2023 PRECISION AGRICULTURE DEALERSHIP SURVEY

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ABOUT THE SURVEY, RESPONDENTS, AND RESPONDENT'S COMPANY/ORGANIZATION

In February-March 2023 CropLife magazine and the Departments of Agricultural Economics and Agronomy at Purdue University conducted the 23nd survey of crop input dealers about precision agriculture technologies. As with previous surveys, recipients were asked questions about how they use precision agriculture within their business, what precision products and services they offer to their customers, their use of data generated on farms, adoption of precision farming by their farmer customers, and questions aimed at understanding practices such as profitability and what barriers exist for adoption. This survey is the longest-running, continuous survey of precision farming practices in the world.

The questionnaire was all electronic, with a link emailed to a subset of CropLife's email list. Survey questions are at the end of this report. With any survey a recipient may not respond, respondents may not answer all questions, or may also answer some questions incompletely. We did not include a respondent's survey responses in this report if they:

- Only answered demographic questions (1, 2, 3, 4, 5, or 6) and nothing else.
- Did not answer 1, regardless of any other responses, which asks about their type of business. We report on business types separately, so 1 was essential for sorting.
- Responded to Question 1 as a farm equipment dealer or agricultural consultant. If those options were chosen, the online survey instrument terminated.
- Did not answer 5, regardless of any other responses, which asks about crops grown in their area. We report field crops and specialty crops separately, so 5 was essential for sorting.

Otherwise we accepted all other responses, however complete or incomplete. In this report we present the 87 surveys from agricultural retail input suppliers working with field crops only. The remainder of the surveys represent retail input suppliers of specialty crops. Respondents identified as working with field crops indicated corn, soybeans, wheat, rice, cotton, milo, sugar beets, dry beans, or hay/forages were the primary crops for the products and services they provide. Those tagged specialty crops were providing products and services primarily to nursery, greenhouse, tree fruits and nuts, vegetables, berries, or grapes.

2017 was the first year we asked respondents specifically about their type of business, if they were input suppliers, equipment dealers, consultants, or other. Prior to that respondents could have fit a broader definition of ag retail by just being on CropLife's mailing list. 2019 was the first year we asked about the crops in their areas so we could distinguish dealers working mostly with specialty crops from dealers working mostly with field crops. Looking at past reports most responses were from the Midwest, so it is assumed most past surveys reflect mainly dealers working with field crops more than specialty. This year most field crop retailer survey responses were from Midwest states, similar to previous reports. Response by state is shown in Table 1 (categories may not add exactly due to rounding).

Table 1, Q17: Respondent location by region and state.

Midwest 75%				South 16%		West 4%		East 6%	
Indiana	9%	Illinois	6%	Alabama	5%	Washington	2%	Maryland	2%
Minnesota	9%	Ohio	6%	Texas	5%	Colorado	1%	New York	1%
Wisconsin	9%	Nebraska	5%	Kentucky	2%			Pennsylvania	1%
Iowa	7%	N. Dakota	5%	Oklahoma	2%			Virginia	1%
Kansas	7%	S. Dakota	3%	Tennessee	2%				
Missouri	7%	Michigan	2%						

Of the ag input retailers 59% indicated they represented a cooperative, 32% an independent dealership and 8% were part of a national or regional dealership (not a cooperative), Figure 1.

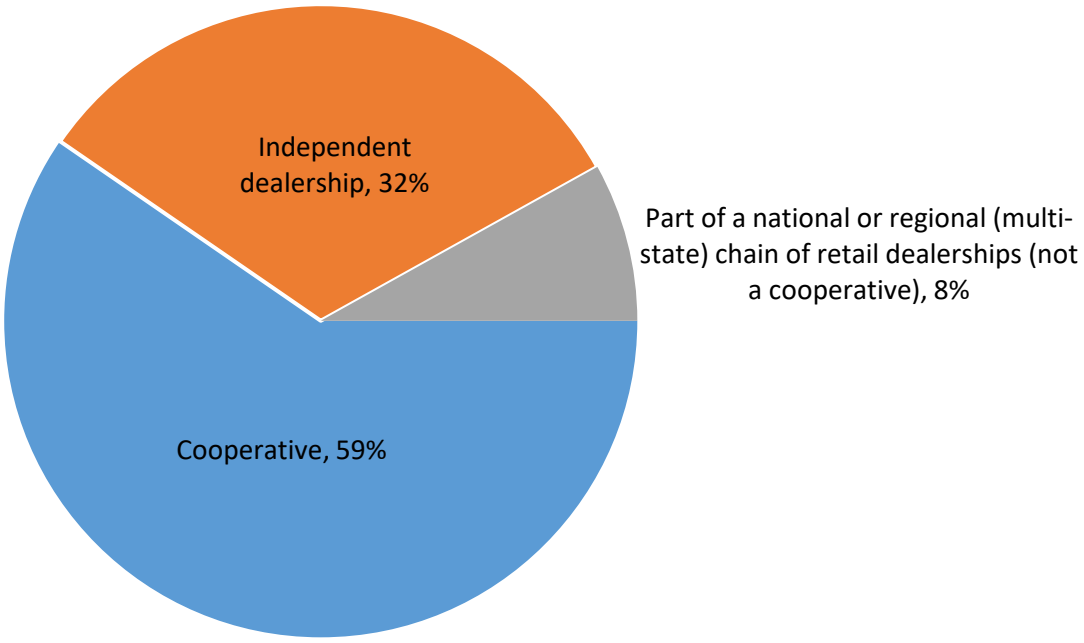
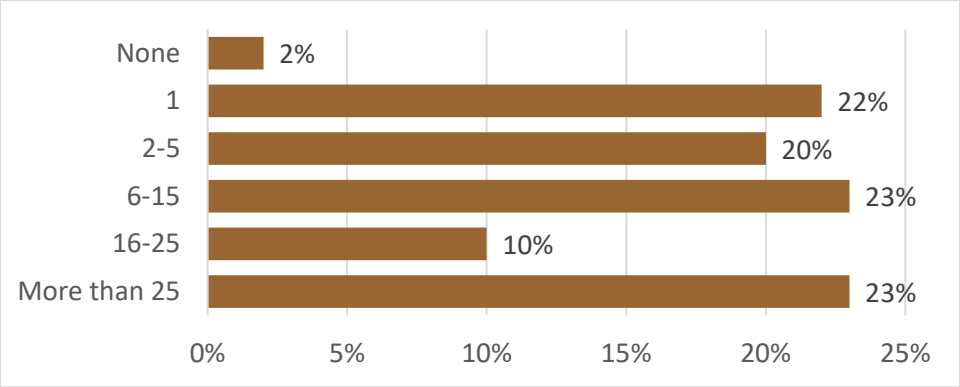


Figure 1, Q1: Organizational type represented by respondents.

The organizations the respondents represent are primarily multiple retail locations, Figure 2. Two percent of the respondents worked for a company that did not own or manage a retail outlet, even though they responded that they were an agricultural retail input supplier. Twenty-two percent of respondents reported having only one retail outlet. The number of respondents that owned or managed five stores or less was 44%. Fifty-six percent of respondents worked for a company that owned or managed six or more stores. Ag retail consolidation is apparent looking back to previous surveys--for example in 2013, a decade prior, just 32% of respondents worked at a company that had six or more stores.



The survey asked about the position the respondent held within their organization. Thirty-three percent reported being the owner or location manager, and 28% were in sales or sales management. Other common job responsibilities for respondents were precision manager (20%), technical consultant/agronomist (10%), and department manager (6%). Overall the respondents of the survey are those that lead and manage the organization, or work directly with customers (Figure 3).

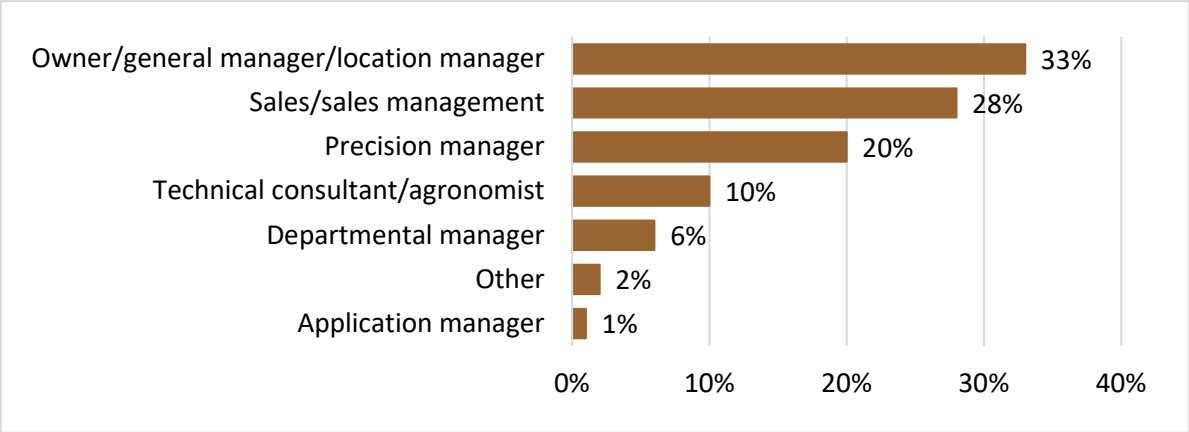


Figure 3, Q3: Responsibility of survey respondent.

DEALER USE OF PRECISION TECHNOLOGIES

Dealers get utility from the precision technologies they use for their own business purposes, such as guidance and section/nozzle controllers on their applicators. We detail that here, followed by the precision products and services they offer to customers in the next section.

The use of guidance technologies by dealers for their custom pesticide and fertilizer applications indicate a maturing market, with 89% of dealers using GPS autoguidance (Figure 4), and 93% of those who offer precision services using guidance of any type (including manual guidance/light bars). These numbers represent the percent of dealerships utilizing the technology in some form, which they may use on some or all of their equipment and on some or all of the acres they service. Manual guidance, which was used by 24% of dealers

in 2000, peaked at 79% in 2009, and has fallen to 36% of dealers in 2023 (data not shown). GPS-guided boom section/nozzle controllers on sprayers, which reduce doubling-up and skips, are used at 82% of dealerships. Another guidance-related technology, sprayer turn compensation, continues to grow, now at 41% of dealerships. About half of dealers are using telemetry to exchange information among applicators or to/from office locations, up dramatically in recent years, and around half are using GPS fleet management to track the locations of vehicles and guide vehicles to work sites. Both of these can improve operational efficiency, so their growth may be partially related to increases in costs for fuel and labor that have occurred in recent years. Over half are using some type of a smart scouting app on a mobile device (not shown). Some year-to-year variation of survey results is normal, as survey respondents differ each year. A difference of a few points in one year may or may not signal a trend.

Note that the survey went from every year to every other year from 2009 to 2019, and is now back to yearly (Figure 4). All technologies used by retailers were down in 2017 compared to 2015, but all rebounded for 2019 and have remained—a weak farm economy then might explain the dip.

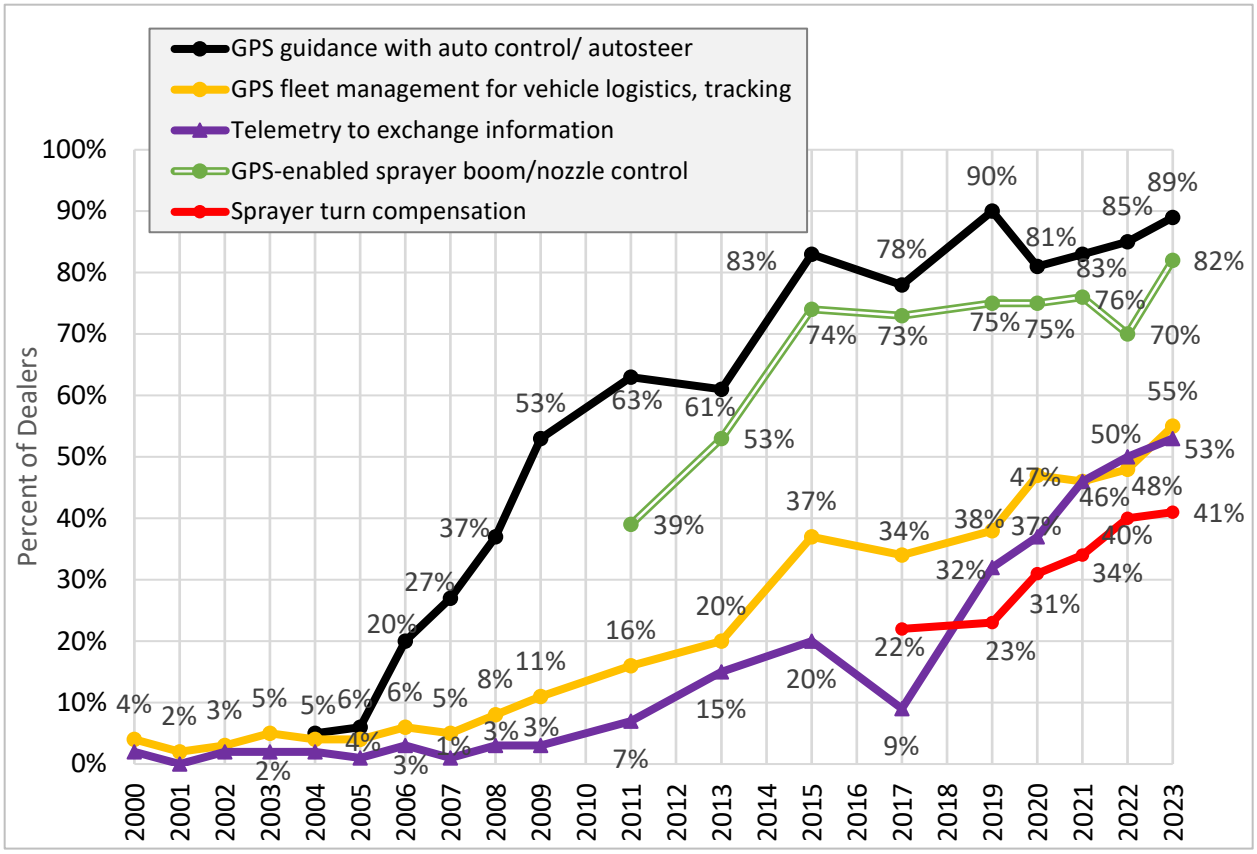


Figure 4, Q7: Retailer use of precision technology for their business.

DEALER OFFERINGS OF PRECISION SERVICES

Another element of precision technology for dealers is in the services they offer to their farmer customers. Respondents were asked to report their current offerings of precision/site-specific services and what they plan to offer three years from now, in 2026 (Figure 5). Current dealer offerings are ranked top to bottom in green.

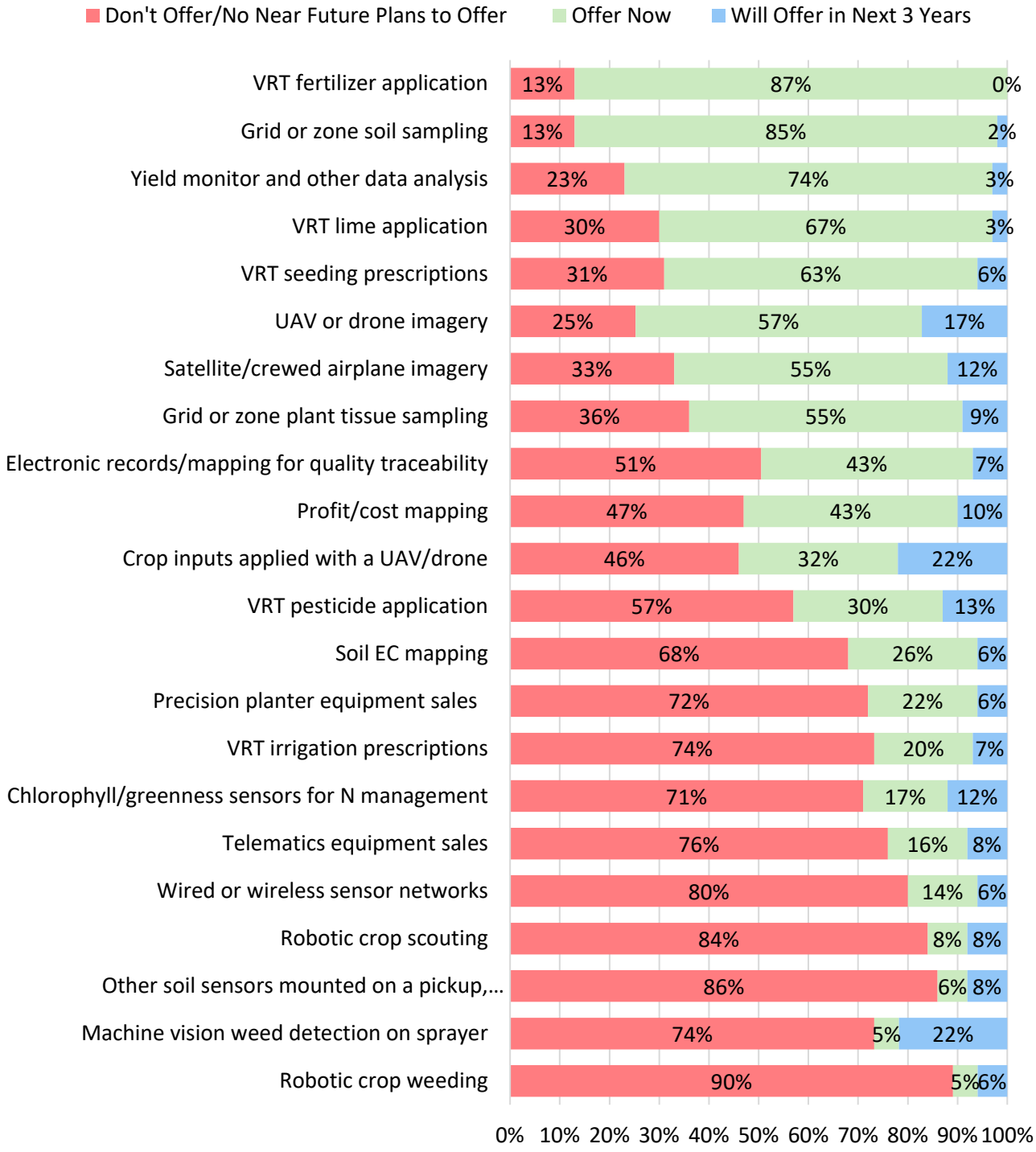


Figure 5, Q10: Dealer offerings of precision services, ranked by current offering. Due to rounding, rows may not total 100%.

VRT fertilizer applications and grid or zone soil sampling lead the offerings at 87% and 85% of dealers, respectively. The next common offerings, half to three fourths of dealers, are yield monitor and other data analysis, VRT lime applications, VRT seeding recommendations, satellite, aerial, and drone imagery, and precision plant tissue sampling. We define aerial as imagery acquired by a crewed airplane. On the other end of the scale only a few dealers responded that they were currently offering services in robotic weeding, robotic scouting, or machine vision weed detection.

Over the next 3 years, the technologies respondents are planning the most growth (longest blue bar in Figure 5) are in VRT pesticide application (13% of respondents will add), crop inputs applied with a UAV/drone (22%), and machine vision weed detection (22%). In many past surveys, dealers have optimistically overestimated their precision offerings plans compared to the actual numbers the survey showed in years following.

Figure 6 shows the adoption of sensor and robotics precision ag services over time, with projections as dotted lines. The 2026 projections are calculated as the sum of question 10 responses for each technology for "offer now" plus "will offer in next 3 years." As with the technologies the dealers are using for their own purposes, these data represent the percent of dealers offering these services, not the percent of acres where these services were applied. Over the years there has been a changing mix in the precision products and services dealers offer to their customers, with increases from 2007 to 2017 but some leveling off after 2020 (Figures 6 & 7).

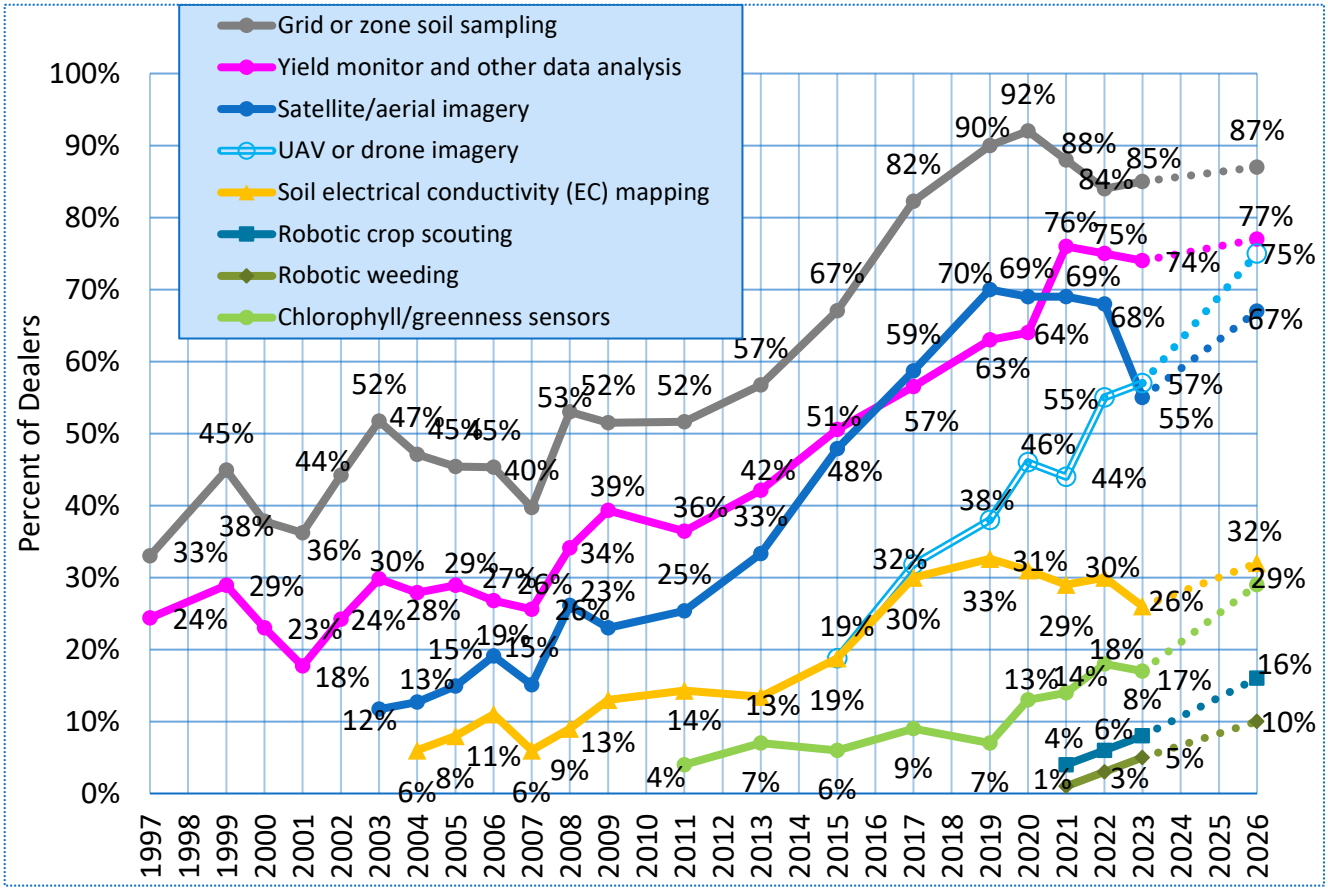


Figure 6, Q10: Dealer offerings of precision services over time, sensing and related technologies. 2026 are projections.

More than half of dealers are now offering UAV/drone imagery, which has increased sharply in the last few years. The ease with which drones can be flown and images georeferenced and stitched compared to just a few years ago are certainly contributing factors. We started asking about drone imagery just eight years ago, and since then it has grown from 19% of dealers offering to 57% today. Imagery can be a foundation for creating management zones or guiding site-specific inputs, and for identifying anomalies. Satellite and aerial imagery still seem to be seeking their place in farm management decisions. Aerial images using film were the foundation for maps of fields since at least the 1930's, and black & white photos were commonly the foundation for soil maps. Multi-spectral imagery became available alongside the advent of digital cameras. Multi-spectral satellite imagery first became available with the launch of Landsat 1 in 1972. Two decades ago few dealers offered satellite or aerial imagery. There was a steady increase in satellite and aerial imagery offerings for many years, but has been going down for the last four years.

Commercially available for over two decades, most dealers are still not offering soil electrical conductivity (EC) mapping or chlorophyll/greenness sensors such as Greenseeker, CropSpec, or OptRx. But a few dealers say they will be adding soil EC mapping or chlorophyll/greenness sensors as part of their services three years out. EC has been shown to relate well to differences in soil salinity and soil texture differences. But for most farming operations it has been difficult to connect site-specific management to soil EC differences. On a procedural note regarding the survey, the soil EC mapping from 2004 to 2009 shown in Figure 6 was asked in a question about what retailers were using for their business, but nearly all EC mapping is part of a dealer offering to a customer. Chlorophyll/greenness sensors offer what seems a perfect opportunity to manage crop nutrient needs in real time. But in practice, there can be substantial productivity losses if waiting to correct nutrient deficiencies after symptoms show in plants. And many farmers are hesitant to depend on in-season fertilization if there is a chance field conditions could cause delays. Not shown on these graphics to allow readability are grid or zone plant tissue sampling, traceability, profit/loss mapping, precision planting equipment sales, VRT irrigation prescriptions, telematics sales, sensor networks, other soil sensors, and machine vision weed detection on sprayers. Most of these were first asked in the last ten years, and their past adoption information can be found in previous survey reports. Variable rate fertilizer applications have been offered by most dealers for 15 years (Figure 7). The mid 2010's were a pivot point, increasing to 69% in 2015 and now just short of 90% of dealers. Starting in 2017 the survey no longer separately asked about VRT single fertilizer applications as compared to multiple product applications—thus the gap in the red lines in Figure 7. The percent of dealers offering VRT seeding prescriptions has leveled in the last three years, compared to a substantial upward burst from 2013 to 2020. Six percent of dealers plan to add this service by 2026.

As noted previously an area of growth anticipated by retailers is high-tech pest management. VRT pesticide application has been up and down for the last few years, and remains a bit higher than a decade ago. Thirty percent of dealers now offer VRT pesticide applications, but 13% more say they will be doing this in three years. In recent years this anticipation was larger than anything else we asked about--a 25% three year out increase estimated in 2017 for 2020, 30% estimated in 2019, a 20% in 2020, 26% in 2021 and 22% in 2022. In 2020 when 27% of dealers said they were offering VRT pesticides and 20% said they would be adding this by 2023, that should add up as 47% now. But those expectations fell far short. The interest in precision pest management might be driven by pesticide costs and availability, as well as continued pest resistance issues. But trying to determine and measure the factors that relate to a variable rate have proven a bigger challenge than anticipated, whether that be organic matter or soil texture for soil applied pesticides, weed, disease, or insect levels for in-season applications, or detecting on the go using image detection. Thirty-two percent of dealers say they are currently offering crop inputs applied via a UAV/drone, a flying robot, just the third time for this question, but over half expect to be offering this by 2026 (Figure 7).

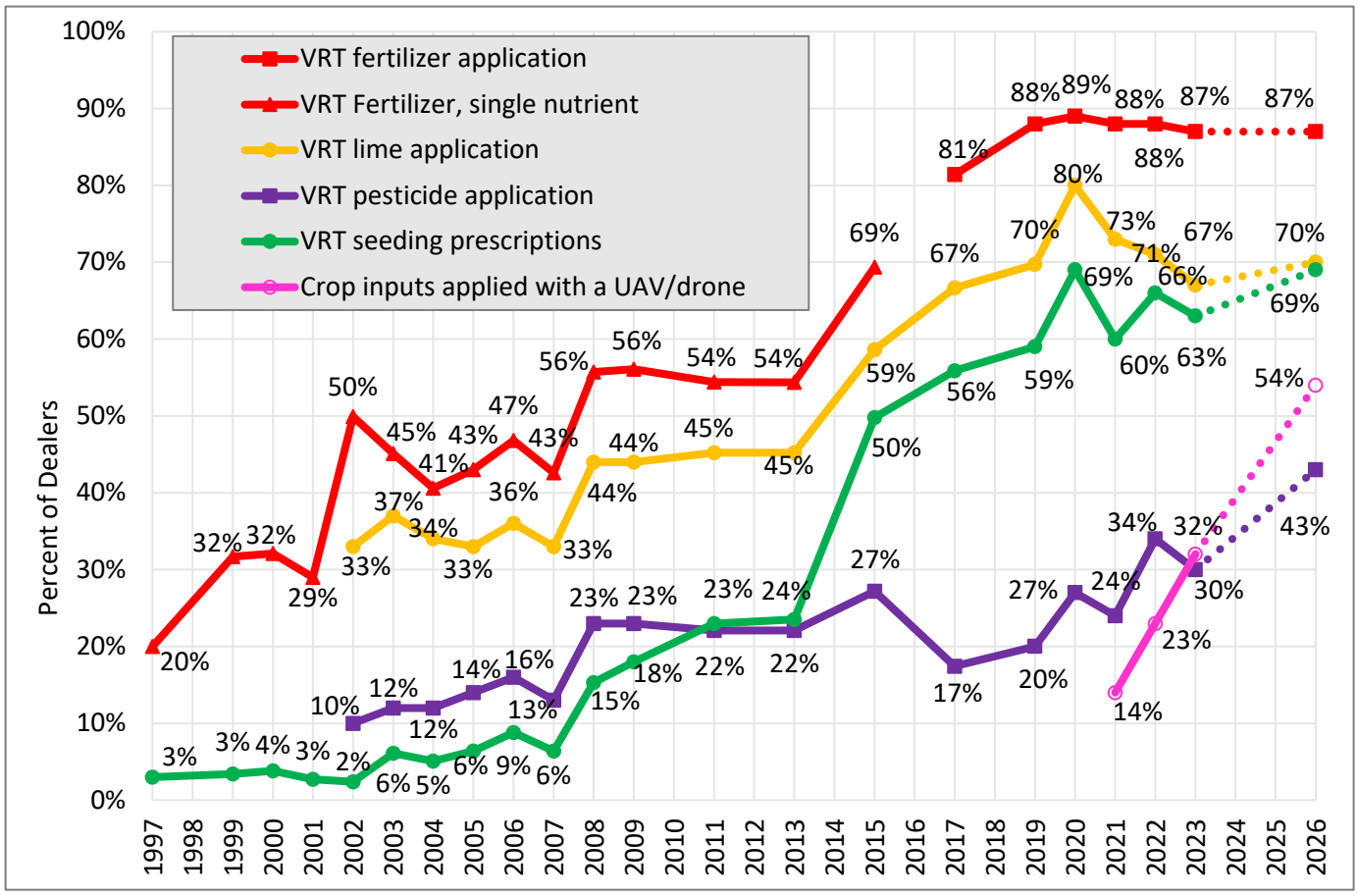


Figure 7, Q10: Dealer offerings of precision services over time, variable rate technologies. Starting at 2017 the survey stopped asking separately about single and multiple fertilizer applications. 2026 are projections.

ANALYSIS OF DATA

Precision agriculture can generate an overwhelming amount of data from yield monitors, soil sampling, machine operations across fields, as-applied amounts, and remote sensors, to name a few. Often producers need assistance in analyzing these data in the hopes they can be turned into meaningful insights. Figure 8 reports how dealers help customers manage farm-level data in decision-making. Respondents could mark any or all that apply. The most common way dealers are helping customers was printing maps, such as yield, soil electrical conductivity, and soil maps, but that is on a decline and we dropped that question for 2023. Beyond printing maps, more than half of dealers are archiving and managing yield, soil test, and other farmer data for future use. Thirty-seven percent of dealers report working with farmers and their on-farm data one-on-one, a third are aggregating data among farmers but within the dealership, and 16% offer services where data is shared outside the dealership. Only 10% of the respondents do not help farmers with their farm-level data. Sixty-eight percent of dealers say their organization has a customer data privacy statement and/or data terms & conditions agreement, steadily up since 2017.

Figure 9 shows the types of decisions where pooled customer data is used for decision-making, reported by dealers as a major influence, some, or no influence. We define pooled data as that which is aggregated from multiple farms, either managed within the dealership or as part of an outside offering. Dealers report pooled data has the most influence on P & K (phosphorus and potassium fertilizer) decisions, more than any other at 42%, always the most since we started asking (Figure 10). About a third of dealers report liming decisions, hybrid/variety selection, and nitrogen decisions are majorly influenced by on-farm pooled data. Fewer indicated pooled data had any major influence on overall planting rates or variable rates.

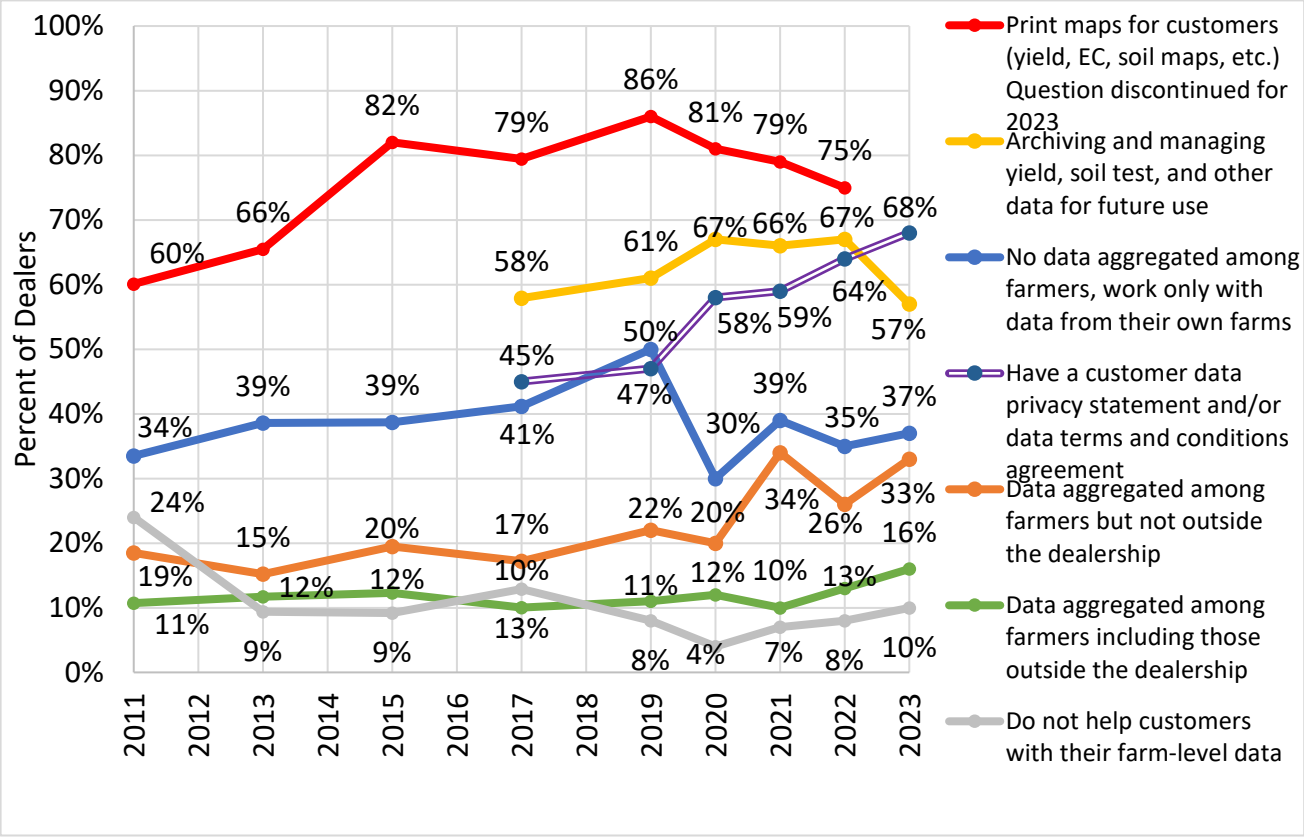


Figure 8, Q8: Managing farm-level data to assist customers in decision making over time.

There has been a remarkable uptick in crop management decisions from pooled data in recent years (Figure 10). Only around 10% of dealers in 2017 reported pooled data was having a major influence on P and K decisions, nitrogen decisions, or liming decisions, and fewer in 2017 indicated data had a major influence on the other management factors. Now, the numbers of dealers using pooled data is multiples of what it was just six years ago, but all except one took a downward turn in 2023.

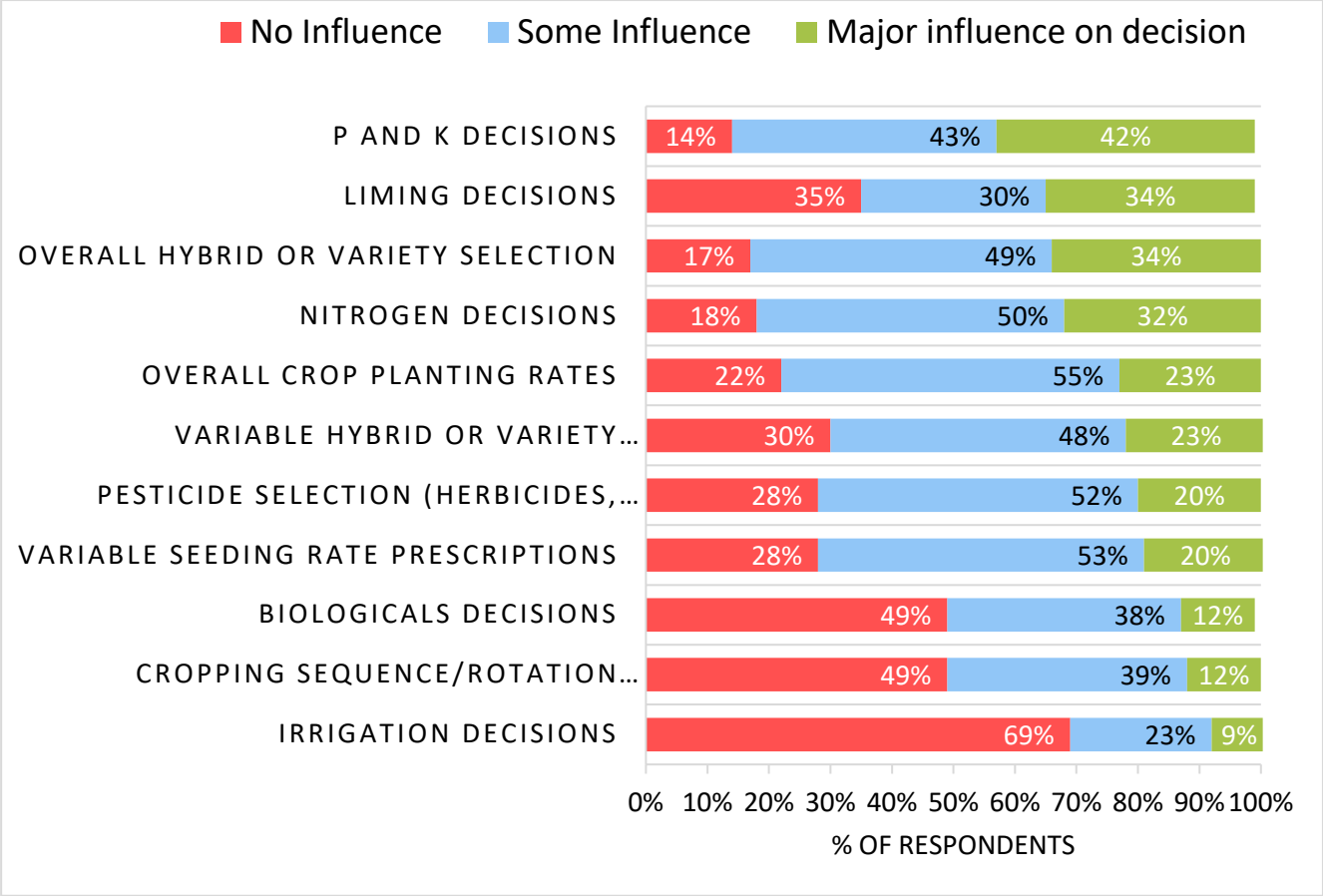


Figure 9, Q9: Crop management decisions influenced by pooled data from customer's farms, ranked by major influence. Due to rounding, percentage numbers for a technology may not total 100.

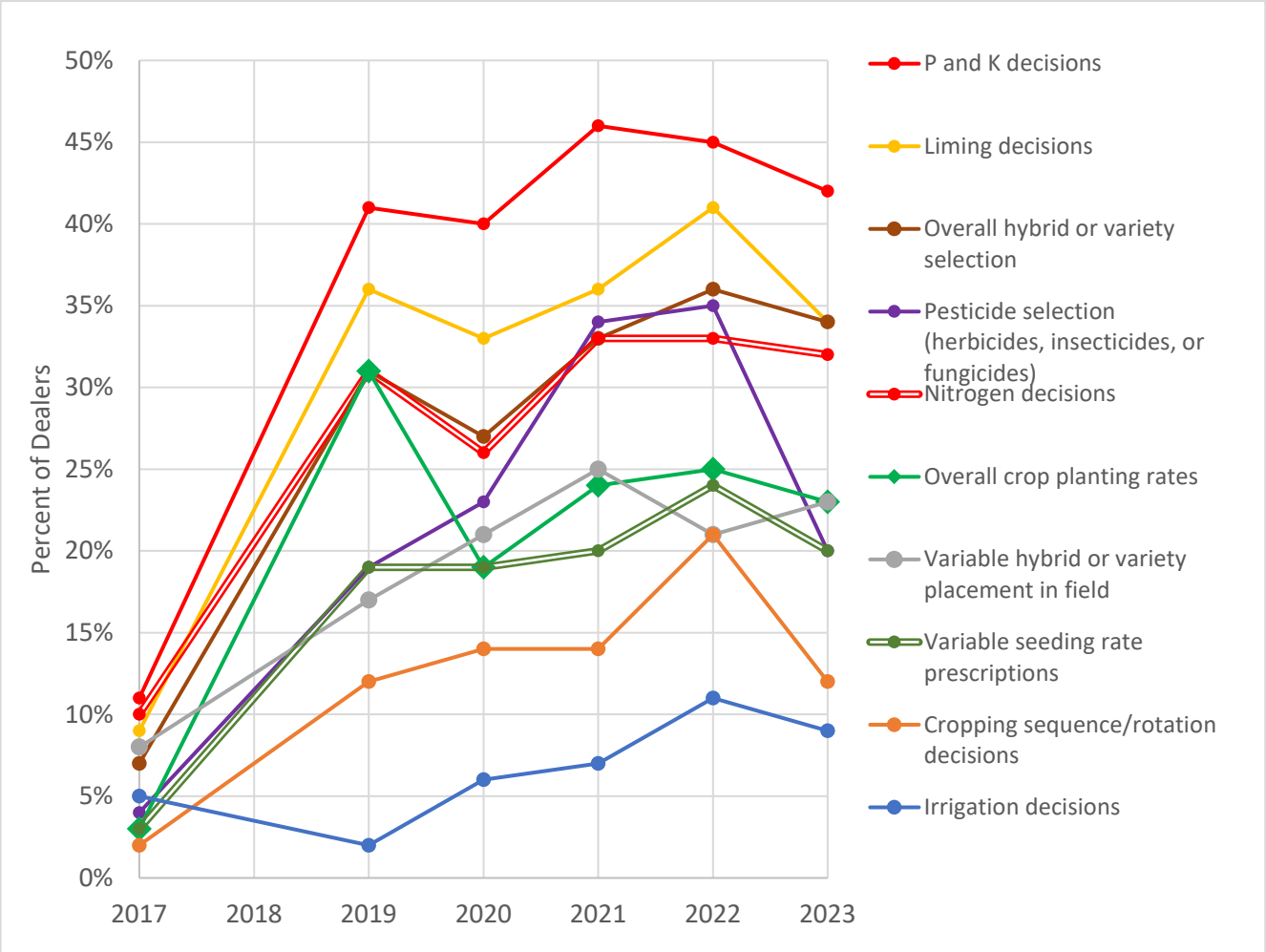


Figure 10, Q9: Percent of dealers over time indicating data had a major influence on management decisions. There was no survey in 2018.

SOIL SAMPLING PROCEDURES

Most agricultural dealers help producers manage soil nutrients, which for most has a foundation in grid or zone soil sampling. The exact location of the soil sample (or subsamples) is easily determined using GPS. The location information combined with a fertilizer recommendation from a lab informs the rates used for variable rate application technology.

In 2023, 85% of dealers offered grid or zone soil sampling (Figures 5, 6). Sixty-seven percent of dealers offered grid soil sampling, lower than previous years, 62% offered traditional or whole field sampling, and 57% offered sampling using management zones (Figure 11), all similar to previous years. Multiple responses were allowed for multiple procedures. For dealers who offer sampling in management zones, more are using soil mapping units or yield maps to delineate the zones, and fewer are using soil electrical conductivity (Figure 12, respondents could only choose one). For dealers who grid sample, 2.5 acres (1 hectare) is the most common grid size, although 21% say they sample in larger grids up to 5 acres and 10% sample in smaller grids (Figure 13). The appropriate grid size is a compromise of the labor/time and equipment needed for sampling and soil testing costs vs. the specificity desired to inform variable rates.

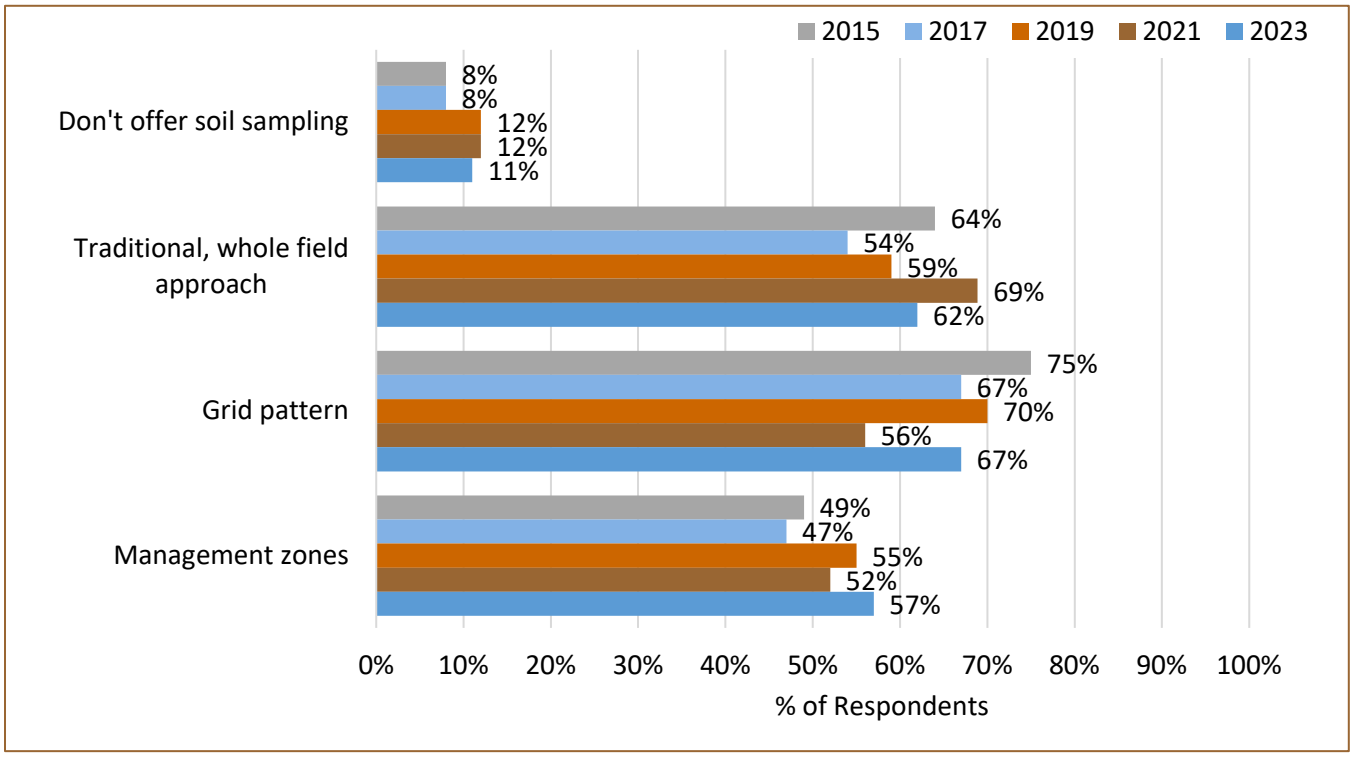


Figure 11, Q6: Types of soil sampling services offered by retailers. Multiple responses were allowed.

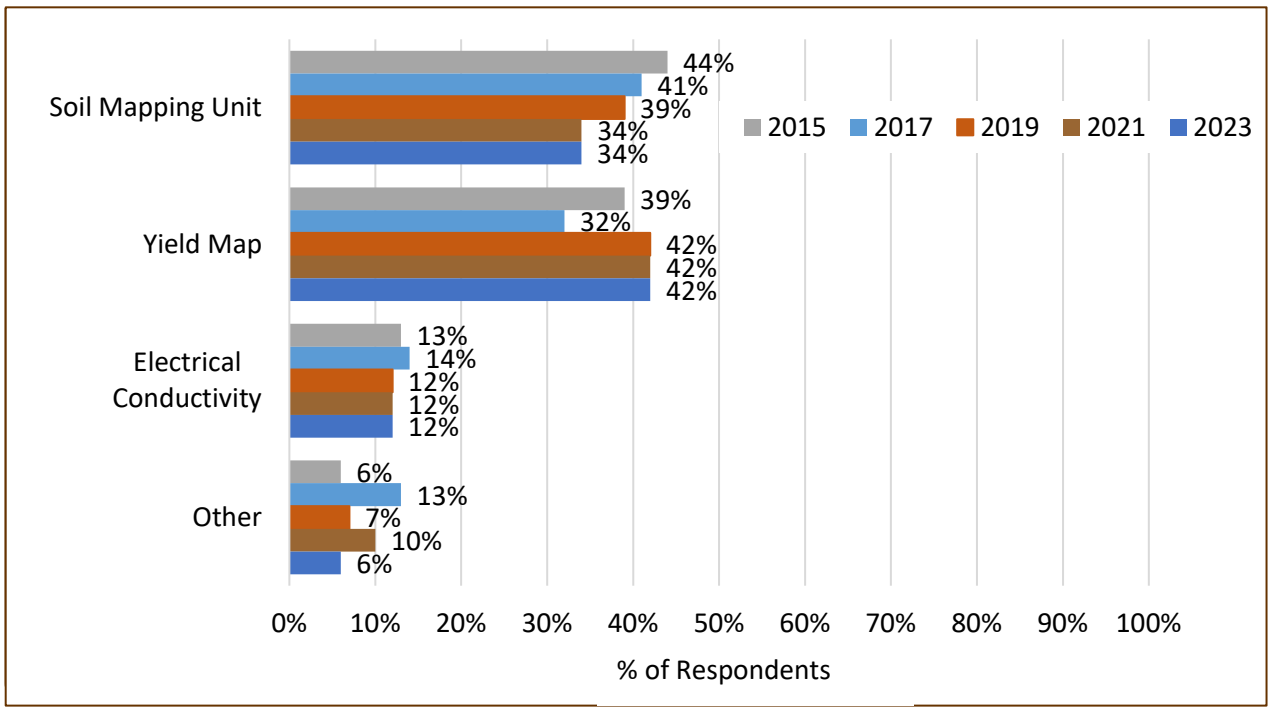


Figure 12, Q6: Factors used by retailers to determine management zones for precision soil sampling. Due to rounding, percentage numbers each year may not total 100.

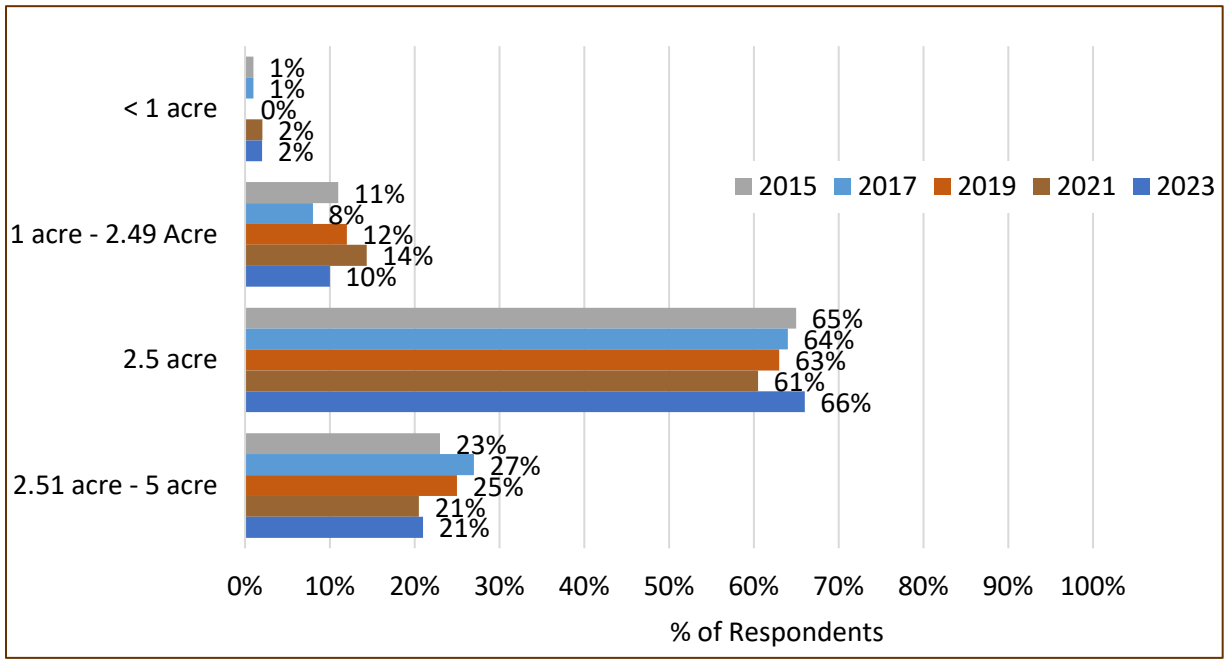


Figure 13, Q6: Grid sizes used by retailers for precision soil sampling. Due to rounding, percentage numbers by year may not total 100.

PROFITABILITY OF PRECISION SERVICE OFFERINGS

Dealerships were asked in the 2022 survey, not in 2023, to report on the profitability of the precision technology services they offer: either making a profit, breaking even, not breaking even, or don't know, Figure 14. This question was not asked in 2023 to help keep the survey length as short as possible. Most dealers are

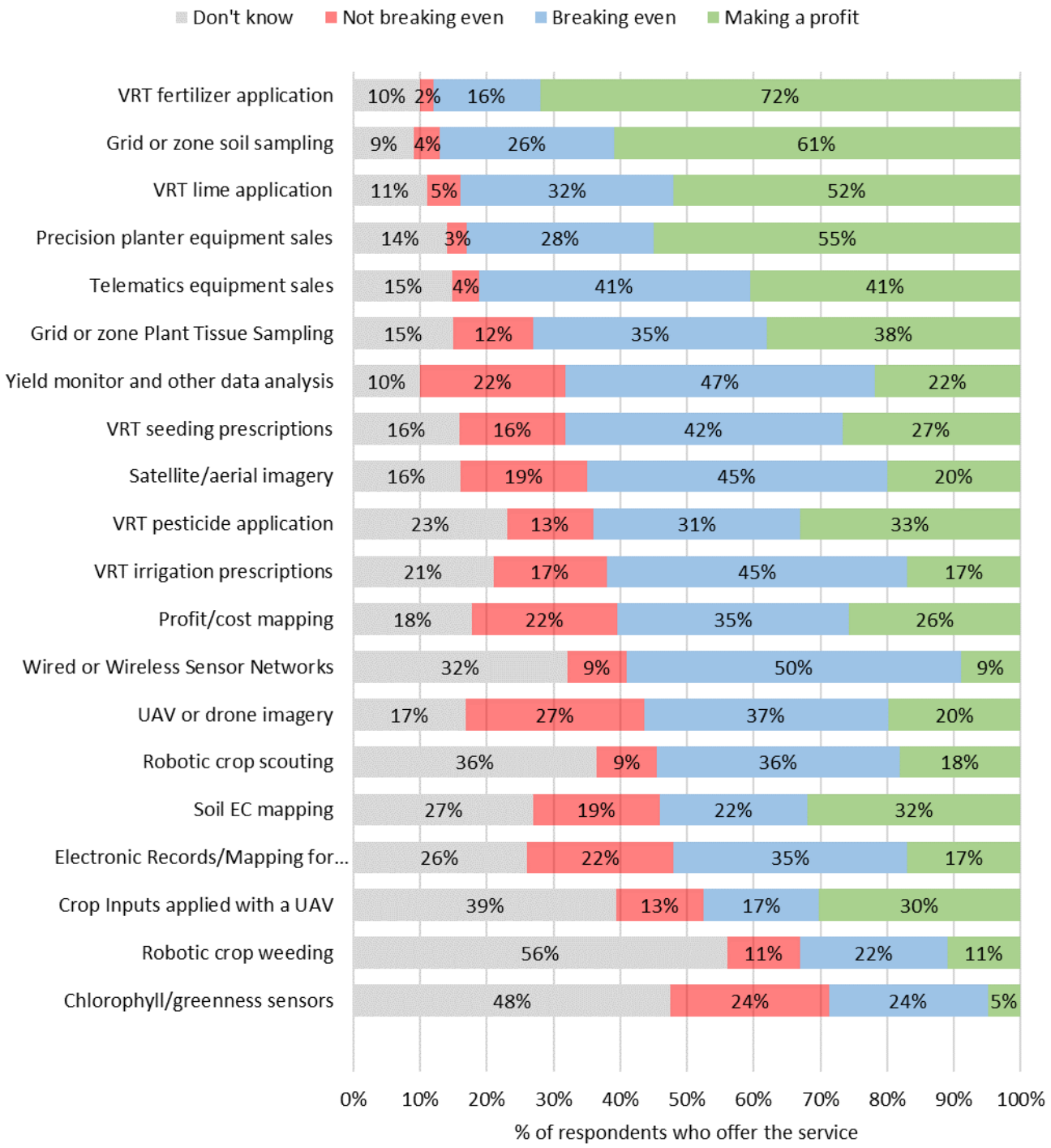


Figure 14: Profitability, ranked by percent at least breaking even (breaking even plus making profit).

at least breaking even in 17 of the 20 service offerings asked, but most dealers are making a profit in just four of the 20.

The services where more than half of agri-dealers are making a profit are VRT fertilizer applications (72% indicate profit), grid or zone soil sampling (61%), precision planter equipment sales (55%), and VRT lime applications (52%). These four offerings stand apart from the others for profitability. The five biggest money losers for dealers are UAV/drone imagery (27% not breaking even), chlorophyll greenness sensors (24% not breaking even), helping farmers with their yield monitor and other data analyses (22%), profit/cost mapping (22%), and electronic records/mapping for traceability (22%).

With many technologies a high percentage of dealers report that they don't know the returns—some of these being newer products and services like robotic weeding, but also including some that have been around many years such as chlorophyll sensors.

Figure 15 shows the percentage of respondents making a profit in certain precision ag services over time. Grid/zone sampling and VRT fertilizer applications continue to be the most profitable for dealers. The percent of dealers indicating these fertilizer-related services return net positive revenue has roughly doubled in the last twenty years, and during that time these have been consistently more profitable than other offerings. Dealers report profits in satellite and aerial imagery and yield monitor and other data analysis have not had similar increases in that same time. In recent surveys profitability is asked about all offerings, but before that profitability was only asked on select services, so just a subset of offerings are shown over time. UAV or drone imagery is a service area where dealers have struggled to make ends meet—possibly because much of imagery is not directly tied to an input that generates revenue.

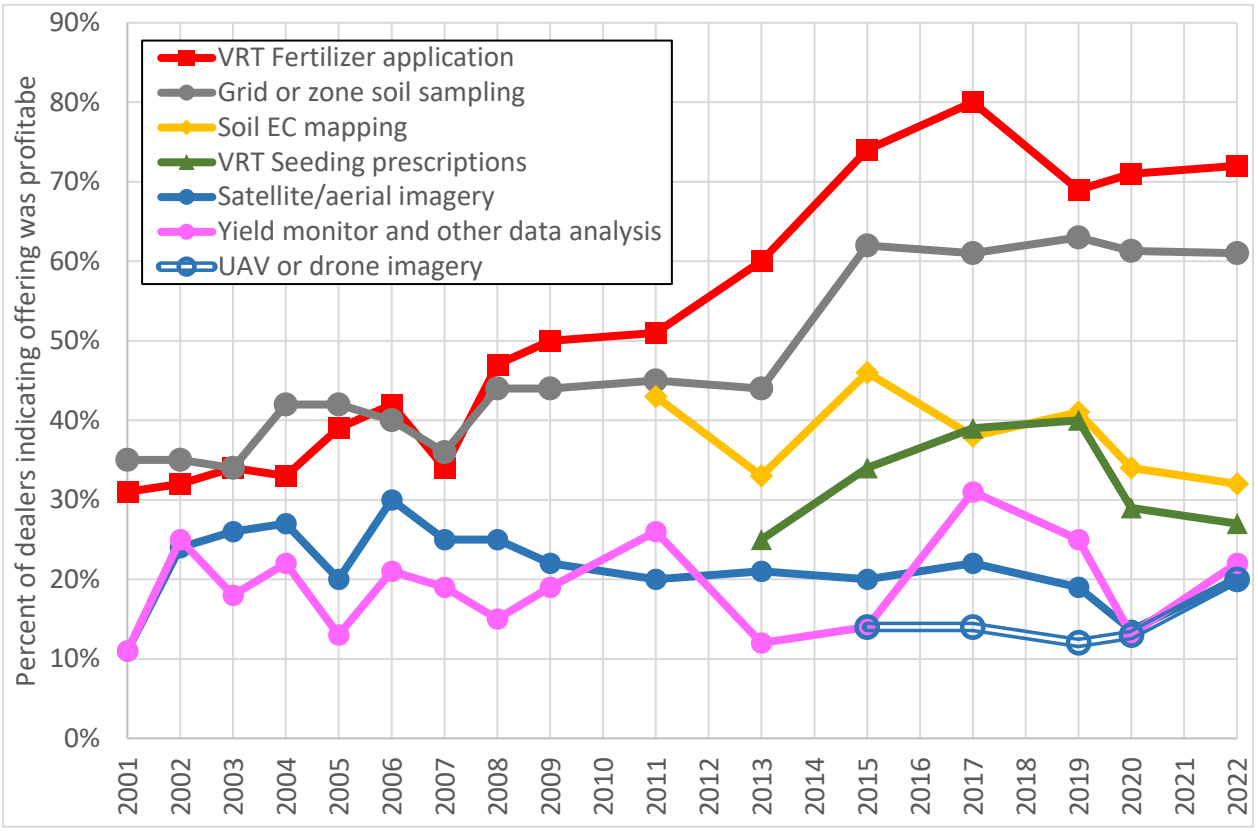


Figure 15: Profitability over time. This question was not asked in 2023.

PRODUCER'S USE OF PRECISION TECHNOLOGIES

While the survey focuses primarily on the technologies used by dealers and precision services offered, we also asked dealers about their customers' practices, and there were few notable changes compared to 2021. Respondents reported on the share of acres in their local market area that are utilizing various precision technologies, not the percentages of farmers. Table 2 shows the estimated market area of an array of

Table 2, Q11: Farmer use of precision technologies, local market area estimated by retailers.

	2017	2019	2020	2021	2022	2023
Guidance/Autosteer	60%	66%	66%	76%	69%	77%
Yield Monitor	-	69%	65%	75%	68%	72%
Sprayer Section Controllers	-	56%	62%	65%	63%	64%
Planter Row or Section Shutoffs	-	45%	46%	52%	51%	54%
Grid or Zone Soil Sampling	45%	52%	52%	60%	57%	51%
VRT Lime Application	40%	41%	44%	56%	52%	43%
VRT Fertilizer Application	38%	39%	44%	51%	49%	43%
Cloud Storage of Farm Data	14%	21%	29%	36%	42%	40%
Variable Down Pressure on Planter	14%	29%	31%	40%	41%	38%
Electronic Records/Mapping for Quality Traceability	-	20%	21%	21%	34%	31%
Any Data Analysis Service	13%	26%	25%	33%	38%	30%
VRT Seeding	13%	19%	19%	23%	22%	22%
Satellite or Aerial Imagery	19%	26%	31%	27%	31%	21%
Soil EC Mapping	9%	10%	14%	17%	19%	15%
VRT Irrigation	-	4%	5%	4%	6%	15%
Variable Hybrid Placement Within Fields	7%	11%	17%	15%	14%	12%
UAV or Drone Imagery	6%	9%	12%	10%	17%	10%
Wired or Wireless Sensor Networks	-	-	-	-	18%	9%
VRT Pesticide Application	3%	8%	7%	8%	9%	6%
Autonomous Support Vehicle (grain cart) for Harvest	-	-	-	0%	5%	6%
Selective Harvest for Quality Improvement	-	4%	7%	7%	15%	5%
Crop Inputs Applied with a UAV/Drone						5%
Chlorophyll/Greenness Sensors for N Management	3%	5%	5%	6%	8%	4%
Robotics/Automation on Harvester	-	0%	1%	1%	3%	3%
Machine Vision Weed Detection on Sprayer	-	-	-	-	-	2%
Robotics/Automation for Scouting	-	-	-	1%	3%	1%
Robotics/Automation for Weeding	-	0%	0%	0%	3%	1%

precision technologies for the last six surveys, ranked most to least for 2023. There was no survey in 2018. Yield monitors and GPS guidance with automatic control have the highest farmer adoption, with dealers reporting around three-fourths of the acres in their market areas using these. Yield monitors are standard equipment on nearly all new combines now, but having a yield monitor doesn't necessarily mean the farmer is creating a yield map. There are many benefits to autosteer that go beyond the cost savings that can come from more precise pass to pass accuracy including less operator fatigue, and more time focused on operating equipment. By mistake, yield monitors and spray section controllers were not on the survey in 2017.

More than half of farm acres employ sprayer section controllers, planter row controllers, and are precision soil sampled. On the opposite end, the much-discussed coming technologies of robotics automation have not yet materialized to any extent on U.S. row crop farms. The robotics harvester question was asked as "robotics/automation *for* harvest" in 2019 and 2020 so could include some responses related to automated grain carts, although the numbers were just 0% and 1%. The question was changed to "robotics /automation *on* harvester" in 2021 and 2022, and a separate question was added for "Autonomous Support Vehicle (grain cart) for Harvest." In Figures 16 and 17, you can see the changes over time in the percent of the market area of various precision ag technologies used by farmers. The two time-scale graphics do not include all technologies to provide for visual clarity—see Table 2 or previous reports.

This was also the fourth year to ask about selective harvest, where grain (or fiber, forage, etc.) are separated by characteristics such as protein or other qualities to maximize revenues. Dealers report it occurs on 5% of

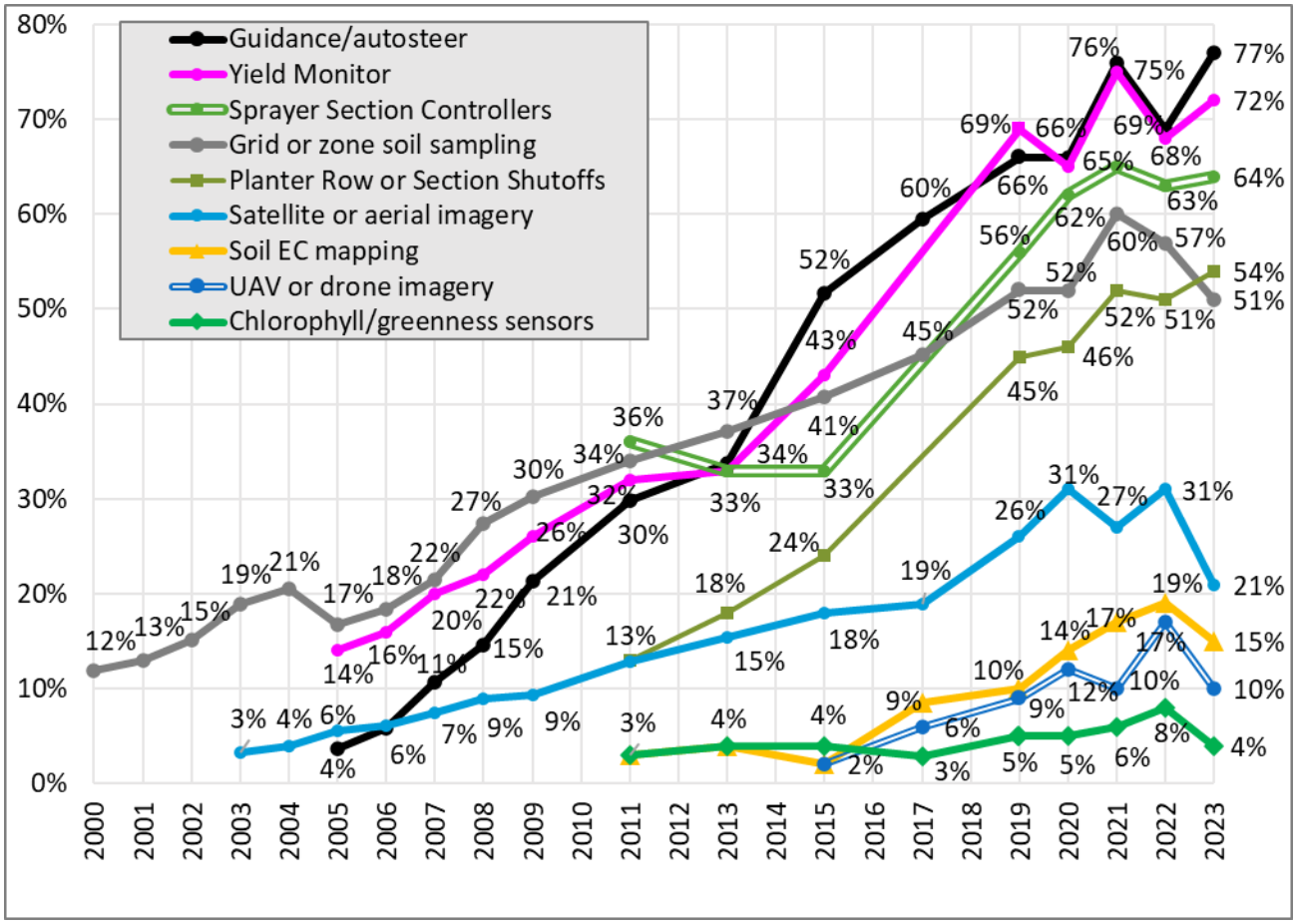


Figure 16, Q11: Producer use of precision technologies, retailers estimate of their market area. Yield monitor, sprayer section controllers, and planter row/section shutoffs were inadvertently omitted in the 2017 survey.

the acres in their trade areas. Some notable increases in the last five years were in cloud storage going from 14% in 2017 to 40% of acres now, planter variable down pressure, from 14% to 38%, and the use of any type of data analysis service, from 13% to 30%.

Just a decade ago there was no precision technology that we tracked used on more than half of farm acreage. Since then many technologies have rapidly expanded in use, but some are plateauing in the last few years. A plateau is inevitable when adoption becomes widespread, but some practices that are not widely adopted have also shown recent downward trends. Not following this pattern are VRT pesticide applications, which are surprisingly lower than a decade ago.

It is interesting that going back 20 years, the percent of acres receiving grid or zone sampling was always higher, normally by a few points, than the percent of acres receiving VRT fertilizers, indicating that not all acres with precision sampling follow up with a precision application. This was the fourth year the survey asked about VRT irrigation, where dealers indicated just 6% of their market area was using this. The VRT irrigation numbers come with substantial consideration, as most responders were from the Midwest where in most areas irrigation is the exception. All precision ag practices show growth on farms in recent years, with the exception of VRT pesticide applications which fell back in 2017 and have partially rebounded.

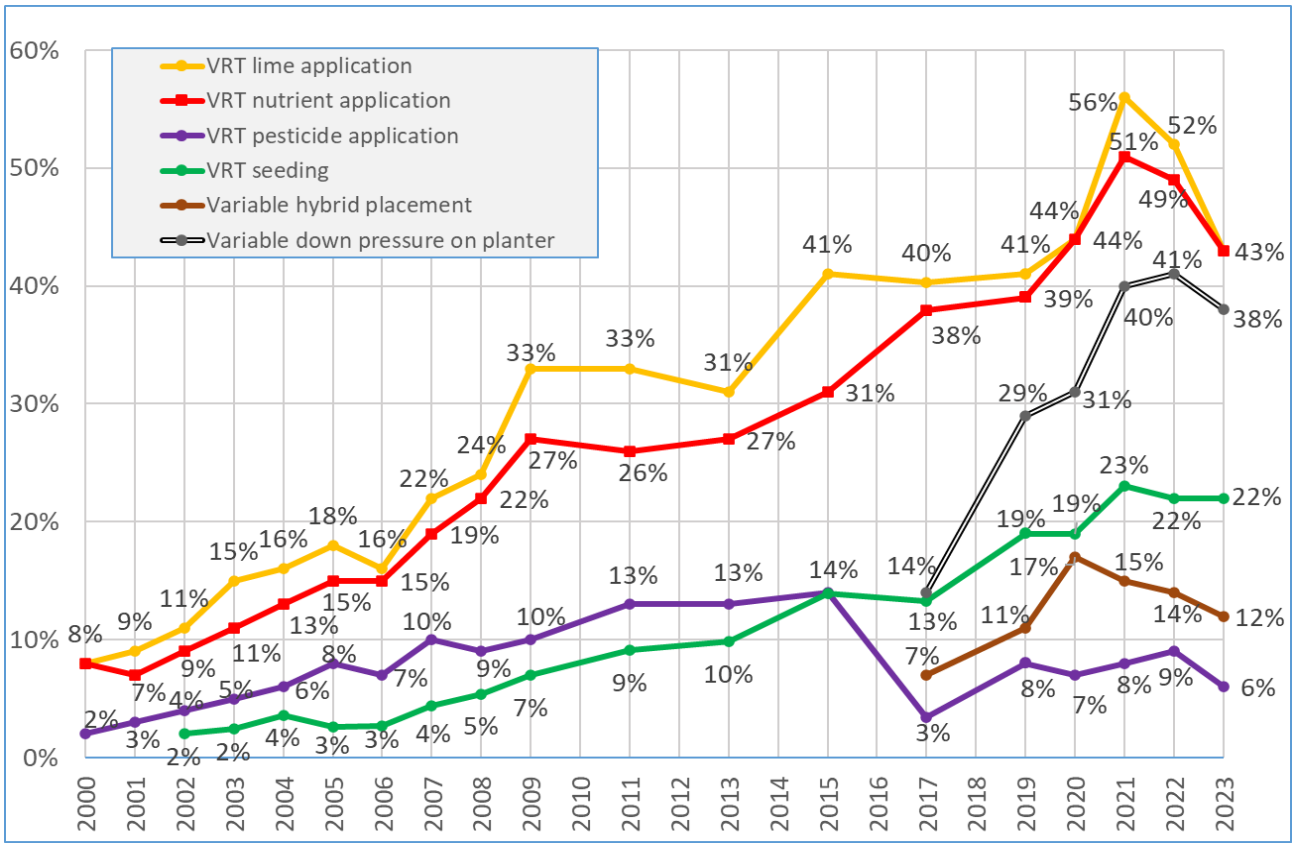


Figure 17, Q11: Farmer use of variable rate technologies (VRT), market area estimated by retailers.

BARRIERS TO GROWTH AND EXPANSION

In an attempt to understand differences in the use of precision technologies, not just report on their use, the survey asked respondents to report on producer and dealer barriers. What is preventing more farmers from adopting or expanding their use of precision farming? What is preventing retailers from offering more precision services? Barriers asked were for precision technologies in general. While information about the barriers for individual technologies would be useful, we didn't feel we could expand these questions to ask about 18 barriers for each technology.

Producer Barriers

Figure 18 shows the perceived barriers as reported by dealers over time for issues that would influence customer decisions on technology. Note the time scale is irregular as the question is not always asked on consecutive surveys. Reported is the percentage who agree or strongly agree the stated barrier is preventing more farmers from adopting or expanding their use of precision agriculture.

Farm income pressure tops all other factors going back almost two decades to when this question was first asked, but as you can see it swings up and down more than any other factor. In 2013 farm income was at

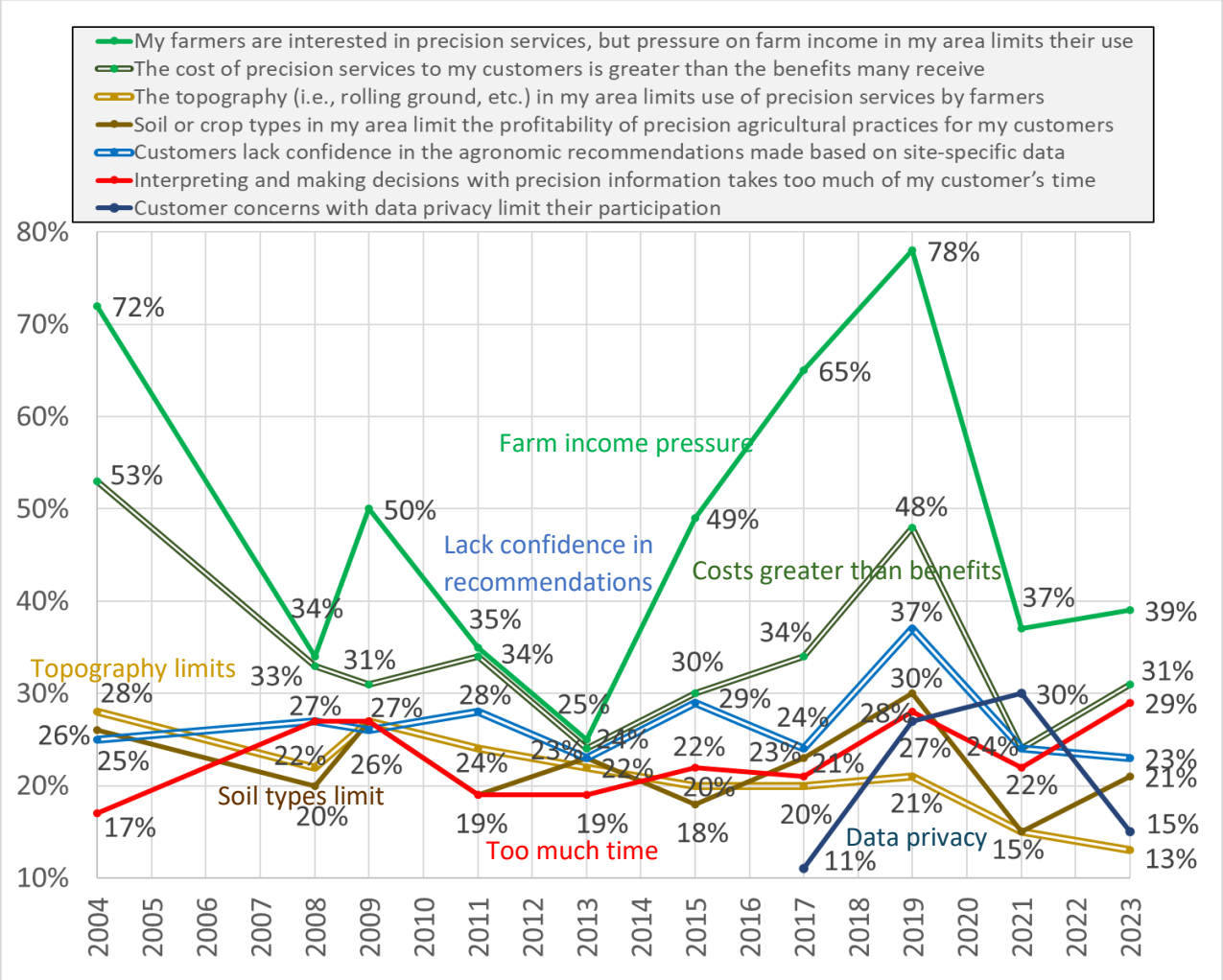


Figure 18: Customer issues that create barriers to expansion and growth in precision agriculture.

historic highs (thus the low point in farm incomes being a barrier), but incomes quickly reversed to be well below the average of the last two decades for 2015 and 2017. The second or third highest across years was also related to farm incomes, the cost of precision services being greater than the benefits. The third or sometimes fourth highest factor for most of the last decade was customer lack of confidence in site-specific agronomic recommendations. Topography limiting use, soil types limiting profitability, and interpreting and making decisions taking too much time are barriers that dealers rate consistently lower from year to year as factors why farmers may not be using precision agriculture.

Dealer Barriers

Figures 19 and 20, using two charts for clarity, show factors related to dealers and technology—what barriers are keeping them from expanding their use of precision agriculture, and what is preventing them as dealers from offering more precision ag services? Similar to the farmer barriers, reported is the percentage who agree or strongly agree the stated barrier is preventing them from adopting or expanding their use of precision agriculture. Many dealer barriers were up in 2023 compared to 2021, but generally down compared to 2019.

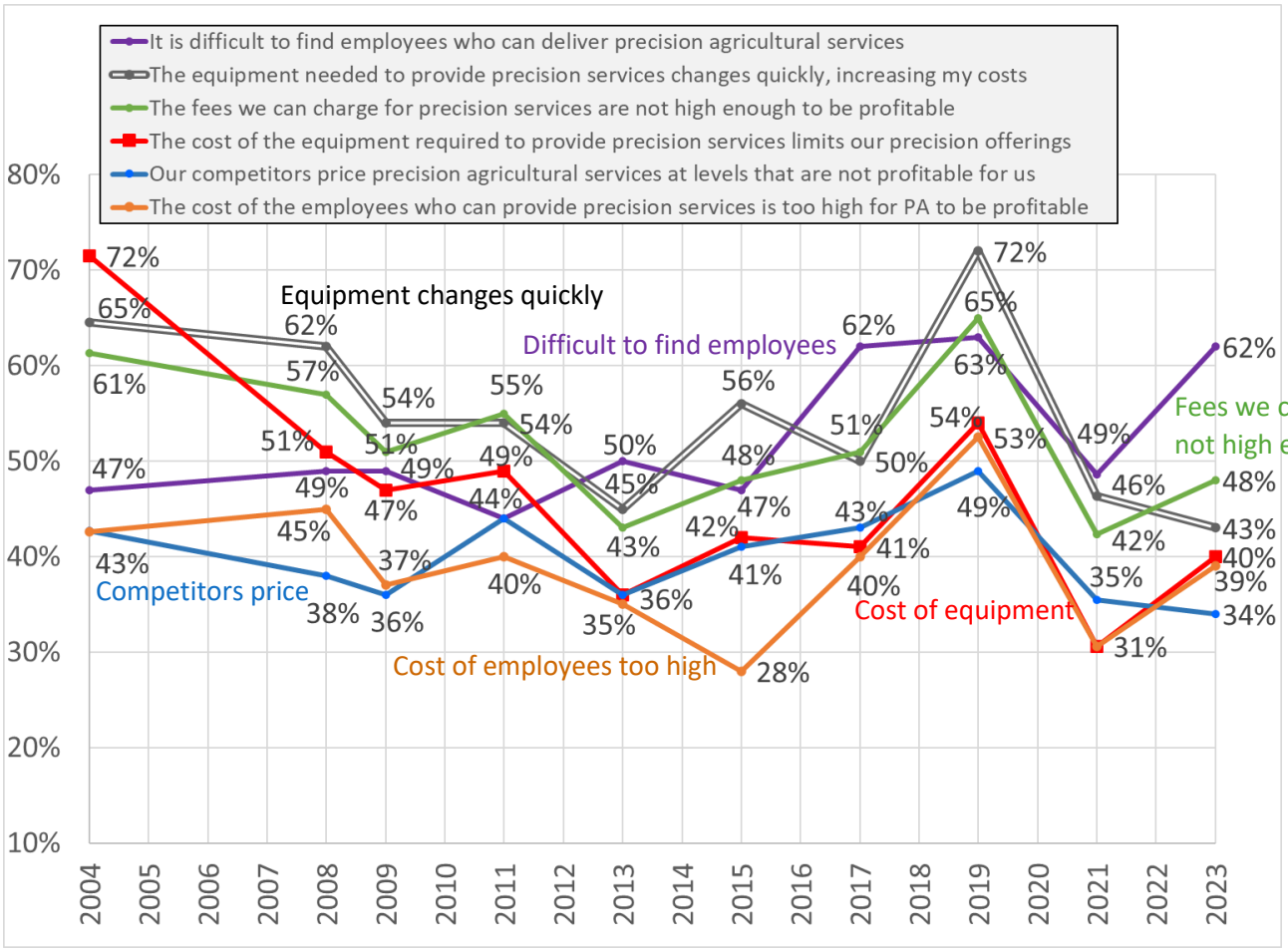


Figure 19: Dealer and technology issues that create a barrier to expansion and growth in precision ag.

The three biggest barriers to success that dealers identified at present are “it is difficult to find employees who can deliver precision agricultural services” at 62%, “the fees we can charge for precision services are not high enough to make precision services profitable,” at 48%, and “incompatibilities across types of precision equipment/technology limit my ability to offer precision services” at 45%. The first two of these were always the highest going back a decade.

On the opposite end of the scale as a barrier was lack of manufacturer support, which dealers have consistently rated low, in fact the lowest always since this question was asked—indicating dealers feel they get good company support. Also consistently low as a barrier is “the equipment required to deliver precision services is too complex for many of my employees,” the second lowest for two decades with the exception of two years.

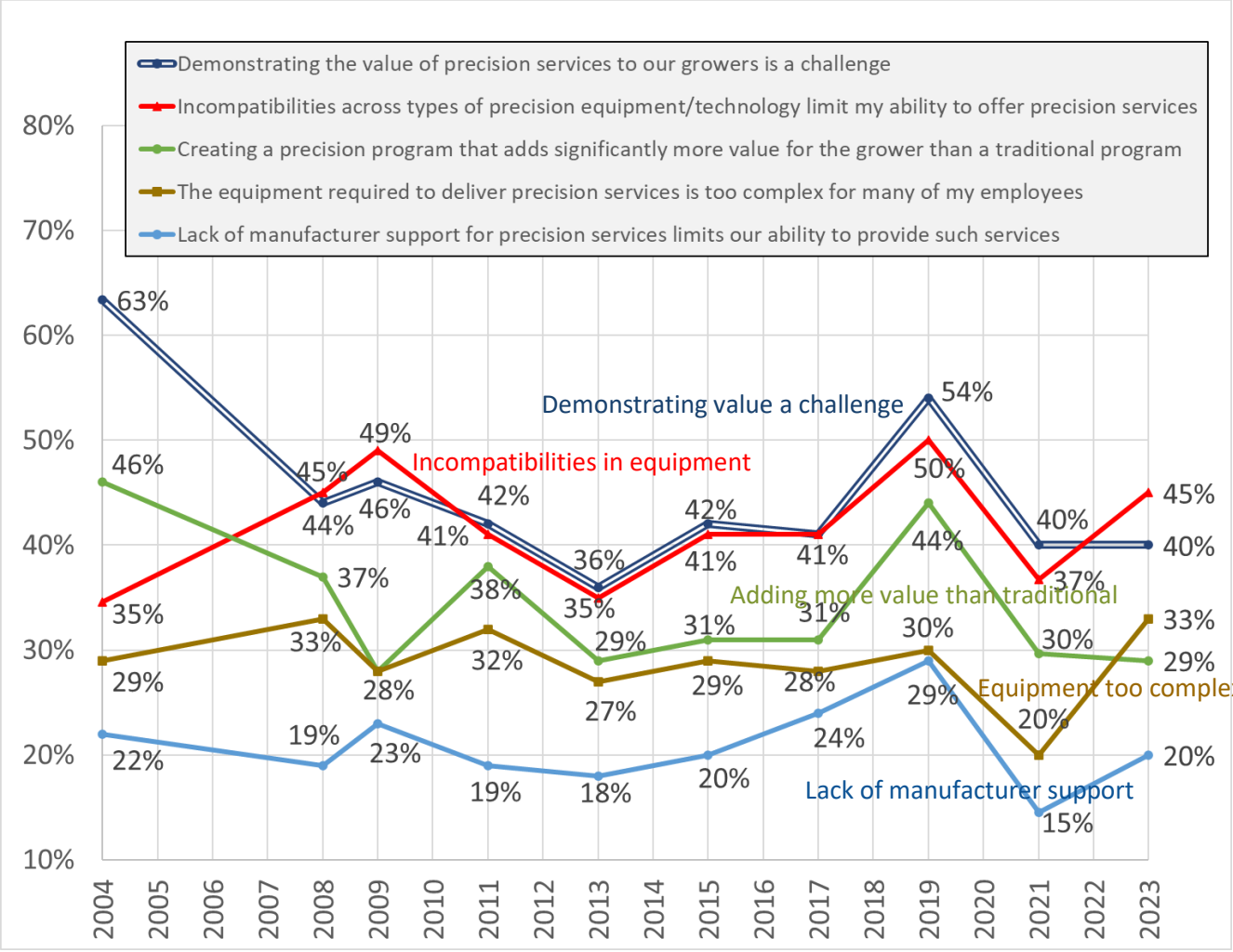


Figure 20: Dealer and technology issues that create a barrier to expansion and growth in precision ag.

SUMMARY

The Precision Agriculture Dealership survey has been tracking the changes in digital technology use in crop retail input establishments and on farms since 1996. Since that time there have been watershed changes to the technologies as well as new types introduced. Three decades ago agri-dealers offering precision services were most likely grid or zone soil sampling along with offering customers variable rate fertilizer applications. And with the advent of the combine yield monitor at about that same time, there was much activity in trying to link soil nutrient tests with crop yield responses, and then working to determine the optimum combination of nutrients and soil amendments for any particular part of a field. With enhancements in planter technology, varying planting rates and varieties soon followed. Soil maps and aerial or satellite imagery were often a part of understanding crop responses, too.

2023's Precision Agriculture Dealership Survey shows continuing shifts. We report on dealers who are serving farmers who primarily grow field crops and are mostly located in the Midwest. Dealers have invested in technology to streamline their logistics, such as fleet management and telemetry, used now by about half of dealers. Most dealers are using autoguidance and spray section/nozzle controllers for their custom pesticide and fertilizer applications, as has been the situation for several years. Precision soil sampling and precision tissue sampling along with VRT fertilizer applications are customer offerings at most dealerships, along with helping customers analyze their yield monitor and other data, offering aerial, satellite, or drone imagery, and making variable seeding recommendations. In the next few years dealers say the greatest areas of growth will be in the numbers of dealers offering crop inputs via UAV/drones, machine vision on sprayers, and UAV/drone imagery. Robotic scouting and robotic weeding services are being offered by a few dealers, but twice as many say they are planning to offer in the future.

Most dealers offer precision soil sampling, but slightly more offer whole field or grid sampling services as compared to management zones. If a dealer is zone sampling, more are using soil maps or yield maps to delineate zones as compared to soil electrical conductivity. If a dealer is grid sampling, most use 2.5 acre grids, about one fifth more commonly sample in larger grids, and about 10% mostly sample in grids smaller than 2.5 acres.

Fertilizer-related dealer offerings such precision soil sampling or VRT fertilizer applications provide greater returns than other precision services. The cost of the technology relative to the value gained in time or inputs mostly determines the return to precision investment. So when the cost and availability of labor, pesticides, fertilizers, and other inputs as well as crop prices grow faster than the cost of electronics and controllers to manage all that, the case for investment in digital ag can be more readily made. Pooled on-farm data is guiding decisions at rates multiples that of just five years ago. Pooled data is used more in crop nutrient management and hybrid/variety selection, and less for helping to guide crop planting rates, variable rate prescriptions, crop rotations, or pesticide selection.

Retailers report that most of the acres in their areas use autoguidance, yield monitors, sprayer and planter row/section controllers, and do grid or zone soil sampling, but most acres still do not manage their fertilizer with a variable rate approach, and fewer yet with variable seeding. Only 20% of acres are using aerial or satellite imagery.

Most of the barriers retailers see affecting their growth into more precision and their customer's adoption of precision technologies were up a bit for 2023, but their relative importance was much the same as in previous years. Economic factors were the highest barriers identified by retailers for their farmer customers. Even though highest, it was a minority of dealers that agreed or strongly agreed farm incomes were holding more farmers from adopting, or that thought the costs of precision farming for their customers were greater than

the benefits. Issues most important to retailers in 2023 for moving precision programs forward in their business were in finding suitable employees to deliver on products and services (62% of dealers agreed or strongly agreed), and in being able to charge enough fees to make a profit (48% of dealers agreed or strongly agreed).

SURVEY INSTRUMENT

CropLife

23rd Precision Agriculture Services Dealership Survey

PURDUE UNIVERSITY

IRB APPROVAL 1702018754

Dear agricultural retailer,

The CropLife/Purdue survey is the longest-running, most widely used survey that chronicles the development and adoption of precision agriculture! We depend on your continued input. Please complete by March 1, 2023. **Thank you for your participation!**

Bruce Erickson & Jess Lowenberg-DeBoer *Purdue University* | Eric Sfiligoj *CropLife/Meister Media*

1. Which best describes your business? *[mark only one]*

[ ] Agricultural retail input supplier. *Sell fertilizers, seeds, or pesticides, and related crop production services to farmers.*
[ ] Farm equipment dealer. We appreciate your interest, but are focusing on ag retail input suppliers. [Survey terminates]
[ ] Agricultural consultant. *Provide advice and services to farmers such as soil testing, scouting, or farm management.* [Survey terminates]
[ ] Other: *[please specify]* _____. [Survey terminates]

2. If you answered agricultural retail input supplier above. Are you a: *[please mark only one]*

[ ] Independent dealership
[ ] Cooperative
[ ] Part of a national or regional chain (not a cooperative)
[ ] Other: *[please specify]* _____

3. Your primary responsibility: *[please mark only one]*

[ ] Owner/general manager/location manager
[ ] Departmental manager
[ ] Precision manager
[ ] Application manager
[ ] Technical consultant/agronomist
[ ] Sales/sales management
[ ] Other: *[please specify]* _____

4. How many total retail outlets does your company own or manage? *[please mark only one]*

[ ] None [ ] 1 [ ] 2-5 [ ] 6-15
[ ] 16-25 [ ] More than 25

5. Rank the following crop types according to the value of products and services you provide to each *[1=highest, 2=next highest, etc. Leave blank if less than 2% of your business.]*

[ ] field crops (corn, soy, wheat, rice, cotton, milo, sugar beets, dry beans, etc.)
[ ] hay and forages
[ ] nursery or greenhouse
[ ] vegetables (incl. potatoes, melons, lettuce, tomatoes)
[ ] tree fruits & nuts
[ ] berries (strawberries, blueberries, raspberries, etc.)
[ ] grapes
[ ] Other: *[please specify]* _____

6. Do you offer soil sampling — traditional, following a grid pattern and/or by management zone? *[mark all that apply]*

[ ] Don't offer soil sampling
[ ] Traditional, whole field approach
[ ] Grid pattern
[ ] Management zones

If grid, what grid size most common? *[mark only one]*

[ ] < 1 acre
[ ] 1 acre - 2.49 acre
[ ] 2.5 acre
[ ] >2.5 acre

If zone, determined by what factor? *[mark only one]*

[ ] Soil mapping unit
[ ] Electrical conductivity
[ ] Yield map
[ ] Other [please specify]: _____

7. In which of the following ways does your dealership use precision technology? *[mark all that apply]*

[ ] GPS guidance systems with manual control (light bar)
[ ] GPS guidance systems with automatic control (autosteer)
[ ] Auto sprayer boom section or nozzle control
[ ] Sprayer turn compensation
[ ] Telematics to exchange information among applicators or to/from office locations
[ ] GPS fleet management for vehicle logistics, tracking locations of vehicles, and guiding vehicles to the next site
[ ] Smart scouting using an app on a mobile device to record field situations and locations
[ ] Predictive models for pest infestations
[ ] Do not use precision technology

8. How do you help manage the farm-level data (i.e., yield maps, soil tests, EC, imagery) of your farmer- customers to assist in their decision-making? *[mark all that apply]*

[ ] No data aggregated among farmers, work with farmers only with the data from their own farms
[ ] Data aggregated among farmers but not outside dealership
[ ] Data aggregated among farmers including those outside dealership
[ ] Archiving and managing yield, soil test, and other data
[ ] Other *[please specify]* _____
[ ] Do not help customers with their farm-level data

9a. What crop management decisions are being influenced by pooled data from your customer's farms?

[please mark only one column per row]	No influence	Some influence	Major influence
Nitrogen decisions	[ ]	[ ]	[ ]
P and K decisions	[ ]	[ ]	[ ]
Liming decisions	[ ]	[ ]	[ ]
Overall hybrid or variety selection	[ ]	[ ]	[ ]
Variable hybrid or variety placement in field	[ ]	[ ]	[ ]
Overall crop planting rates	[ ]	[ ]	[ ]
Variable seeding rate prescriptions	[ ]	[ ]	[ ]
Pesticide decisions (herbicides, insecticides, or fungicides)	[ ]	[ ]	[ ]
Cropping sequence/rotation decisions	[ ]	[ ]	[ ]
Irrigation decisions	[ ]	[ ]	[ ]
Biologicals decisions	[ ]	[ ]	[ ]
Other *[please specify]*: _____	[ ]	[ ]	[ ]

9b. Does your company have a customer data privacy statement and/or data terms & conditions agreement?

[ ] Yes [ ] No

10. **Which services/products do you offer now? If not now, will you in three years? If you don't offer now and have no plans for the near future, leave blank.**

	Offer now	Will offer by 2026
VRT fertilizer application	[ ]	[ ]
VRT lime application	[ ]	[ ]
VRT pesticide application	[ ]	[ ]
VRT seeding prescriptions	[ ]	[ ]
VRT irrigation prescriptions	[ ]	[ ]
Yield monitor and other data analysis	[ ]	[ ]
Satellite or crewed airplane imagery	[ ]	[ ]
UAV/drone imagery	[ ]	[ ]
Grid or zone soil sampling	[ ]	[ ]
Grid or zone plant tissue sampling	[ ]	[ ]
Soil electrical conductivity (EC) mapping	[ ]	[ ]
Other soil sensors mounted on a pickup, applicator or tractor (example:pH sensor)	[ ]	[ ]
Chlorophyll/greenness sensors for N management (GreenSeeker, Augmenta Mantis, OptRx, etc.)	[ ]	[ ]
Precision planter equipment sales	[ ]	[ ]
Telematics equipment sales (Farmobile, Trimble DCM-300, etc.)	[ ]	[ ]
Profit/cost mapping	[ ]	[ ]
Electronic records/mapping for traceability	[ ]	[ ]
Wired or wireless sensor networks, IoT	[ ]	[ ]
Robotics/automation for crop scouting	[ ]	[ ]
Robotics/automation for mech. weeding	[ ]	[ ]
Machine vision weed detection on sprayer	[ ]	[ ]
Crop inputs (seeding, pesticides, fertilizers) applied with a UAV/drone	[ ]	[ ]

11. **Approximately what percentage of the total acreage in your market area (all growers, not just your current customers) is currently using the following practices?**

VRT fertilizer application	_____%
VRT lime application	_____%
VRT pesticide application	_____%
VRT seeding	_____%
Variable hybrid/variety placement within fields	_____%
Variable rate irrigation	_____%
Satellite or crewed airplane imagery	_____%
UAV/drone imagery	_____%
Guidance/autosteer	_____%
Sprayer section controllers	_____%
Planter row or section shutoffs	_____%
Variable down pressure on planter	_____%
Grid or zone soil sampling	_____%
Soil EC mapping	_____%
Chlorophyll/greenness sensors for N management	_____%
Yield monitor	_____%
Cloud storage of farm data	_____%
Any data analysis service (Granular, FieldView, FBN, etc.)	_____%
Wired or wireless sensor networks, IoT	_____%
Robotics/automation for mechanical weeding	_____%
Robotics/automation for crop scouting	_____%
Robotics/automation on harvester	_____%
Autonomous support vehicle (grain cart) for harvest	_____%
Electronic records/mapping for traceability	_____%
Machine vision weed detection on sprayer	_____%
Selective harvest for quality improvement	_____%
Crop inputs (seeding, pesticides, fertilizers) applied with a UAV/drone	_____%

12. **In a typical year how many total acres do you custom apply at your specific location (fertilizer, chemicals, seeding – total acres including multiple applications)?** _____acres *[If none, go to Question 16]*
13. **In 2022, approximately what percentage of your total fertilizer sales were custom applied?** _____%
14. **In 2022, approximately what percentage of your total crop protection sales were custom applied?** _____%
15. **In 2022, approximately what percentage of your total custom application (total acres, all products) used:**
    Manual GPS guidance (light bar) _____% Auto sprayer boom section or nozzle control _____%
    Automated GPS guidance (autosteer) _____% Variable rate prescription map _____%
16. **What are the primary barriers preventing more farmers from adopting or expanding their use of precision agricultural services and/or preventing you from offering more precision services?**
    Please rate the following statements on a scale from 1 (strongly disagree) to 5 (strongly agree).

		Disagree				Agree
Customer Issues	The cost of precision services to my customers is greater than the benefits many receive	1	2	3	4	5
	My farmers are interested in precision services, but pressure on farm income in my area limits their use	1	2	3	4	5
	The topography (i.e., rolling ground, etc.) in my area limits use of precision services by farmers	1	2	3	4	5
	Soil or crop types in my area limit the profitability of precision agricultural practices for my customers	1	2	3	4	5
	Interpreting and making decisions with precision information takes too much of my customer's time	1	2	3	4	5
	Customers lack confidence in the agronomic recommendations made based on site-specific data	1	2	3	4	5
	Customer concerns with data privacy limit their participation	1	2	3	4	5
Dealer issues	The cost of the equipment required to provide precision services limits our precision offerings	1	2	3	4	5
	The cost of the employees who can provide precision services is too high for precision ag to be	1	2	3	4	5
	It is difficult to find employees who can deliver precision agricultural services	1	2	3	4	5
	The fees we can charge for precision services are not high enough to make precision services profitable	1	2	3	4	5
	Lack of manufacturer support for precision services limits our ability to provide such services	1	2	3	4	5
	Creating a precision program that adds significantly more value for the grower than a traditional agronomic program is difficult for us	1	2	3	4	5
	Demonstrating the value of precision services to our growers is a challenge	1	2	3	4	5
	Our competitors price precision agricultural services at levels that are not profitable for us	1	2	3	4	5
	The equipment needed to provide precision services changes quickly, increasing my costs	1	2	3	4	5
	The equipment required to deliver precision services is too complex for many of my employees to use	1	2	3	4	5
	Incompatibilities across types of precision equipment and technology (different data formats, inability to share information) limit my ability to offer precision services	1	2	3	4	5

17. **For your retail location, what state are you located in?** _____. **THANKS AGAIN FOR YOUR INPUT!**