3 years; 1M acres applied in 2024; expect 2M acres for 2025


**~76%** Reduction in herbicide volume on a 415-acre trial


**~67-81%** Reduction in herbicide volume over 3 years




**~43-90%** In total product savings averaged across multiple plots


**~60-70%** Reduction in herbicide volume over multiple trials


**~87%** Reduction in herbicide used in post-emergence applications compared to broadcast spraying

Note: It's important to note whether studies or company material on targeted spray application references total herbicide reduction or just certain application window reductions such as post-emerge

## Research highlighted three key inputs that informed our national herbicide reduction modeling

**3 herbicide application windows**
with varying reduction in herbicide used
*Burndown, Pre-emergence, Post-emerge*

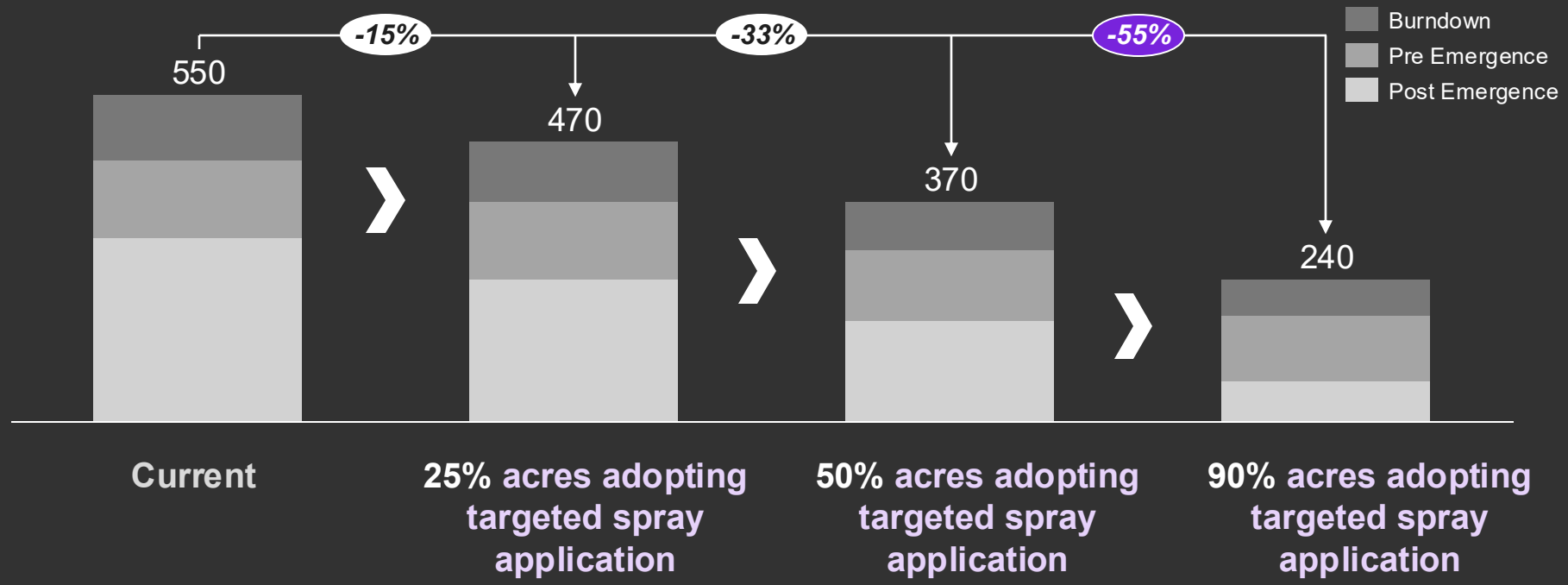
**~15-95% herbicide reduction**
depending on application window

**3 adoption scenarios** ranging from 25-90% of acres adopting

**At a national level, near-full adoption of targeted spray application could result in a 55% annual reduction in applied herbicide volumes**

## Adoption Assessment: Overall Reduction in Applied Herbicide Volume at Varying Levels of Targeted Spray Application Adoption

*In million pounds of herbicide active ingredient applied*




Crops: Corn, soybeans, cotton, wheat, peanuts, potatoes, sugarbeets, hay, and alfalfa | Average chemical reductions by application window: Burndown: 40-50%, Pre Emergence: 15-20%, Post emergence 1: 75-90%, Post emergence 2: 80-95%, Post emergence 3: 85-95%

**At near-full adoption, targeted spray application will reduce nationally applied herbicide volumes by 55% annually, enough to fill to ~12,000 rail cars. If the rail cars were lined up end to end, it would span 136 miles.**

Source: USDA NASS, Iowa State University, Kearney Analysis & Expert Input

# Targeted spray application must overcome operational, perceptual and economic barriers to achieve broad adoption by farmers

## Enablers of Adoption

### Economic

- Herbicide costs incurred by the farmer have increased 20-30% in the last 3 years
- Weed resistance is proving to be a challenge. Farmers' options to control weeds are limited
- Many use cases are demonstrating attractive grower ROI
- Reduced tank refill time improves overall efficiency

### Technological

- Weed detection models improve each year as training data grows each season
- Major OEMs and technology providers are backing targeted spray technology
- Vision systems can be used for other purposes besides targeted spray

### Policy

- Recent regulation has limited farmers' ability to apply herbicides in some states
- Targeted spray application provides a tangible path to lowering overall usage

## Barriers of Adoption

### Economic

- Initial costs prohibit small and medium-sized farms from adopting
- Hardware costs combined with acreage fee cost structure could face challenges with grower adoption
- Targeted sprayers tend to have a higher maintenance and upkeep cost compared to traditional sprayers

### Familiarity

- The business model is complex
- Farmer confidence in the efficacy of the technology remains low in many cases
- Farmers are generally reluctant to add complexity

### Technological

- Continuous R&D investment is required to advance and maintain software models that power targeted spray application technology

### Operational

- The use of targeted sprayers can be limited in certain dusty or low-light conditions



Source: Farm Progress, University of Minnesota Extension, University of Arkansas – Division of Agriculture Research & Extension, Iowa State Extension, CropLife, Sprayers101

# Thank you

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KEARNEY

# Kearney's expert network brings vast knowledge and experience to the team

## Project Team

**Doug Griffin**
Partner, Atlanta

- 10+ years of consulting experience
- 25+ years of experience in ag machinery up to C-Suite roles

**Tyler Uden**
Manager, Chicago

- 10 years of consulting experience
- 15+ projects for OEMs in the agricultural equipment space

**Lainey McInnis**
Manager, Atlanta

- 10 years of consulting experience
- Focus on crop inputs, ag retail, ag equipment, and ag tech

**Shaun Ramchander**
Associate, New York

- 7+ years consulting experience
- 10+ years in agriculture
- Led 4 prior AEM projects

**Bo Bader**
Consultant, Chicago

- 2+ years consulting experience
- 7+ years in agriculture

## Subject Matter Experts

**Justin Upmeyer**
Expert Advisor

- Grew up on a farm in northern Iowa
- Actively implementing regenerative ag practices to ensure long-term environmental sustainability
- 22-year career at John Deere with focus on product management, marketing, and precision ag technology integration
- Led initiatives in machine automation, guidance systems, telematics, data collection/management, and connected support
- Deep experience applying technology across planters, drills, sprayers, combines, tractors, and harvesters

**Robert Boyle**
Expert Advisor

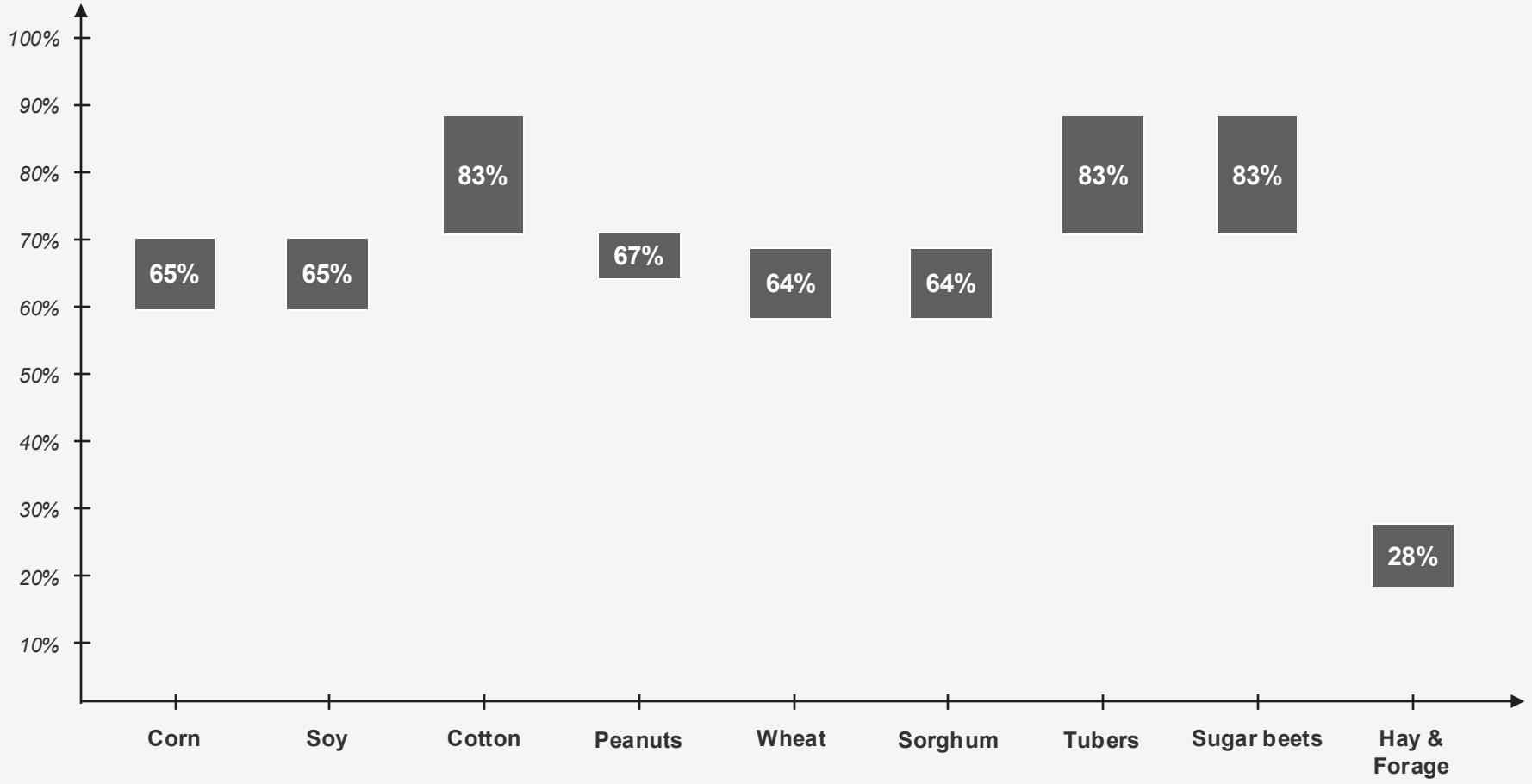
- 30+ years of experience driving innovation and strategic growth in agriculture and aftermarket businesses
- Led Deere Intelligent Solutions Group pilots, testing new precision ag service concepts with farmers and dealers to drive farm profitability
- Deep expertise in agriculture, precision ag technology, and aftermarket parts/services, with a proven ability to align strategy, operations, and dealer networks to deliver profitable growth

# Appendix

KEARNEY

# Rate of adoption of auto guidance

## Auto guidance improves efficiency by reducing overlap and avoiding skips during field passes with tillage, planters, sprayers and harvesters.




**KEY**

**Inputs Impacted by Technology**

- ALL INPUTS
- FERTILIZER USE
- HERBICIDE USE
- FUEL USE
- WATER USE

**Degree of Variability in Adoption**

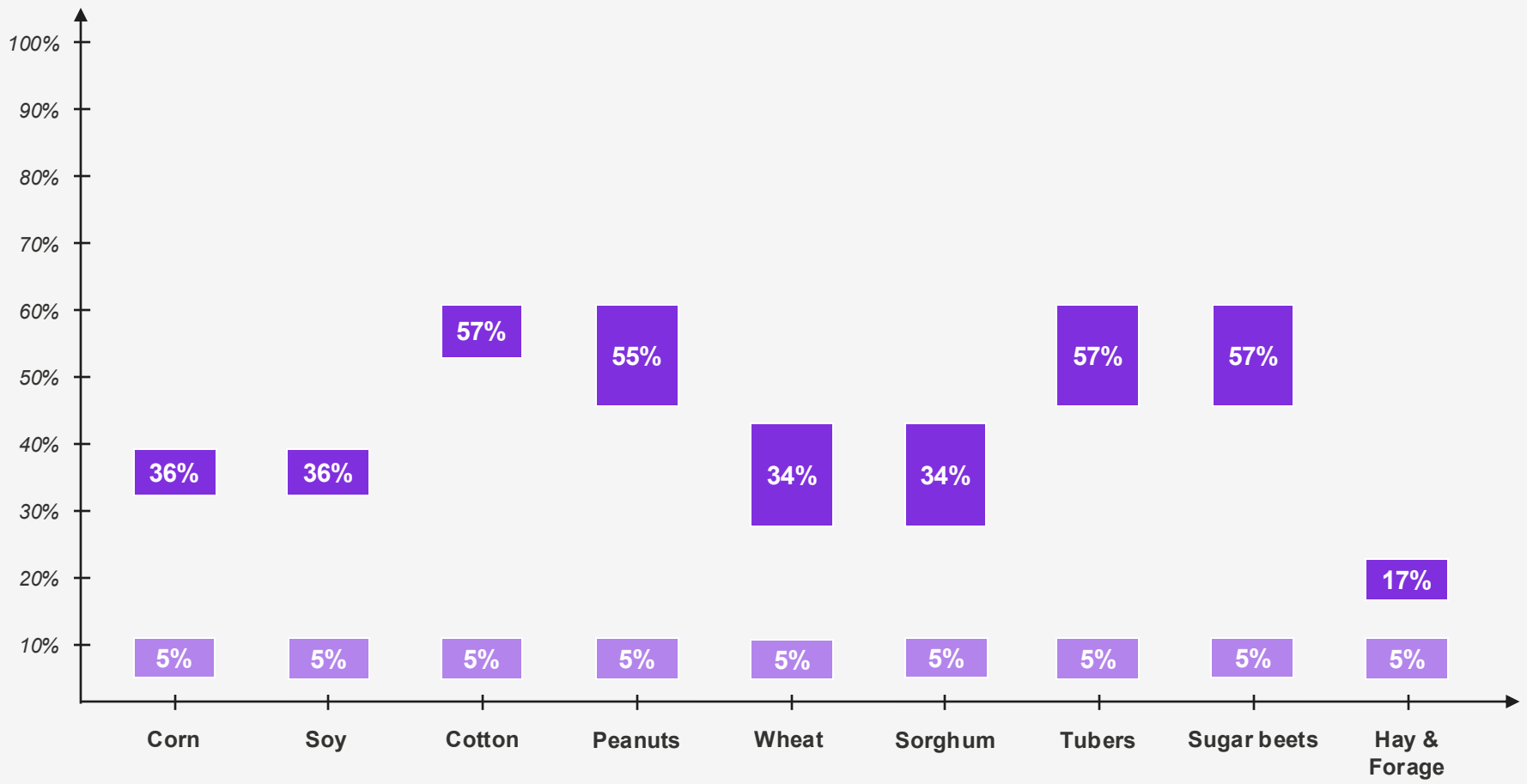
HIGH MED LOW



Source: Kearney Analysis based on USDA NASS, USDA ERS, Purdue Precision Ag Dealership Survey, Iowa State University, North Dakota State University, South Dakota University, The Ohio State University, University of California (Davis), University of Illinois, University of Kentucky

# Rate of adoption of variable rate application

## Variable rate technologies improve efficiency by adjusting seed, fertilizer and pesticide applications according to prescription maps.

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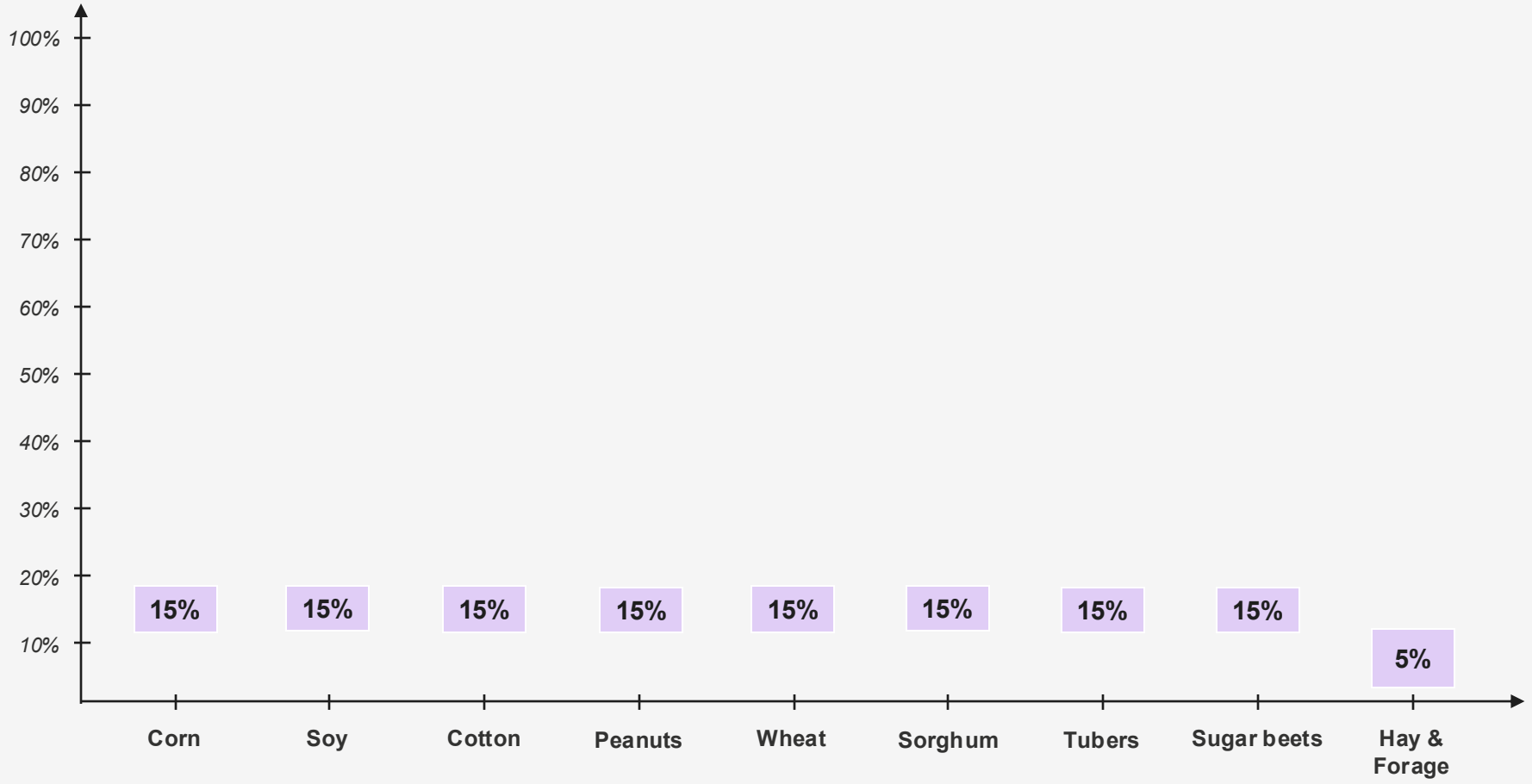
Source: Kearney Analysis based on USDA NASS, USDA ERS, Purdue Precision Ag Dealership Survey, Iowa State University, North Dakota State University, South Dakota University, The Ohio State University, University of California (Davis), University of Illinois, University of Kentucky

# Adoption of fleet analytics & telematics

## Fleet analytics & telematics helps operators improve efficiency by monitoring machine usage and fleet performance, leading to long-term reductions in fuel use.

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Source: Kearney Analysis based on USDA NASS, USDA ERS, Purdue Precision Ag Dealership Survey, Iowa State University, North Dakota State University, South Dakota University, The Ohio State University, University of California (Davis), University of Illinois, University of Kentucky

# Adoption of precision irrigation

## Computer sensor–driven precision pivots reduce overall water use on acres where they are adopted.


**KEY**

**Inputs Impacted by Technology**

- ALL INPUTS
- FERTILIZER USE
- HERBICIDE USE
- FUEL USE
- WATER USE

**Degree of Variability in Adoption**

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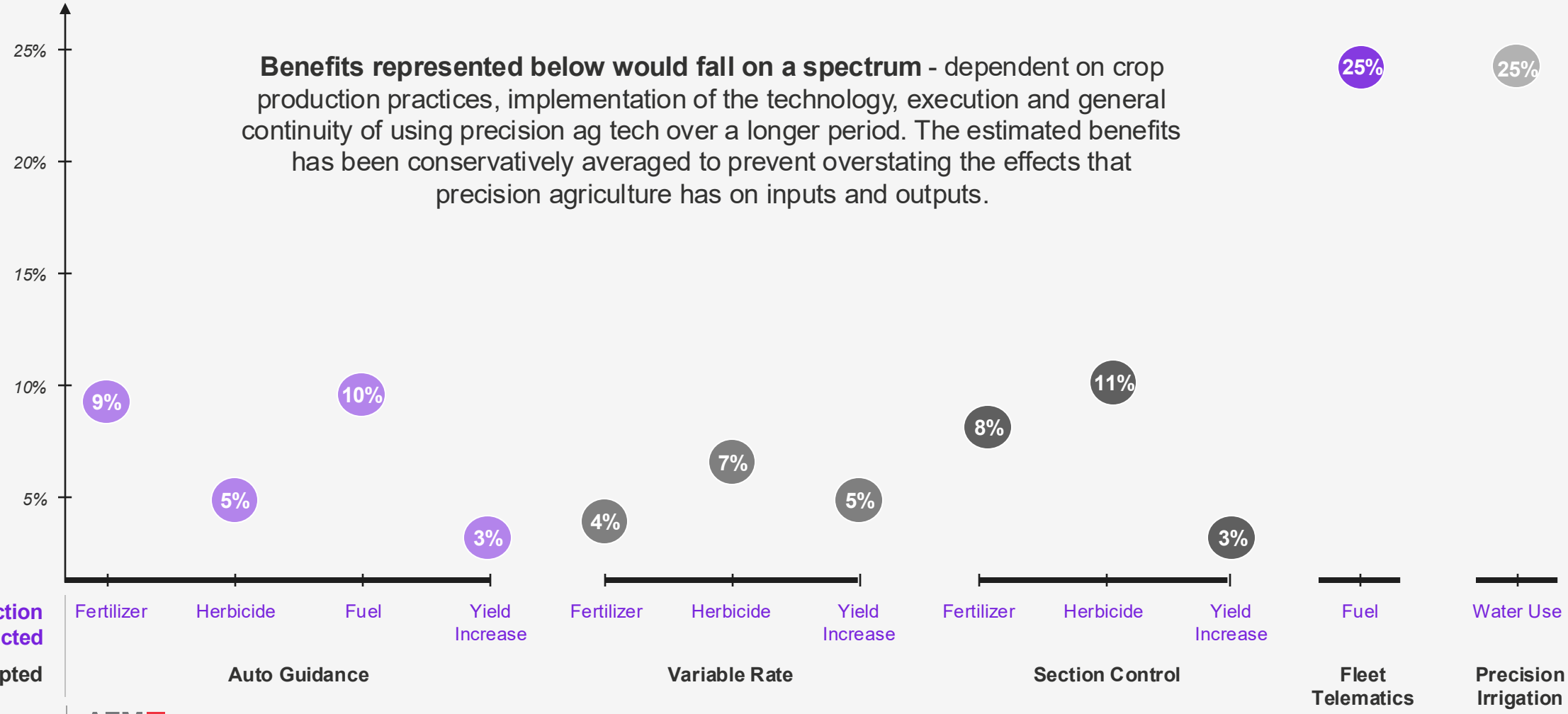
Source: Kearney Analysis based on USDA NASS, USDA ERS, Purdue Precision Ag Dealership Survey, Iowa State University, North Dakota State University, South Dakota University, The Ohio State University, University of California (Davis), University of Illinois, University of Kentucky

# Estimated benefits of precision ag technologies

**Represents the percent decrease in the use of inputs (increase in the case of yields) resulting from the adoption of precision ag technologies applicable to all crops.**




Source: Kearney Analysis based on USDA NASS, USDA ERS, Purdue Precision Ag Dealership Survey, Iowa State University, North Dakota State University, South Dakota University, The Ohio State University, University of California (Davis), University of Illinois, University of Kentucky

# Shifts in Precision Ag Benefits Study: 2019 vs. 2025 Comparison

| | 2019 | | 2025 | |
|---|---|---|---|---|
| | Current Benefit | Future Benefit | Current Benefit | Future Benefit |
| Production Increases | 4.2% | 6.4% | 4.5% | 6.1% |
| Fertilizer Optimization | 7.4% | 14.2% | 7.6% | 14.0% |
| Herbicide Optimization | 8.8% | 15.2% | 9.3% | 12.4% |
| Fuel Reduction | 6.4% | 15.6% | 7.0% | 7.4% |
| Water Reduction | 4.3% | 20.5% | 4.8% | 19.9% |



Source: Kearney Analysis based on USDA NASS, USDA ERS, Purdue Precision Ag Dealership Survey, Iowa State University, North Dakota State University, South Dakota University, The Ohio State University, University of California (Davis), University of Illinois, University of Kentucky

**Breakout view:** At a national level, near-full adoption of targeted spray application could result in a 55% annual reduction in applied herbicide volumes

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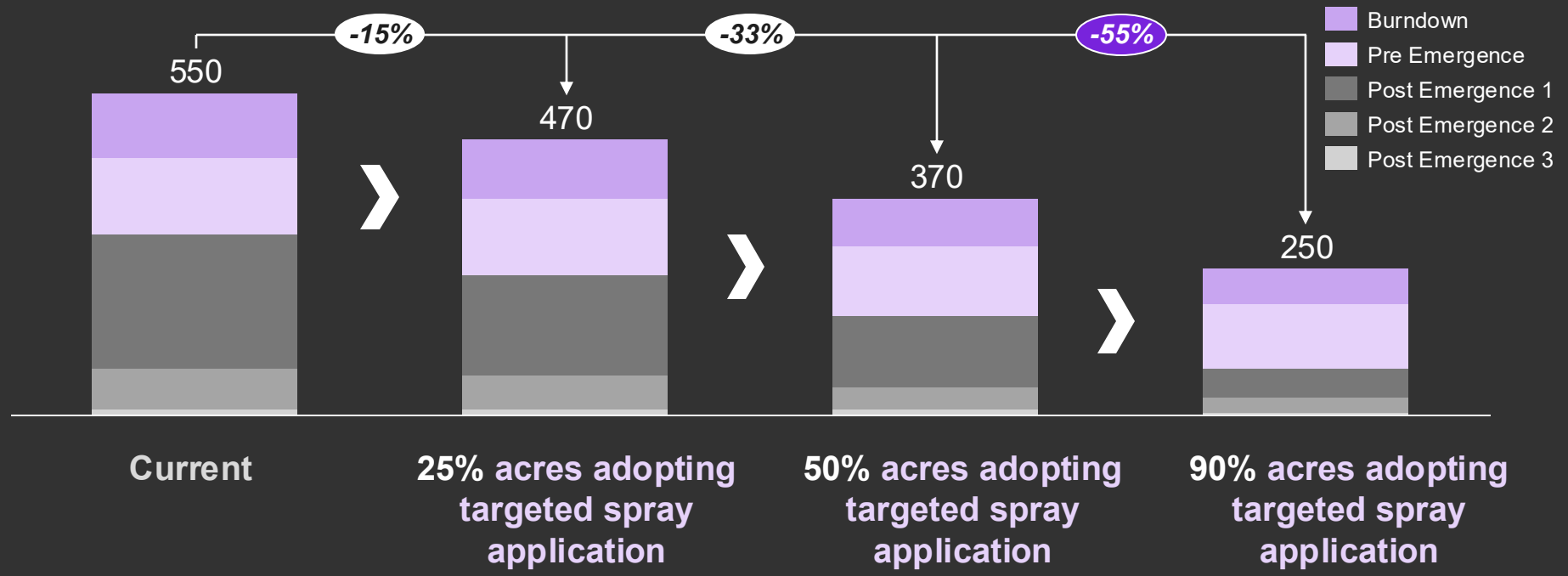


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Source: USDA, Iowa State University, Kearney Analysis & Expert Input

# Impact to key agricultural value chain stakeholders

## Farmers

- Less herbicide spend resulting in the potential for higher profitability
- Simplified logistics of spraying and time saving
- Increased yields and cleaner fields
- Improved soil health, biodiversity and structure

## Ag Equipment

- New revenue streams via hardware + usage-base fee / recurring model
- Dealer and grower enablement requires training, tools, incentives
- Tech complexity demands strong support and reliability
- Focus shifts from new iron sales to ongoing consulting services

## Crop Protection

- Product mix shifts toward higher-value chemistries
- New service models – “spraying-as-a-service”
- Sustained demand for many pre-emergent herbicides as they will continue to be applied via broadcasting
- Slower resistance development extends product lifecycle

Sources: Kearney, Farm Progress, University of Minnesota Extension, University of Arkansas Agricultural Experiment Station, Iowa State Extension,