

AI Adoption in Agriculture

Why the gap persists and what must change

27% to 22%
drop in the share of US farms using precision agriculture, 2023 to 2025

+46%
increase in Chapter 12 farm bankruptcy filings in 2025

0 of 13
platforms reviewed combine voice, compliance and an audit trail. Until now.

FarmBot™

An analysis of the US, UK and EU
Published by FarmBot Technology, LLC and Diverse AI Solutions, LLC

Diverse AI SOLUTIONS

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FOREWORD

A note from our Co-Founder and CEO

I have spent two decades leading digital transformation and data strategy for organizations including Google, Meta, Microsoft, Accenture, IDEO and Emirates Airlines, across the United States, London, Singapore and the Middle East. In every market I saw the same design flaw. Every product has a default user, and everyone else has to adapt. Building for everyone else has become the work of my career. Agriculture is where enterprise scale, inclusive design and data strategy meet. It is the most overlooked market I have worked in, and one of the most important.

This paper began with a number I could not set aside. Between 2023 and 2025, the share of US farms using precision agriculture fell from 27% to 22% (USDA NASS 2025a). Over the same period, the cost of computing, cloud infrastructure and AI model access kept falling and the capabilities of the tools kept expanding (US GAO 2024). A technology that improves while fewer people use it calls for an explanation. The most common explanation is farmers are resistant to change. The evidence reviewed here supports a different reading. In a 2026 survey, 81% of farmers described themselves as proactive experimenters or logical adopters, and only 3.3% said they avoid new technology until it is the absolute last resort (Bushel 2026). The barriers that farmers and dealers name most often are cost, complexity, data interpretation and integration (Erickson and Lowenberg-DeBoer 2025; US GAO 2024). These are product characteristics, and they raise a design question: who were the tools built for? Too many of the people who feed us were simply forgotten in the answer.

The same question applies to regulation. Farmers face a large and growing body of rules, and the evidence shows that notification often fails to reach them before penalties begin. The Corporate Transparency Act episode of 2024 and the results of the FDA's Foreign Supplier Verification Program illustrate a recurring structural pattern.

It is an honor to build custom products for farmers around the world, and a real privilege to help revolutionize the agtech industry alongside farmers like Mateo Kehler, our inaugural Founding Farmer.

I offer this paper as a contribution to a shared evidence base. It documents the adoption gap, the compliance burden and the market response, and it is candid about where the evidence is thin. FarmBot Tech is building a product for this market, and the final sections describe our approach. The evidence sections can be read, and challenged, independently of it.

Detria Williamson

Detria Williamson
Co-Founder and CEO, FarmBot Tech

ABOUT THIS RESEARCH

Type of research. This paper is desk research. It draws on secondary sources from USDA, the EU Joint Research Centre, DEFRA, peer-reviewed academic literature, industry surveys, regulatory enforcement data and market intelligence compiled between 2020 and 2026.

Scope. The paper examines the United States, the European Union and the United Kingdom, the three markets where the gap between precision agriculture's promise and its results is most extensively documented. US evidence leads the argument throughout, with European and UK data corroborating and extending it. Canada, India, Sub-Saharan Africa and Latin America present analogous dynamics and are reserved for later research.

Original analysis included in this paper.

1. *Competitive platform review.* Thirteen commercial agricultural platforms in the US, UK and EU were assessed against three capabilities: a voice-first interface, integrated regulatory compliance guidance and a verifiable digital audit trail. The review combined AI-assisted research with manual verification against primary sources. No platform assessed combined all three capabilities.
2. *Customer-experience evidence search.* G2, Capterra, app store ratings, industry surveys and Net Promoter Score benchmark databases were searched for published customer-experience data on the platforms assessed. For the majority of platforms, no published data on reliability, trust, quality, customer care or ease of use was found.

Research in progress. FarmBot Tech and Diverse AI Solutions are conducting ongoing qualitative research with farmers across crop, livestock and textile sectors. No findings from that research are included in this paper. Results are planned for a subsequent report.

Limitations. The evidence is secondary and was published by different organizations using different definitions and survey methods. Dealer estimates describe dealers' markets and do not measure farms directly. The Rogers adopter percentages are a theoretical model and not a measured share of farms. The competitive review reflects public information available when it was conducted.

KEY FINDINGS

1. US precision agriculture adoption fell from 27% to 22% of farms between 2023 and 2025 (USDA NASS 2025a).
2. Large farms use precision tools at more than five times the rate of small farms, 68% against 13% (McFadden and Lim 2024).
3. Eighty-one percent of farmers describe themselves as proactive experimenters or logical adopters. Only 3.3% avoid technology until a last resort (Bushel 2026).
4. Chapter 12 farm bankruptcy filings rose 46% in 2025, to 315 (AFBF 2026).
5. More than 230,000 farming operations were unknowingly exposed to federal felony-level penalties under the Corporate Transparency Act, and fewer than 11% of eligible businesses had filed when the AFBF issued its alert (AFBF 2024a, 2024b).
6. Wearable sensors are used on 12% of large US livestock farms and 1% of small ones (McFadden and Lim 2024). Dealers estimate satellite and aerial imagery use fell from 31% to 22% of acres between 2022 and 2025 (Erickson and Lowenberg-DeBoer 2025).
7. Of 13 commercial platforms reviewed, none combines voice-first interaction, integrated compliance guidance and a verifiable audit trail (FarmBot Tech competitive review, 2026).

Executive Summary

AT A GLANCE

27% to 22%

drop in the share of US farms using precision agriculture, 2023 to 2025
USDA NASS 2025

5x
Large farms use precision tools at more than five times the rate of small farms (68% vs 13%)
USDA ERS 2024

81%
of farmers are proactive experimenters or logical adopters. Only 3.3% avoid new technology until a last resort
Bushel 2026

230,000+
farms were unknowingly exposed to felony-level penalties under the Corporate Transparency Act, per AFBF's October 2024 aler t
AFBF 2024

0 of 13
platforms reviewed combine voice-first interaction, compliance guidance and a verifiable audit trail
FarmBot Tech competitive review, 2026

THE BOTTOM LINE

The adoption shortfall is a supply-side design issue with measurable consequences for farm viability, food security, and rural economic resilience.

Precision agriculture adoption in the United States fell from 27% to 22% between 2023 and 2025. The technology did not get worse. As this paper documents, it was designed for a minority of farmers. The evidence is examined across the US, the EU and the UK.

Across all three geographies, the evidence points to the same conclusion. The adoption shortfall is a supply-side design issue with measurable consequences for farm viability, food security and rural economic resilience.

The economic context is severe. US farm bankruptcies rose 46% in 2025, the cattle herd contracted to its smallest size since 1951 and commodity prices fell as much as 58% from their 2022 peak. In the EU, 44% of small commercial farms disappeared between 2007 and 2022. In the UK, 29% of farm businesses recorded a net loss in 2023/24, and only 4% of farmers feel very positive about their future in farming.

Within that environment, precision agriculture has delivered tools that 68% of large US farms use and 13% of small farms use. The design assumptions built into those tools describe a significant but minority segment: large operations, agronomists on staff, reliable connectivity and time to interpret data-intensive systems. Rogers' Diffusion of Innovations explains the pattern, since tools built for innovators and early adopters do not reach the pragmatic mainstream without redesign. The average US farmer manages three or more software platforms that cannot share data, and over 60% of mid-career farmers find integration between their digital tools difficult.

The same divide runs through livestock and satellite data. Wearable sensors are used on 12% of large US livestock farms and 1% of small ones, and dealers estimate that satellite and aerial imagery use fell from 31% to 22% of acres between 2022 and 2025. The layer that turns satellite observations into farm-

level guidance was built for the agencies and insurers that verify claims about the land, and not for the farmer.

Voice is the access mechanism that can reach farmers where they work. There are 8.4 billion voice assistants in use globally, 82% of US farms have smartphones, and rural connectivity across the three geographies is sufficient to support voice. No commercial platform reviewed combines voice-first interaction with integrated farm data.

Regulatory compliance is the most urgent use case. EU farmers spend an average of seven working days a year on CAP administration, at about €1,230 per farmer. Research on US aquaculture found regulation consumes between 9% and 30% of operating expenses. The FDA's Foreign Supplier Verification Program has recorded a non-compliance rate that has never fallen below 43%, driven by the complete absence of any program. These outcomes reflect information systems that do not reach the people they govern.

The market has not closed the gap. No platform reviewed combines voice-first interaction, regulatory compliance guidance and a verifiable audit trail. The AI in agriculture market is projected to reach $8.5 billion by 2030, and investment is concentrating on the already-served segment. FarmBot Tech aggregates farm data across the regulatory, agronomic and operational domains that farmers must navigate. Its first applications are livestock and satellite data, delivered through a voice-first interface, with compliance as the primary use case.

Introduction

Between 2023 and 2025, the share of US farms using precision agriculture practices to manage crops or livestock fell from 27% to 22%. Over the same period, the underlying technology continued to improve and the cost of computing, cloud infrastructure and AI model access continued to fall (USDA NASS 2025a; US GAO 2024). This is the central question the paper investigates. The tools are better and cheaper, and fewer farmers are using them.

The conventional explanation is a demand-side account in which farmers are resistant, risk-averse or unready. That framing is long-standing. Precision agriculture dealers have overestimated adoption across 26 technologies for more than two decades (Malone et al. 2026). Farmers report a different position. They describe themselves as logical adopters waiting for a proven business case, and fewer than one in twenty avoids new technology. The barriers they name are complexity of use, integration failure, unclear return on investment and tools that do not fit how they work.

The paper's argument has four parts. First, the farm economy across all three geographies is under structural pressure that makes the technology gap urgent. Second, the gap reflects design. Precision agriculture was built for innovators and early adopters, and the mainstream majority has been waiting for tools built for them. Third, the divide is widest in livestock and satellite data, and voice is an access mechanism that agricultural platforms have not been designed around, with the infrastructure for it already in place. Fourth, regulatory compliance is the most consequential and least addressed use case for a platform that fills this gap, and for specific groups of farmers the absence of that platform functions as a barrier to market entry.

The paper is not a technology review, a critique of individual platforms or an assessment of farmer capability. The tools are the subject of scrutiny. Farmers are the intended beneficiaries.

PART 01

The stakes and the gap

Farm economies are under strain, and the tools meant to help most farmers were built for someone else.

01 The stakes

02 The gap

27% to 22%

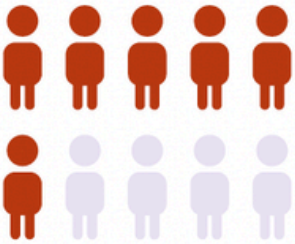
drop in the share of US farms using precision agriculture, 2023 to 2025 (USDA NASS 2025)

01 SECTION ONE The stakes

46%

rise in Chapter 12 farm bankruptcy filings in 2025, to 315

AFBF 2026



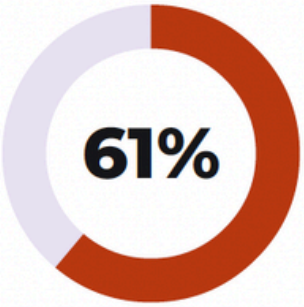
6 in 10 US farmers say farming may not continue in its current form without changes

Modern Ag Alliance 2026



44% of EU small commercial farms disappeared between 2007 and 2022

Greenpeace 2024



61% of farms in England failed to recover their full costs, including unpaid labor, in 2023/24

Defra 2025

Up to 58%

drop in major commodity prices since 2022

Modern Ag Alliance 2026

86.7M head US cattle herd in January 2025, the smallest since 1951

USDA NASS 2025

THE ECONOMIC PICTURE

The commodity price spike that followed Russia's invasion of Ukraine masked deteriorating fundamentals in the farm economy. When prices corrected, farms that had held on through input cost inflation were exposed. US farm production expenses reached $473.1 billion in 2025, and only about half of US farmers expected to be profitable that year (USDA ERS 2026; Modern Ag Alliance 2026). Chapter 12 farm bankruptcy filings rose for the second year in a row, reaching 315 in 2025, a 46% increase from 2024 (AFBF 2026).

$473.1B

US farm production expenses in 2025

USDA ERS 2026

> "most challenging farm economies in recent memory"
>
> **Modern Ag Alliance, State of the American Farmer 2026**

Farmers share that assessment. Sixty percent of those surveyed believe that without a course correction, farming in America will cease to exist as we know it (Modern Ag Alliance 2026).

The European income picture is volatile and, at the aggregate level, misleading. In 2023, EU agricultural labor productivity per annual work unit fell an estimated 6.6%, driven by a 7.9% drop in real factor income, with the steepest national declines in Estonia (-57.9%), Ireland (-30.3%) and Lithuania (-30.2%) (Eurostat 2023). The aggregate figure improves in part because smaller, unviable farms exit. Between 2007 and 2022, the EU lost 44% of its small commercial farms, those with €2,000 to €49,999 in standard output per year, while the number of mega-farms, with standard output above €250,000, grew by 56% (Greenpeace 2024). Consolidation of this kind signals which farms the market is leaving behind.

In the United Kingdom, 29% of Great Britain's farm businesses recorded a net loss in 2023/24, compared with 17% the year before, and formal agricultural insolvencies in England and Wales rose from 83 in 2023 to 97 in 2024 (DEFRA 2025a; Insolvency Service 2025). The post-Brexit transition from the Basic Payment Scheme to the Environmental Land Management scheme removed a floor on which many smaller operations depended, without yet replacing it with accessible alternatives.

CLIMATE AS COMPOUNDING PRESSURE

Drought, flooding and growing-season unpredictability amplify the income volatility farmers already face. A 2026 European Environment Agency briefing synthesizing 51 farm-level case studies found that climate-resilient agriculture can act as downside-risk protection. It reduces both the probability and the severity of bad-year income shocks, and its payoffs rise as hazard exposure rises (EEA 2026). The inverse also holds, since farms without climate adaptation investment face greater exposure when market conditions are least forgiving. In the United States, drought from 2021 through 2023 led farmers to place breeding females on feed instead of keeping them to produce calves. That liquidation cycle pushed the cattle herd to a 74-year low (AFBF 2025).

WHO BEARS THE WEIGHT

The strain is uneven. Sixty-eight percent of large US crop-producing farms use precision agriculture tools such as yield monitors and yield or soil maps. Thirteen percent of small crop-producing farms do (McFadden and Lim 2024). The farms most exposed to economic stress are small operations with thinner margins and fewer resources to absorb shocks, and they are the farms where the technology access gap is widest.

Regenerative and certified organic producers face a separate set of pressures at any scale. The USDA Regenerative Agriculture Pilot Program, launched in December 2025 with $700 million in funding, signals policy recognition of this segment. The 17,445 certified organic farms operating in the US face certification and compliance burdens that existing precision agriculture tools were not built to address (USDA NRCS 2025; USDA NASS 2022).

BEYOND CROP FARMING

Livestock and textile crop producers are under parallel stress, and the tools available to them are fewer. US pig producers faced negative margins in 2022 and 2023, with losses averaging $20 to $40 per head (NPPC 2023). UK pig farmers reached their low point in 2021, with estimated net margins of -£58 per head (AHDB 2025). EU pork production fell 11.8% from its 2021 peak to 2023 (Eurostat 2025b). US cotton prices fell about 24% between 2022/23 and 2024/25, and 2023/24 harvested acreage was the lowest since 1866/67 (USDA AMS 2025; Meyer and Dew 2024). British wool auction prices fell to as low as 60 pence per kilogram, returning 25 pence or less to producers after handling costs (British Wool 2025).

The tools available to these producers are fewer still, as Section Three documents.

A PUBLIC-GOOD QUESTION

When farms struggle, the consequences extend beyond the farm gate. In 2024, 32% of people in rural areas worldwide faced moderate or severe food insecurity, compared with 23.9% of urban residents. Urban food insecurity declined from 25.7% while rural rates stayed virtually unchanged (FAO et al. 2025). The financing gap facing smallholder farming operations in developing regions exceeds $200 billion a year, against a total financing need of $323 billion (ISF Advisors 2025). Strain on farms in the US, Europe and the UK reaches supply chains, food prices, rural employment and community stability across borders.

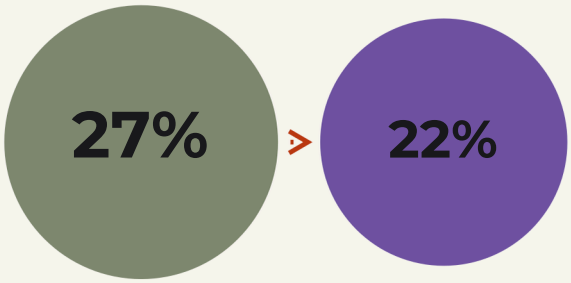
KEY TAKEAWAY

Strain on US, EU and UK farms shows up in prices, margins and bankruptcies, and it falls hardest on small operations, the same farms where the technology gap is widest.

02 | SECTION TWO The gap

US farms using precision agriculture fell from 27% to 22% in two years

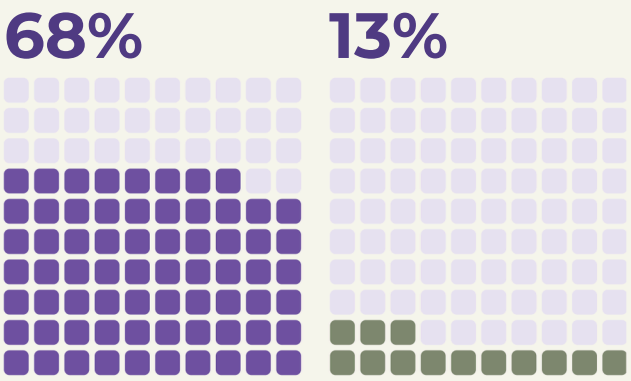
Share of US farms using precision agriculture, area-proportional circles



SOURCE USDA NASS, Technology Use, Aug 2025

Large farms use precision tools at more than five times the rate of small farms

Share of crop-producing farms using precision agriculture, 2023, each square is one percentage point



SOURCE USDA ERS, McFadden and Lim 2024 (via Agriculture Dive)

ADOPTION IS FALLING

In 2023, 27% of US farms used precision agriculture practices to manage crops or livestock. By 2025, that figure had fallen to 22%, a 19% relative decline in two years, at a time when the economic case for adoption had never been stronger (USDA NASS 2025a). In seven of fourteen southern US states, adoption decreased outright. Tennessee, North Carolina and Alabama recorded relative declines of 61%, 37% and 32% (USDA NASS 2025a). In Europe, adoption grew significantly between 2008 and 2020 and has slowed since, likely because of economic uncertainty. The EU Joint Research Centre's 2025 survey of 1,444 farms in nine member states found that 93% of farms use some form of general digital technology, while individual specialized precision tools are used by only 3% to 23% of farms in any category (Tur Cardona et al. 2025).

-19%

relative decline in US precision agriculture adoption in two years

USDA NASS 2025a

DESIGNED FOR SOMEONE ELSE

Precision agriculture tools were built for a specific kind of operation: large, well-capitalized, with agronomic expertise on staff, fast and reliable connectivity, and the management time to learn and interpret data-intensive systems. That profile describes a minority of farms. It does not describe the 86% of US farms classified as small family farms (Lim and Lacy 2025), the 44% of EU small commercial farms that left the market between 2007 and 2022, or livestock and fiber producers for whom precision tools have had minimal reach (Greenpeace 2024).

86%

of US farms are classified as small family farms

Lim and Lacy 2025

The barriers farmers cite reflect this mismatch. The 2025 Purdue University Precision Agriculture Dealership Survey, a 25-year longitudinal study, found that 55% of dealers identified farm income pressure as the primary constraint on adoption. Four further barriers followed: precision services cost more than the benefits farmers receive (36%), data privacy concerns limit participation (33%), farmers lack confidence in site-specific agronomic recommendations (32%) and interpreting data takes too much of the farmer's time (31%) (Erickson and Lowenberg-DeBoer 2025). Each of these describes a feature of the product or the service model.

The US Government Accountability Office reached a consistent conclusion independently. Its 2024 review identified seven systemic barriers, including high acquisition costs, difficulty with data analysis and interpretation, a lack of interoperability standards and unreliable rural broadband (US GAO 2024).

McKinsey's 2023 survey of 5,500 row- and specialty-crop farmers across four global regions found that farmers require a minimum 3:1 return on investment before seriously considering a new farm management technology. Fifty percent of farmers globally were unwilling to pay anything for farm management software, and 40% of North American farmers cited unclear return on investment as a top barrier (Fiocco et al. 2023). A systematic review of 28 adoption studies found that perceived complexity significantly reduces adoption intent, even when farmers understand the financial case (Lee, Orton, and Lu 2024).

THE INTEGRATION CHALLENGE

The problem compounds at the platform level. The average US farmer uses three separate software programs for farm business management, and 38% use four or more (Bushel 2026). These systems do not communicate. Bushel's 2026 State of the Farm report found that over 60% of mid-career farmers, who manage the most complex operations, find integration between their digital tools difficult, citing the need to re-enter the same information across systems. Easier data integration and automation ranked among the top requested improvements. Farmers are asking for the tools they already have to work together (Bushel 2026).

60%+

of mid-career farmers find integration between their digital tools difficult

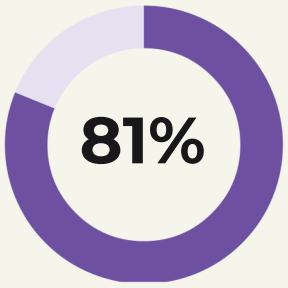
Bushel 2026

Poor interoperability has a trust cost. Yeo and Keske (2024) found interoperability to be a key facilitating condition and trust to be a central moderating factor in adoption decisions. Each generation of disconnected products adds to the adoption deficit.

THE SOPHISTICATED-ADOPTER TEST

Nearly 81% of farmers are experimenters or logical adopters

Share of farmers by willingness to adopt new technology, 2026



81% proactive experimenters or logical adopters

3.3% avoid technology until it is the absolute last resort

SOURCE Bushel, 2026 State of the Farm Report, p. 14 (n = 668)

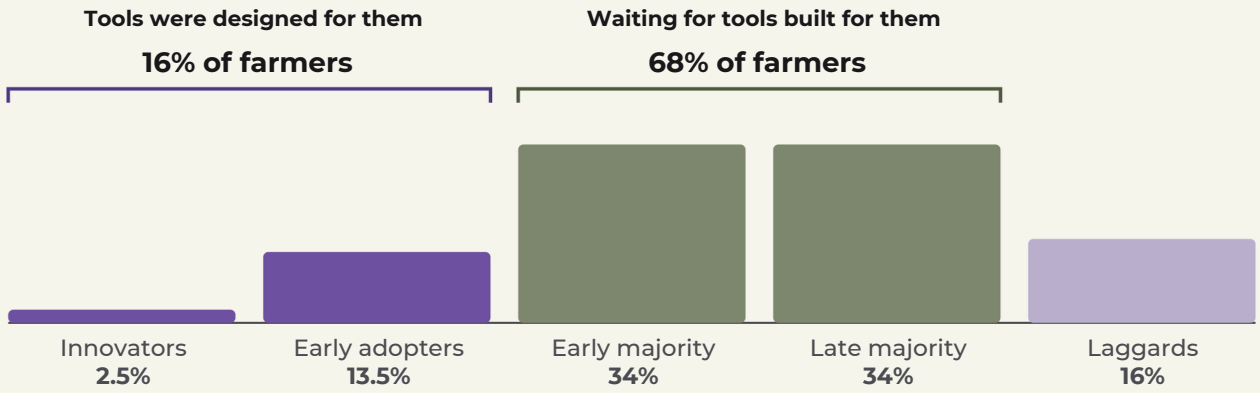
The design gap extends beyond small or low-resource operations. Bushel's 2026 report found that 81% of farmers across all operation sizes describe themselves as either proactive technology experimenters or logical adopters waiting for a

proven business case. Only 3.3% actively avoid technology until it is the absolute last resort (Bushel 2026). Technically sophisticated farmers also report that existing tools fall short. Data interpretation takes too long, support is unavailable during critical field operations, and the workflow friction of managing multiple disconnected platforms exceeds the value the platforms deliver (Fiocco et al. 2023; Yeo and Keske 2024; Bushel 2026).

ROGERS AND THE WRONG ADOPTER

Precision tools were designed for roughly the first 16% of a typical adoption curve

Rogers adopter categories, share of a population. A theoretical model and not a measured share of farms.



SOURCE Rogers, Diffusion of Innovations (2003), as summarized by Windon 2024 (Penn State Extension)

Everett Rogers' Diffusion of Innovations framework has accumulated over 163,900 citations since its origins in hybrid corn adoption research in the 1940s, and it provides a structural explanation (Rogers 2003; Ryan and Gross 1943). Rogers identified five adopter categories: Innovators (2.5%), Early Adopters (13.5%), the Early Majority (34%), the Late Majority (34%) and Laggards (16%) (Windon 2024). Precision agriculture tools were designed for the first two groups, roughly 16% of farmers who are risk-tolerant, well-resourced and comfortable with unproven systems. Demonstration programs, early-adopter outreach and dealership services have historically targeted this segment.

The Early and Late Majority together make up 68% of farmers. They are pragmatic and need technology that is simple, proven and well supported before they commit. Their reluctance to adopt tools designed for someone else was rational. Rogers identifies five attributes that determine diffusion: relative advantage, compatibility with existing practices, complexity, trialability and observability. Precision agriculture performs well on relative advantage in controlled settings. It performs poorly on compatibility, complexity and trialability for the mainstream farmer.

KEY TAKEAWAY

Adoption fell while the tools improved. The barriers that farmers and dealers name are cost, complexity, data interpretation and integration, which are features of product design.

PART 02

Livestock, satellite data and voice

The divide is widest in livestock and satellite data, and voice is a practical way to close it.

03 Livestock and satellite data

04 Voice, the access layer

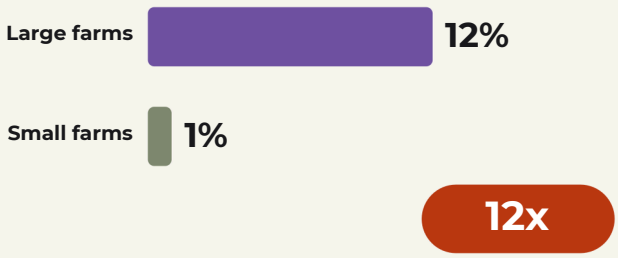
12% vs 1%

of large and small US livestock farms use wearable sensors (McFadden and Lim 2024)

03 SECTION THREE Livestock and satellite data

Large livestock farms use wearable sensors at about 12 times the rate of small farms

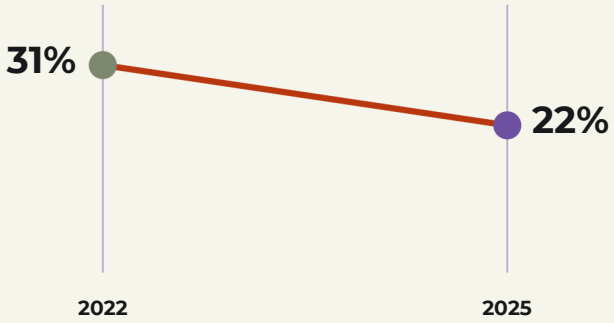
Share of livestock farms using wearable sensor technology



SOURCE USDA ERS, McFadden and Lim 2024

Dealers estimate imagery use fell from 31% to 22% of acres, 2022 to 2025

Share of acres using satellite or aerial imagery, dealer estimate



SOURCE Erickson and Lowenberg-DeBoer 2025 (Purdue)

Precision tools were built mostly for row crops. Livestock and fiber producers have fewer options, and satellite data remains out of reach for most farms. This section documents both divides, because livestock operations and satellite-derived evidence are where the adoption gap is widest and where the next generation of farm tools is being built.

THE LIVESTOCK GAP

Precision livestock farming, the sector equivalent of precision crop agriculture, has barely reached livestock operations. Wearable sensor technologies are used on 1% of small US livestock farms and 12% of large ones (McFadden and Lim 2024). The stress on these sectors is documented in Section One, and the compliance obligations specific to livestock are documented in Section Five.

AN UNADDRESSED MARKET

No major platform in any of the three geographies addresses the compliance or traceability requirements specific to livestock or textile crop producers. The obligations specific to livestock farmers, including USDA FSIS requirements, EPA CAFO regulation and animal welfare certification, are addressed by no commercial platform reviewed. Premium buyers and export markets increasingly demand seed-to-store traceability in textile crops and farm-to-fork traceability in livestock, and neither group has an integrated platform solution.

THE SATELLITE DIVIDE

The same divide runs through satellite data. USDA agencies use aerial photography and satellite imagery to maintain farm records and to assist inspections and determinations about individual operations (USDA FSA 2024; USDA RMA 2024). The layer that turns those observations into farm-level guidance was not built for the mainstream farmer. The GAO reported, citing agency officials, that imaging technologies have not been widely adopted because farmers had no ready way to turn imagery into decisions (US GAO 2024, 38 to 39).

On the farm, dealers estimate that imagery was used on 22% of acres in their markets in 2025, down from 31% in 2022, and fewer than half of dealers now offer it (Erickson and Lowenberg-DeBoer 2025, 10, 21 to 22). Farm size follows the same line. In the US, 12% of large family farms used drones in 2023, against 2% of small family farms (McFadden and Lim 2024). In the EU, maps from satellite data reach 22% of surveyed farms, and small farms trail both medium- sized farms (29%) and large ones (Tur Cardona et al. 2025, 29, 35, 95).

THE DATA LAYER: AVAILABLE, NOT YET INTEGRATED

Hyperspectral satellite imagery records light across hundreds of narrow bands, which enables detection of plant stress, soil composition and nutrient levels at field scale. Commercial providers now offer it. NASA's Commercial Satellite Data Acquisition program describes Pixxel's Firefly constellation as operational and has acquired Pixxel data for scientific purposes (NASA 2026c). Wyvern's Dragonette constellation, which NASA describes as enabling vegetation-health and soil analysis, is undergoing evaluation in the same program (NASA 2026b). Tanager-1, built by Planet around a NASA JPL-developed spectrometer, measures methane and carbon-dioxide point-source emissions for the Carbon Mapper Coalition (NASA 2024). The infrastructure is being built and validated at the institutional level. Yet the sources reviewed for this paper show no verifiable evidence of commercial hyperspectral data reaching farmers at scale through an agricultural product.

Reliability is an industry-wide frontier. A reported accuracy describes the crop, region and season in which a model was tested, and studies in Slovakia and the US Midwest show that performance can change when a model moves to a new year or region (Rusňák et al. 2023; Ma et al. 2023). This validation work separates a promising dataset from a decision-ready tool, and no agricultural product has yet completed it at scale.

WHERE FARM DATA AND EVIDENCE MEET

Satellite data now also functions as evidence. Insurers, agencies and importers increasingly use it to verify claims about the land, and the farmer is the subject of that verification (Section Five). A layer that turns satellite observations into plain-language guidance, and into evidence a farmer can see, question and share, is the missing piece. Voice, discussed next, is one of the most practical ways to deliver it.

KEY TAKEAWAY

Wearable sensors reach 12% of large US livestock farms and 1% of small ones, and dealers estimate satellite imagery use is falling. The step from data to farm-level guidance is the missing layer.

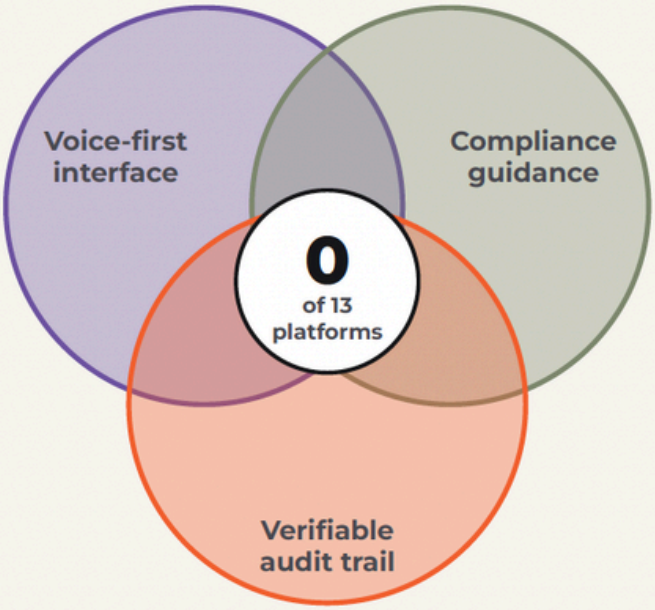
04 | SECTION FOUR
Voice, the access layer

8.4 billion
voice assistants are in use worldwide, more than the global population
Statista 2024

82%
of US farms have smartphones
USDA NASS 2025

168 million
US voice assistant users projected by 2029, up from 140 million in 2022
eMarketer 2025

No platform reviewed combines all three
Thirteen commercial agricultural platforms in the US, UK and EU assessed against three capabilities



SOURCE FarmBot Tech competitive review, 2026. AI-assisted research with manual verification.

VOICE IS ALREADY A DEFAULT INTERFACE

There are 8.4 billion voice assistants in use globally, more than the human population and double the number in use in 2020 (Statista 2024a). eMarketer projects 168 million US voice assistant users by 2029, up from 140 million in 2022 (eMarketer 2025). About one in five internet users worldwide used voice search actively as of early 2025 (Kemp 2025). Voice is an established interface for hundreds of millions of people.

THE ACCESS LAYER FARMERS ALREADY USE

Eighty-two percent of US farms have smartphones (USDA NASS 2025a). Rural internet access in the EU reached 91% of households by 2023, and the urban-rural gap narrowed from 9.7 to 4.4 percentage points since 2013 (Eurostat 2024). In the UK, 89% of rural premises have superfast broadband access (DEFRA 2026). The devices and connectivity needed for voice are in place across all three geographies. What farmers lack is a voice interface designed for their work.

WHAT VOICE REMOVES

Research from Carnegie Mellon University found that well-designed speech interfaces outperform touch-tone equivalents for task completion, for both literate and low-literate users (Sherwani et al. 2009). The most rigorous voice-first adoption evidence comes from sub-Saharan Africa, where interactive voice response programs have run at scale long enough to produce controlled trial data. In a randomized controlled trial with 408 smallholder pig farmers in Uganda, 91% rated their voice experience as good or very good, and 96.7% would welcome another voice-delivered course (Dione et al. 2021). Women farmers cited scheduling flexibility as a particular benefit.

96.7%

of Ugandan pig farmers in a randomized trial would welcome another voice-delivered course

Dione et al. 2021

The practical reasons are straightforward. Voice is hands-free in field conditions, requires no typing or screen literacy, works in the language the farmer speaks and is available during work. Evaluated against Rogers' five attributes, voice fits existing behavior, reduces complexity and lets a farmer try it with a single question. Observability is the exception, since no agricultural voice AI is deployed at scale and peer-community evidence is limited. Voice matters most where farm data is richest and hardest to read. Satellite data now supports soil moisture, drought and crop monitoring (NOAA NESDIS 2023; EUSPA 2024), and accuracy carries real stakes.

> **a monitoring error "may cost farmers millions of dollars in crop yield loss"**
>
> **NOAA NESDIS 2023**

The World Bank notes that generative AI can work across satellite imagery, weather reports and sensor data, and that natural-language voice interfaces are helping overcome barriers to technology uptake among small-scale producers (World Bank 2025). In a Gates Foundation-funded pilot in Bihar, India, the team behind a voice-based advisory service reported that integrating weather data made its advice more relevant and actionable (Collis et al. 2025).

THE MARKET GAP

In the United States, the most directly relevant development is a USDA NIFA Phase I Small Business Innovation Research award of $124,333 to Good Agriculture Inc. to build an AI-assisted farm data collection tool for small and mid-sized farms. It concluded at Phase I and had not been publicly deployed at scale at the time of writing (USDA NIFA 2024). ExtensionBot, built on content from more than 35 Cooperative Extension institutions, is text-based. Its next version, announced in August 2025, adds image support and not voice (Extension Foundation 2025a, 2025b). The USDA's FY2025 to 2026 AI Strategy centers on internal efficiency, data readiness and governance and does not describe farmer-facing voice advisory tools (USDA 2025).

In the EU, a German pilot called SmartFarm Co-Pilot (€499,955, 2024 to 2027) is developing a voice assistance system for hands-free documentation. It remains in the pilot phase (EU CAP Network 2024). In Croatia, AGRIVI received €1.15 million in Horizon Europe funding to develop ROBI, an AI agronomic adviser delivered as a WhatsApp text chatbot, and the funded project closed in May 2024 (European Commission 2023a). The commercial product that followed is sold as a white-label service to agri-input companies (AGRIVI 2025). No active agricultural voice AI deployment was identified in the UK.

KEY TAKEAWAY

Voice-first agricultural AI has worked at scale in India, Kenya, Ethiopia and Nigeria. The review found no comparable deployment at scale in the US, UK or EU.

PART 03

Compliance and the market

Rules often fail to reach farmers, and the market has not built the platform that would.

05 Compliance

06 The market

07 Barriers to entry

230,000+

farming operations unknowingly exposed to felony-level penalties (AFBF 2024)

05 | SECTION FIVE Compliance

Oct 2024
AFBF alert, 230,000+ farm operations exposed

Mar 2025
FinCEN removes the filing requirement for domestic companies

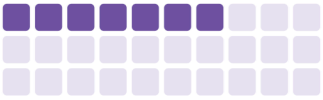
Aug 2026
Treasury final rule limits reporting to foreign businesses

REGULATORY VOLUME

90,402

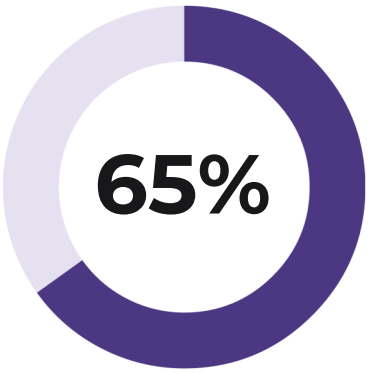
pages in the Federal Register in 2023, up 12% in a year
GW Regulatory Studies Center 2025

TIME COST



7 working days a year the average EU farmer spends on CAP paperwork, at about €1,230.
European Commission 2024

TRUST



of UK farmers on survey holdings are not at all confident in Defra to deliver planned changes
Defra 2025

THE CORPORATE TRANSPARENCY ACT EPISODE

In October 2024, the American Farm Bureau Federation issued an alert that more than 230,000 farming operations had unknowingly exposed themselves to federal felony-level penalties. The law was the Corporate Transparency Act, a corporate disclosure regulation with no agricultural focus and no targeted outreach to farmers. It captured most farming operations because of their LLC, partnership or S-corporation structure (Parsons, Hewlett, and Tranel 2024). Penalties included civil fines of $591 accumulating daily, criminal fines of up to $10,000 and up to two years in federal prison. When the alert was issued, fewer than 11% of eligible businesses nationwide had filed the required reports (AFBF 2024a, 2024b). Farmers did not ignore the law. They never heard about it.

<11%

of eligible businesses had filed when the AFBF issued its alert
AFBF 2024

FinCEN removed the filing requirement for domestic US companies in March 2025 (FinCEN 2025). The exposure is resolved, but the episode showed a structural vulnerability. Farmers have no reliable channel through which compliance obligations reach them before penalties begin to accumulate.

THE WEIGHT OF COMPLIANCE

The Federal Register reached 90,402 pages in 2023, a 12% increase from the prior year (GW Regulatory Studies Center 2025). Farmers contend with requirements from the EPA, the USDA, the FDA, the Department of Labor and an expanding body of state legislation, none of it coordinated.

The direct cost is quantifiable. Peer-reviewed research by Engle et al. (2025) found that regulatory compliance consumes between 9% and 30% of total farm operating expenses in the most heavily regulated US farming sectors. For US aquaculture alone, this translates to $196 million in direct annual regulatory costs, more than 8,000 jobs lost and $1.4 billion in foregone economic activity a year when multiplier effects are included. Total US farm production expenses reached $473.1 billion in 2025, with interest costs up 73% and labor costs up nearly 50% since 2020 (USDA ERS 2026; Cross 2025).

Legal exposure extends beyond paperwork. Agtech contracts often give technology companies extensive control over farm data, and no settled legal framework determines who bears liability when an AI-driven recommendation causes a regulatory violation (Kher 2025; Glassman and Pohl 2024). Buyers also impose requirements. Seed-to-store provenance records demanded by large retailers and export documentation required by international supply chains place digital traceability obligations on farmers who lack the tools to meet them (FDA 2022; Kroger 2023).

RULES CHANGE FASTER THAN FARMERS CAN TRACK THEM

The AFBF testified before the House Committee on Agriculture about simultaneous obligations under the Clean Water Act, the Endangered Species Act, NEPA, FIFRA, FSMA, SEC climate disclosure and immigration and labor rules.

> **a "flurry of requirements" that no individual farm can reasonably track**
>
> **AFBF testimony, Duvall 2023**

The Modern Ag Alliance's 2026 report found that 42% of farmers anticipate increased regulatory or legal burdens, and 80% believe they should be consulted on the operational impacts of regulatory changes (Modern Ag Alliance 2026).

State legislation adds a further layer. Nebraska LB 525, passed April 11, 2026, became the first US state law to designate farmers as the sole legal owners of their operational data and requires written consent for access to agricultural data (Nebraska Legislature 2026). Tennessee's Information Protection Act, effective July 1, 2025, requires data protection assessments for AI-driven profiling (Tennessee General Assembly 2023; Pınarbaşı 2024). These laws respond to legitimate concerns about data sovereignty, and they create a patchwork of state-by-state obligations.

EU AND UK REGULATORY COMPLEXITY

The European Commission's 2024 CAP simplification survey, with nearly 27,000 respondents, is the largest single measurement of farmer compliance experience to date. EU farmers spend an average of seven working days a year on CAP-related administration, at an average annual cost of €1,230. About €600 of that goes to external advisors hired to prepare and submit aid applications. Seventy-eight percent of farmers applying for CAP support rely on some outside help, and 60% or more of the burden was attributed to Member State implementation choices and not EU-level rules. The Commission applied its 2024 conditionality simplifications retroactively to that year, which acknowledged that requirements had proven too difficult to meet in practice (EU CAP Network 2025).

In the UK, the DEFRA Farmer Opinion Tracker for April 2025 found that 65% of farmers on survey holdings are not at all confident in DEFRA's ability to deliver planned changes to schemes and regulations, and 72% are not at all confident that those changes will lead to a successful future for farming (DEFRA 2025b). National Farmers' Union modelling found that upland farms under current Environmental Land Management equivalents face a 37% reduction in total support income compared with prior Basic Payment Scheme receipts (Case 2023).

LIVESTOCK AND TEXTILE COMPLIANCE

Livestock and textile crop farmers face sector-specific obligations with little relevant guidance from general-purpose platforms. US livestock farmers navigate USDA FSIS processing requirements, EPA rules for concentrated animal feeding operations and NPDES permitting. As of 2024, about 68% of known CAFOs nationally operated without NPDES permits (EPA 2025). The pattern is consistent with uncertainty about obligations and the absence of accessible guidance.

68%

of known CAFOs operated without NPDES permits as of 2024

EPA 2025

Regenerative livestock practices add an emerging layer of grazing rotation documentation, animal welfare certification and buyer-required welfare standards. No federal definition or regulatory framework for regenerative agriculture exists (Johnson and Stubbs 2025). In the EU, the Deforestation Regulation created a new requirement for cattle and cattle-derived supply chains, with detailed documentation of land use history and provenance now required for products entering EU markets (European Commission 2023b). For wool and alpaca producers, no mandatory framework exists, and voluntary certification schemes such as the Responsible Wool Standard and the Global Organic Textile Standard serve as the main verification mechanisms. The cost of certification is a market access barrier for some producers.

THE TRUSTED GUIDE GAP

No commercial platform in the US, EU or UK has built an integrated, plain-language compliance guide for farmers. The dominant platforms were designed for agronomic decision support. Even well-funded recent entrants lack compliance guidance among their documented features. Farmers Business Network raised $50 million for its AI expansion in 2025, serving 117,000 farms and 187 million acres, and its documented features do not include compliance guidance (FBN 2025).

The compliance gap also concerns who gathers the evidence. In the US, federal crop insurance procedures allow adjusters to use remote sensing devices "in conjunction with aerial photos or satellite imagery to assist in making inspections and determinations" (USDA RMA 2024, 6). A Risk Management Agency pilot lets approved insurance providers use remote-sensed data in place of field inspections for certain prevented-planting claims (USDA RMA 2025, 59). Conservation organizations are moving the same way. In one study of 17 US land trusts, four had developed protocols that substitute remote image assessment for a portion of annual easement monitoring visits (Thomas 2020). In the EU, an Area Monitoring System using Copernicus Sentinel data must cover all area-based CAP aid applications in every Member State, and farmers are notified when it detects a non-compliance (European Commission 2022). In England, the Rural Payments Agency tested satellite imagery for remote monitoring of the 2022 Sustainable Farming Incentive (RPA 2023). Agreement holders must keep records and evidence showing they comply (DEFRA and RPA 2026). Buyers are offered similar evidence. The EU's deforestation observatory publishes satellite maps to help importers with due diligence, though the maps have no legal value on their own and farm visits or photographic evidence may still be required (AGRINFO 2025). These systems were built for the insurers, agencies and importers that verify claims about the land. The farmer is their subject and, in the EU and England, the party expected to respond with evidence.

Hyperspectral imagery could become the next evidence layer. No US, EU or UK compliance program reviewed for this paper uses it yet. The federal activity documented to date is NASA's acquisition and evaluation of commercial hyperspectral data (NASA 2026a, 2026b). No tool yet puts that data in the farmer's hands.

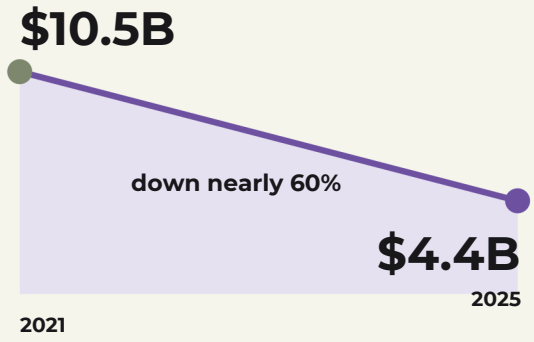
KEY TAKEAWAY

Obligations often reach farmers late or not at all, and the cost shows up as time, money and legal exposure.

06 | SECTION SIX The market

Agtech venture funding fell nearly 60% from its 2021 peak

Global agtech startup funding, US$ billions



SOURCE Crunchbase News, May 13, 2026

$56.3B

global agrifoodtech investment at its 2021 peak, down to about $16B in 2024

AgFunder 2025

57%

rise in median pre-money valuation for rounds above $25 million, 2023 to 2024

Capstone Partners 2025

Platform	Voice-first	Compliance guidance	Audit trail
Farmers Business Network, Norm	No	None disclosed	None disclosed
Land O'Lakes, Oz	Yes, co-op network only	No	No
Bayer, E.L.Y.	No	Label guidance for Bayer staff	No public specification
Taranis and Syngenta, Ag Assistant	No	No	No

Assessed from public information, 2026.

A MARKET IN FLIGHT TO QUALITY

Global agrifoodtech investment peaked at $56.3 billion in 2021, fell to $16.7 billion in 2023, a correction of about 70%, and stabilized at $16 billion in 2024 (AgFunder 2025). Within that, precision agriculture and farm technology attracted $3.8 billion in equity venture capital in 2024, up 8.7% from 2023, and agtech equity investment reached $1.3 billion in the first quarter of 2025, up 25% year over year. Median pre-money valuations for rounds above $25 million rose from $143 million in 2023 to $225 million in 2024, a 57% increase (Capstone Partners 2025). Fewer deals, larger checks and premium valuations are concentrating in companies with proven unit economics. Capital is consolidating toward the already-served segment.

The AI in agriculture market is projected to grow from $2.2 billion in 2024 to $8.5 billion by 2030, a 25.1% compound annual growth rate (BCC Research 2026). Generative AI in agriculture is forecast at $226 million in 2024, growing to $2.16 billion by 2033 (Grand View Research 2025). Agentic AI and knowledge graphs, the enabling layers, are growing faster, at 44.6% and 36.6% (MarketsandMarkets 2025a, 2025b). The market is large and the infrastructure exists. The investment has not yet produced a platform built for the majority it has passed over.

FOUR PERSISTENT GAPS ACROSS THIRTEEN PLATFORMS

Thirteen commercial agricultural platforms were assessed against three capabilities: a voice-first interface, integrated regulatory compliance guidance and a verifiable digital audit trail. The review combined AI-assisted research with manual verification against primary sources. No platform assessed combines all three. Independent trade analysis is consistent with this, finding that compliance data in today's agricultural platforms and that a fragmented ecosystem with poor interoperability remains among the sector's documented restraints on adoption (Research and Markets 2026).

> "lives everywhere but in one place"
>
> **Prins 2026**

A fourth, design-level gap underlies the three functional gaps. Most platforms reviewed were built for innovator and early adopter segments, technically confident operators willing to invest time in configuration. The mainstream 68% remains largely unserved.

Four recent entrants illustrate the gaps. Farmers Business Network's Norm, backed by $50 million raised in July 2025 and covering 117,000 farms, is a text-based agronomic and crop marketing assistant with no disclosed compliance guidance (FBN 2025). Land O'Lakes' Oz, launched in November 2025 with Microsoft, is the first major commercial agricultural AI to disclose a voice layer, but its scope is limited to the cooperative's retail agronomists and it has no compliance engine or audit trail (Microsoft 2025; Kell 2025). Bayer's E.L.Y. embeds product label guidance in its pipeline and has the most advanced compliance-adjacent architecture reviewed, but it serves Bayer employees and agronomists, is not voice-first and has no public audit trail specification (AI Breakthrough 2025). The Taranis and Syngenta Ag Assistant, formalized in October 2025, applies leaf-level computer vision to crop intelligence and has no compliance or audit trail layer (Syngenta 2025).

THE CUSTOMER-EXPERIENCE GAP

Searches of G2, Capterra, app store ratings, industry surveys and NPS benchmark databases found no published customer-experience data for the majority of platforms assessed on reliability, trust, quality, customer care and ease of use. The absence of published data is itself a finding. For context, B2B software companies report a median NPS of 41 in Retently's 2026 benchmark and 38 in Survicate's 2025 cross-industry B2B median (Retently 2026; Survicate 2025). Agtech has historically prioritized functionality over the experience dimensions that determine whether a farmer returns. Seasonal feedback loops, multi-stakeholder operations and connectivity friction complicate measurement, and these are tractable design problems.

KEY TAKEAWAY

Capital is concentrating in the already-served segment, and none of the 13 platforms reviewed combines voice-first interaction, compliance guidance and a verifiable audit trail.

07 | SECTION SEVEN Barriers to entry

For three groups, regulatory complexity goes beyond cost and functions as a barrier to market entry, program disqualification and legal exposure. The groups are international farmers exporting to the US, commercial farmers generally and US farmers navigating government program requirements. In each, regulatory complexity is rising, notification is inadequate and the consequences fall hardest on those with the least capacity to absorb them.

INTERNATIONAL FARMERS EXPORTING TO US MARKETS

In FY2024, 43.8% of inspected importers still had no supplier verification program

Share of inspected importers with no program, FDA Foreign Supplier Verification Program



SOURCE Negron 2024 (FDA FSVP inspection data)

Under the FDA's Foreign Supplier Verification Program, every US importer of food must maintain a written verification program for each foreign supplier. In FY2022, 85% of inspected importers had no program in place. In FY2024, 43.8% still had none, a meaningful improvement, though it still means nearly half of inspected importers failed the most basic requirement (Negron 2024). The most common cause is unawareness. Analysis of FDA enforcement from August 2025 through March 2026 identifies four recurring patterns: no program for any foreign supplier, general food safety documentation submitted in place of an FSVP, HACCP plans or international certifications with no product-specific FSVP, and corrective action responses consisting of statements of intent and not completed documentation (Lehat 2026a, 2026b). None resembles willful non-compliance. Consequences are severe. Importers in violation face Detention Without Physical Examination of future shipments and placement on Import Alert 99-41, and refused shipments must be destroyed or re-exported within 90 days (Lehat 2026b). FSVP documentation is written in legal English, and USDA's own plain-language compliance reporting acknowledges persistent challenges in reaching non-English-speaking agricultural operators (USDA 2024).

COMMERCIAL FARMERS

The EU CAP Network's 2025 study, drawing on 27,000 respondents, identified unclear and unstable rules and poor communication from authorities as the leading drivers of compliance burden (EU CAP Network 2025). The difficulty lies in the instability of the rules as well as their volume. In the UK, 57% of farmers report no confidence at all in DEFRA's ability to deliver planned changes, and 66% are not at all confident that the changes will lead to a successful future for farming (DEFRA 2025c).

US FARMERS NAVIGATING GOVERNMENT PROGRAMS

Under conservation compliance rules, a producer in FSA, NRCS or RMA programs found in violation of Highly Erodible Land or Wetland Conservation provisions faces simultaneous disqualification from FSA farm loans, disaster assistance, conservation program benefits and federal crop insurance premium support (USDA FSA 2017). A single violation triggers loss of all, and benefits already received may need to be repaid.

31%

of EQIP applicants were awarded contracts nationally, 2010 to 2020
Day and Happ 2021

Between 2010 and 2020, only 31% of EQIP applicants and 42% of CSP applicants nationally were awarded contracts. In Mississippi in 2020, 17% of EQIP applicants and 5% of CSP applicants received funding (Day and Happ 2021). Fiscal year 2024 saw the highest acceptance rates since FY2018 for EQIP and since FY2012 for CSP, attributed to Inflation Reduction Act funding that depends on contested Congressional appropriations (IATP 2024).

THE ACCESS MECHANISM THAT DOES NOT YET EXIST

Across the three groups, regulation is evolving, the information system is not reaching the people it governs and the consequences fall on those least equipped to navigate complexity. For international farmers, non-compliance closes the US market. For program participants, it triggers cascading disqualification. A platform that delivers aggregated, plain-language regulatory information in the farmer's own language, covering what has changed, what to do and when, could help remove these barriers.

KEY TAKEAWAY

For importers, program participants and commercial farmers, unclear and unstable rules carry consequences from lost market access to program disqualification.

PART 04

What must change

Each audience has a lever, and FarmBot Tech describes its own approach.

08 What must change

09 FarmBot Tech's approach

0 of 13

platforms reviewed combine voice, compliance guidance and an audit trail

08 SECTION EIGHT What must change

The evidence in this paper supports one conclusion. The adoption gap in precision agriculture reflects design, compliance and market structure, and the measures reviewed show it widening. Adoption is declining, investment is concentrating in the already-served segment and regulatory environments are growing more complex.

FOR FARMERS

Farmers were handed complexity where they needed clarity, fragmentation where they needed integration and silence where they needed guidance on regulations changing around them. Technology built for the operation the market left behind should work for farmers growing crops, raising livestock, producing fiber or navigating a government program whose requirements changed without notice.

FOR TECHNOLOGY COMPANIES

Most farmers who have not adopted precision agriculture belong to the pragmatic majority Rogers identifies as the Early and Late Majority. They need technology that fits their context. The barriers are documented and consistent: complexity of use, integration challenges, no compliance guidance and design assumptions built for a different farm profile. The segment already served represents a minority of the addressable market, and the underserved majority is larger.

FOR POLICYMAKERS

A rule can carry criminal penalties for 230,000 farms and reach fewer than 11% of them. An import verification program has run for years with non-compliance that never fell below 43%. Conservation applications are declined for more than two in three applicants nationally. Plain-language guidance, proactive notification through channels farmers use and simplification that narrows the gap between what the law requires and what a farmer can reasonably know are prerequisites for a compliance system that works. The World Bank's 2025 analysis of AI in agrifood systems concluded that AI must be guided by values and embedded in governance frameworks that prioritize inclusivity and accountability (World Bank 2025).

FOR INVESTORS

Capital in agtech is real and increasingly concentrated in companies serving large, tech-ready operations. That pattern is rational in the short term. The underserved majority, which includes small and mid-size crop farmers, livestock producers, textile crop farmers, international exporters and program participants, represents a market that is larger and structurally underserved.

KEY TAKEAWAY

Each audience has a different lever: design for the majority, notify before penalties begin, and fund the segment that has been passed over.

09 SECTION NINE FarmBot Tech's approach

We build tech to bridge the gap between traditional wisdom and modern demands, putting the future of ag directly into farmers' hands.

Detria Williamson, Co-founder and CEO, FarmBot Tech

FarmBot Tech is designed to aggregate farm data across the regulatory, agronomic and operational domains that farmers must navigate. Its first applications address the two divides documented in Section Three. For livestock, the platform combines satellite data with the daily entries farmers make in animal logbooks to build a roadmap for each animal and for the herd, covering grazing patterns, fertility periods, sickness and quarantine flags and drought warnings. For land, it builds with Pixxel, whose Firefly satellites capture more than 150 contiguous spectral bands at about 5 meter resolution, and translates that data into plain-language guidance and into field-level evidence that farmers can share with lenders, insurers, buyers and conservation programs.

Voice is how farmers reach it. A farmer asks which fields are showing stress this week, or a rancher asks what changed in the rules that apply to the operation, and hears a plain-language answer without stopping work. Compliance remains the primary use case because it is the most urgent and the most unaddressed, and because the cost of failure is immediate. Farmers unaware of a regulatory change face fines, program disqualification and market exclusion that a timely alert could prevent.

The same data layer supports subsidy and grant discovery across USDA programs, EU CAP mechanisms and the UK Sustainable Farming Incentive (future state), weather and risk decision support, and export market access.

Model validation with working farms is an explicit item on the partners' joint roadmap, along with a farmer education series that shows farmers which questions their land's data can now answer. The first products, for grapes, coffee, cattle and dairy, are scheduled to begin rolling out in the fourth quarter of 2026.

FUTURE RESEARCH: SATELLITE DATA AND FARM-LEVEL EVIDENCE

Three research gaps follow from this paper's satellite evidence. First, no landscape analysis yet maps commercial hyperspectral systems against the evidence requirements of USDA compliance programs, and none was found in the sources reviewed here. Second, satellite data use by farm size remains largely unmeasured. Among the sources reviewed, only the EU's 2025 farm survey reports it (Tur Cardona et al. 2025), and no comparable US or UK figure was found. Third, institutional access to commercial hyperspectral data is growing faster than independent farm-scale validation. NASA's Commercial Satellite Data Acquisition program has acquired Pixxel datasets for scientific purposes (NASA 2026c), but research procurement is not operational validation. Regenerative agriculture raises the stakes. USDA's $700 million Regenerative Pilot Program requires participants to test soil health in the first and last year of their contracts, and states that outcomes are "tracked, measured, and credited back to the farmer" (USDA NRCS 2025). Verification of soil carbon, cover crops and land management is a

confirmed direction on the three-year FarmBot Tech and Pixxel joint roadmap, together with farmer education on what satellite data can offer (FarmBot Technology, LLC, co-author). The full research case is reserved for a subsequent publication.

INAUGURAL FOUNDING FARMER: MATEO KEHLER

FarmBot Tech has named Mateo Kehler its inaugural Founding Farmer. Kehler is a co-founder of Jasper Hill Farm in Greensboro, Vermont. Founding Farmers place working farmers at the center of how FarmBot Tech builds. They serve as ambassadors for the company and as partners in product development, contributing the field experience that shapes what we design and how we design it. Their perspective is integral to our work and to who we are as a company.

> **"Most farmers I know stopped expecting anyone to build something for them. We do the paperwork at night after the day's work is done, and we don't hear about a new rule until a regulator shows up. All we have ever asked for is something that works.**
>
> **When something goes wrong on a farm, there is nobody to hand it to. The animals still need tending, the bills still come, and the rules keep changing without a word to us. A tool that carries part of that load would mean more than people in offices probably realize."**
>
> **Mateo Kehler, Inaugural Founding Farmer, FarmBot Tech**

Glossary

Agentic AI Artificial intelligence systems capable of executing multi-step tasks and making decisions autonomously, without continuous human prompting. Agentic AI can plan, act, and adjust across complex workflows. Relevant to agricultural platforms that automate compliance tracking, advisory, and data aggregation.

CAP (Common Agricultural Policy) The European Union's primary agricultural subsidy and regulation framework, governing farm income support, environmental obligations, and rural development across all 27 EU member states. CAP compliance requirements represent a significant administrative burden for EU farmers.

CAFO (Concentrated Animal Feeding Operation) A US regulatory classification for large-scale livestock operations that confine animals for 45 or more days per year. CAFOs above defined size thresholds must obtain environmental discharge permits under the Clean Water Act. As of 2024, approximately 68% of qualifying CAFOs nationally operate without required permits.

CAGR (Compound Annual Growth Rate) A measure of the rate at which a value grows over multiple years, expressed as a percentage per year. Used in this paper to describe growth projections for AI in agriculture, generative AI, agentic AI, and knowledge graph markets.

CSP (Conservation Stewardship Program) A voluntary USDA-NRCS program that compensates farmers for maintaining and improving existing conservation practices on their land. Unlike EQIP, CSP rewards ongoing stewardship rather than the installation of new practices.

Diffusion of Innovations (Rogers) A theoretical framework developed by Everett Rogers (first published 1962; 5th edition 2003) that describes how new technologies spread through a population over time. Identifies five adopter categories (Innovators, Early Adopters, Early Majority, Late Majority, and Laggards) and five attributes that determine whether a technology is adopted (relative advantage, compatibility, complexity, trialability, and observability).

DWPE (Detention Without Physical Examination) An FDA enforcement action that detains imported food shipments at the U.S. border without physical inspection, based on prior evidence of non-compliance from a specific supplier, country, or commodity. Detained shipments are held until the importer demonstrates the product meets U.S. requirements.

Early and Late Majority In Rogers' Diffusion of Innovations framework, the combined 68% of any population who adopt new technologies after innovators and early adopters have established them. Characterized by pragmatism, risk-aversion, and a need for simplicity, proof, and peer adoption before committing.

ELM (Environmental Land Management Scheme) The UK's post-Brexit replacement for the EU Basic Payment Scheme. Comprises three tiers, the Sustainable Farming Incentive (SFI), Countryside Stewardship (CS), and Landscape Recovery Scheme (LCS), each with distinct eligibility conditions and compliance requirements.

EQIP (Environmental Quality Incentives Program) A voluntary USDA-NRCS program providing financial and technical assistance to farmers implementing conservation practices that address soil health, water quality, air quality, and wildlife habitat. Demand consistently exceeds available funding, resulting in significant annual rationing.

EUDR (EU Deforestation Regulation) European Union legislation introduced in 2024 requiring detailed documentation of land use history and supply chain provenance for specified commodities, including cattle and certain textile products , entering EU markets.

Extension Services University-based and government-funded agricultural advisory services that provide farmers with research-based information, training, and technical support. In the United States, delivered primarily through the USDA Cooperative Extension System in partnership with land-grant universities. Referenced in this paper in the context of ExtensionBot, a text-based AI advisory tool funded by USDA NIFA.

FinCEN BOI (Financial Crimes Enforcement Network, Beneficial Ownership Information) A US federal reporting requirement under the Corporate Transparency Act, requiring businesses with fewer than 20 employees and under $5 million in receipts to disclose their beneficial owners. More than 230,000 farming operations were required to file. Penalties for non- compliance included significant daily fines and potential criminal charges.

FSVP (Foreign Supplier Verification Program) An FDA requirement under the Food Safety Modernization Act mandating that every US importer of food develop and maintain a written verification program for each foreign supplier and product. Non-compliance has never fallen below 43% in any fiscal year since inspections began, with the most common violation being the complete absence of any program.

FSMA (Food Safety Modernization Act) Landmark 2011 U.S. legislation that shifted food safety regulation from responding to foodborne illness outbreaks to preventing them. Administered by the FDA, FSMA introduced mandatory preventive controls, produce safety standards, and the Foreign Supplier Verification Program (FSVP).

FSIS (Food Safety and Inspection Service) A USDA public health agency responsible for ensuring the safety, wholesomeness, and accurate labeling of meat, poultry, and egg products through continuous inspection programs at processing facilities.

GAEC (Good Agricultural and Environmental Conditions) EU CAP conditionality standards that farmers must meet to receive subsidy payments. Include requirements on soil cover, crop rotation, non-productive areas, and landscape features.

Generative AI (GenAI) A category of artificial intelligence that generates new content, text, images, audio, or data, based on patterns learned from training data. In agriculture, applied to advisory systems that generate plain-language responses to farmer queries.

HACCP (Hazard Analysis and Critical Control Points) A science-based food safety framework that identifies biological, chemical, and physical hazards at each stage of production and establishes critical control points to prevent or eliminate them. Now embedded in FSMA requirements and widely mandated by international trading partners and retail buyers.

HEL (Highly Erodible Land) A USDA designation for cropland with high susceptibility to soil erosion. Producers receiving federal farm program benefits must manage HEL under an approved conservation plan or risk losing eligibility for payments, crop insurance support, and conservation program access.

IVR (Interactive Voice Response) A telephony technology that allows users to interact with an automated system using voice commands or keypad inputs. Used in agricultural extension contexts in multiple countries as a low-technology voice interface for farmer advisory services.

Knowledge Graph A structured data architecture that maps relationships between entities, such as crops, regulations, field conditions, and compliance requirements, enabling AI systems to reason across interconnected information.

LLM (Large Language Model) A type of generative AI trained on large volumes of text data, capable of understanding and generating human language. In agricultural contexts, LLMs are used to process farmer queries and generate advisory responses in plain language.

Nebraska LB 525 (Agricultural Data Privacy Act) Passed April 11, 2026, the first US state law to designate farmers as the sole legal owners of their operational data, including agronomic, climate, weather, land, livestock, and management data.

NPS (Net Promoter Score) A customer loyalty metric that asks respondents how likely they are to recommend a product or service on a scale of 0-10. Calculated as the percentage of promoters (9-10) minus the percentage of detractors (0-6).

NPDES (National Pollutant Discharge Elimination System) A US EPA permit program under the Clean Water Act that regulates water discharges from point sources, including Concentrated Animal Feeding Operations. Livestock operations above defined size thresholds that discharge must obtain NPDES permits before operating.

Precision Agriculture (Precision Ag) The use of data, technology, and analytics to optimize farm management decisions at a granular level , including GPS-guided machinery, variable-rate application of inputs, yield monitoring, remote sensing, and farm management software.

PLF (Precision Livestock Farming) The application of precision agriculture principles to livestock management, including wearable sensors, activity monitors, and data-driven health and productivity tools.

RAG (Retrieval-Augmented Generation) An AI architecture that enhances LLM responses by retrieving relevant information from a specific knowledge base before generating a response. Reduces hallucination risk by grounding outputs in verified source data.

Rogers' Diffusion of Innovations See Diffusion of Innovations (Rogers).

SFI (Sustainable Farming Incentive) One of three tiers of the UK's Environmental Land Management scheme, offering payments to farmers who adopt sustainable farming practices.

TIPA (Tennessee Information Protection Act) Tennessee state data privacy legislation effective July 1, 2025. Requires data protection assessments for AI-driven profiling activities, directly applicable to precision agriculture platforms operating in Tennessee. Includes a NIST Privacy Framework safe harbor provision.

Voice AI / Voice-First AI Artificial intelligence systems that use voice as the primary interaction interface, accepting spoken input and delivering spoken or audio responses. Distinguished from text-based chatbots by their accessibility in field conditions (hands-free, no screen required) and their suitability for users with limited digital literacy or connectivity.

WC / Wetland Conservation Compliance ("Swampbuster") A Farm Bill provision restricting the conversion of wetlands to agricultural production. Farmers who drain or fill a wetland to produce crops may lose eligibility for federal farm program payments, conservation benefits, and crop insurance premium suppor t .

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ABOUT FARMBOT TECH

FarmBot Tech is an agricultural technology company developing an AI-powered platform to make emerging technologies more accessible and actionable for farmers. Through a radically inclusive approach to product development, FarmBot Tech co-creates solutions with farmers and brings together artificial intelligence, voice technology, connected agricultural data and satellite intelligence. Its mission is to close the agtech adoption gap, strengthen rural resilience and accelerate the adoption of regenerative agricultural practices globally.

ABOUT DIVERSE AI SOLUTIONS

Diverse AI Solutions (DAIS) is an AI transformation consulting and research firm that helps organizations turn AI investments into measurable business results. Through a human-centered approach, DAIS provides AI strategy, workflow redesign, governance, and human-led, AI-assisted research and thought leadership that inform business decisions, industry innovation, and policy discussions. Its mission is to make AI transformation practical, inclusive, and sustainable.

MEDIA CONTACT

FarmBot Technology | media@farmbottech.com | farmbottech.com