2024 PRECISION AGRICULTURE DEALERSHIP SURVEY

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Departments of Agronomy and Agricultural Economics

Purdue University

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LIST OF FIGURES AND TABLES WITH REFERENCE TO 2024 SURVEY QUESTION

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

In February-March 2024 CropLife magazine and the Departments of Agricultural Economics and Agronomy at Purdue University conducted the 24th survey of crop input dealers about precision agriculture technologies. Recipients were asked questions about what precision products and services they offer to their customers, the profitability of these products and services, custom applications of fertilizers and pesticides, their usage of drones for custom applications, and questions about automation and artificial intelligence. To keep the survey length reasonable for respondents, we ask some questions in alternate years—so some survey questions that were asked in 2023 and not 2024 are included in this report, as well as some time-series information that goes back many years, in some cases into the 1990's. This survey is the longest-running, continuous survey of precision farming practices in the world.

The questionnaire was all electronic using QuestionPro due to its formatting capabilities, 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 thanked the respondent then 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 108 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, Q6: Respondent location by region and state.

Midwest 76%				South 11%		West 7%		East 6%	
Iowa	19%	Wisconsin	6%	Kentucky	3%	Colorado	3%	Maryland	2%
Illinois	11%	Nebraska	4%	N Carolina	3%	California	2%	Virginia	2%
Indiana	11%	N Dakota	3%	Tennessee	2%	Wyoming	2%	New York	1%
Minnesota	6%	Michigan	2%	Alabama	1%	Washington	1%	W Virginia	1%
Missouri	6%	S Dakota	2%	Georgia	1%				
Ohio	6%	Kansas	1%	Oklahoma	1%				
				Texas	1%				

Of the ag input retailers 47% indicated they represented a cooperative, 32% an independent dealership and 18% were part of a national or regional dealership (not a cooperative), Figure 1.

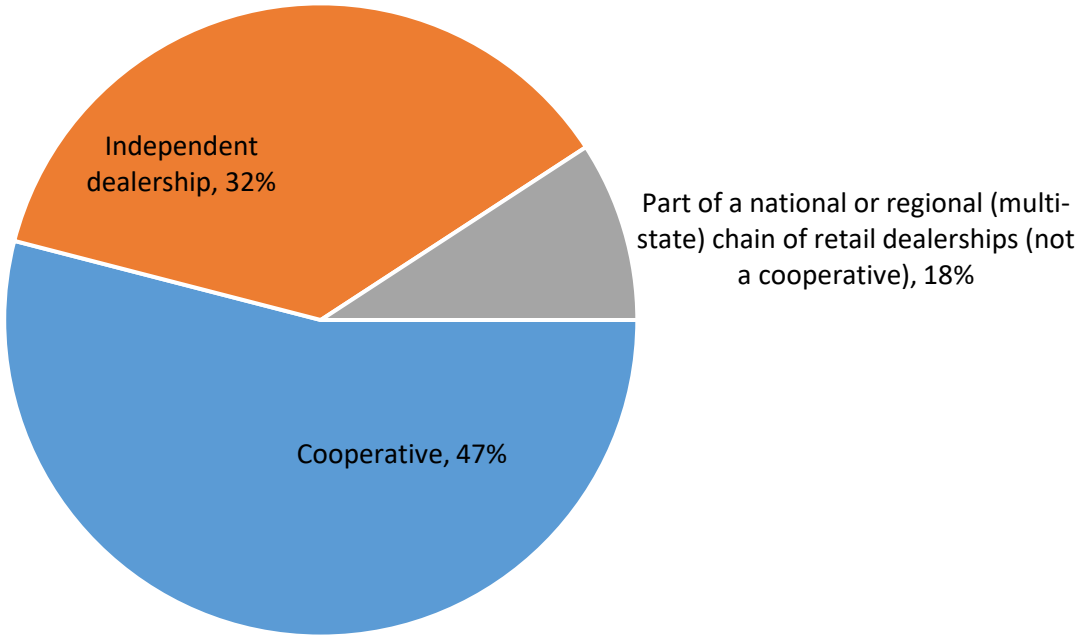

Figure 1, Q1: Organizational type represented by respondents.

The organizations the respondents represent are primarily multiple retail locations, Figure 2. Four 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-four percent of respondents reported having only one retail outlet. About half of respondents owned or managed five stores or less, and about half 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, 32% of respondents worked at a company that had six or more stores.

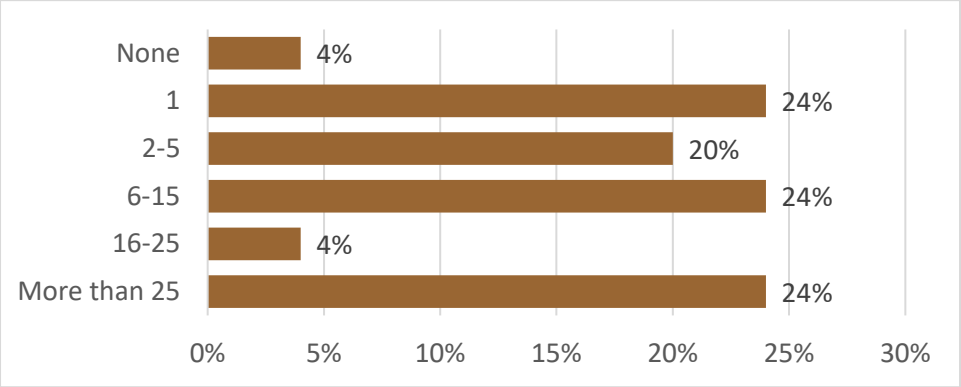

Figure 2, Q4: Number of retail outlets owned or managed by company of respondent.

The survey asked about the position the respondent held within their organization. Thirty-one percent reported being the owner or location manager, and 26% were in sales or sales management. Other common job responsibilities for respondents were precision manager (18%), 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).

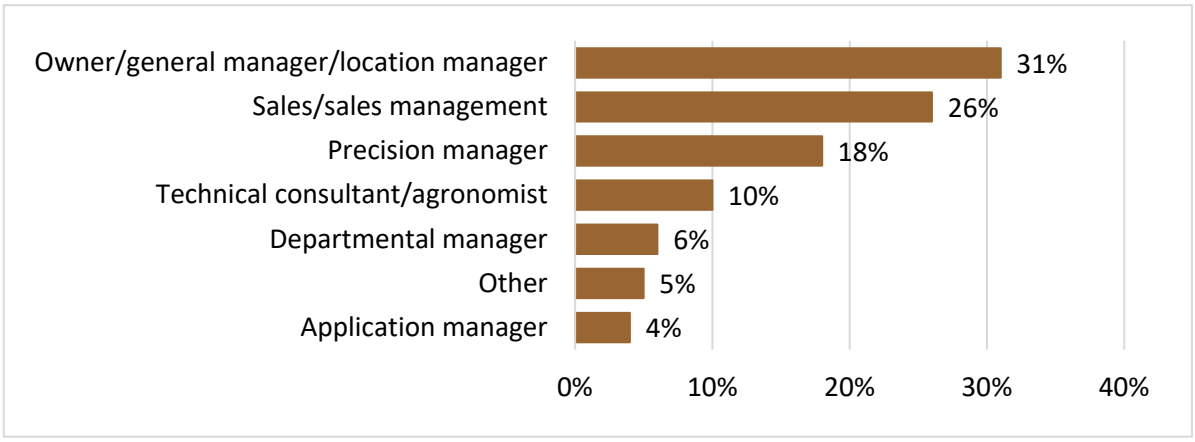

Figure 3, Q3: Responsibility of survey respondent.

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) in 2023. 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. Turn compensation adjusts rates along the sprayer boom so amounts applied are not too low on the outside of a turn, where the boom is moving faster, nor too high on the inside of a turn, where the boom is moving slower. 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 the changing costs for fuel, and the availability of labor. 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, then back to yearly. 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. To keep the survey as short as possible, this question was not asked in 2024.

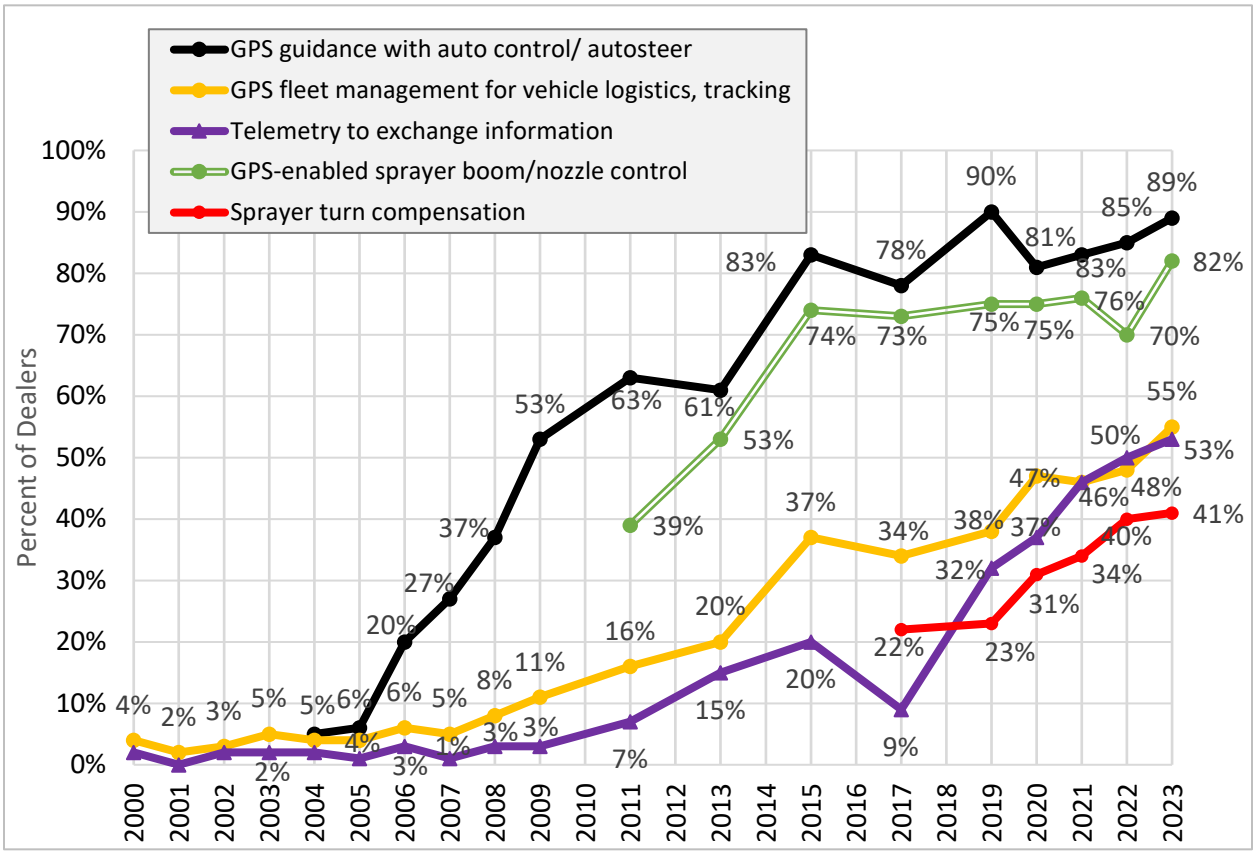

Figure 4, from 2023: Retailer use of precision technology for their business. Question not asked in 2024.

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 2027 (Figure 5). Current dealer offerings are ranked top to bottom in green. Due to rounding, rows may not total 100%.

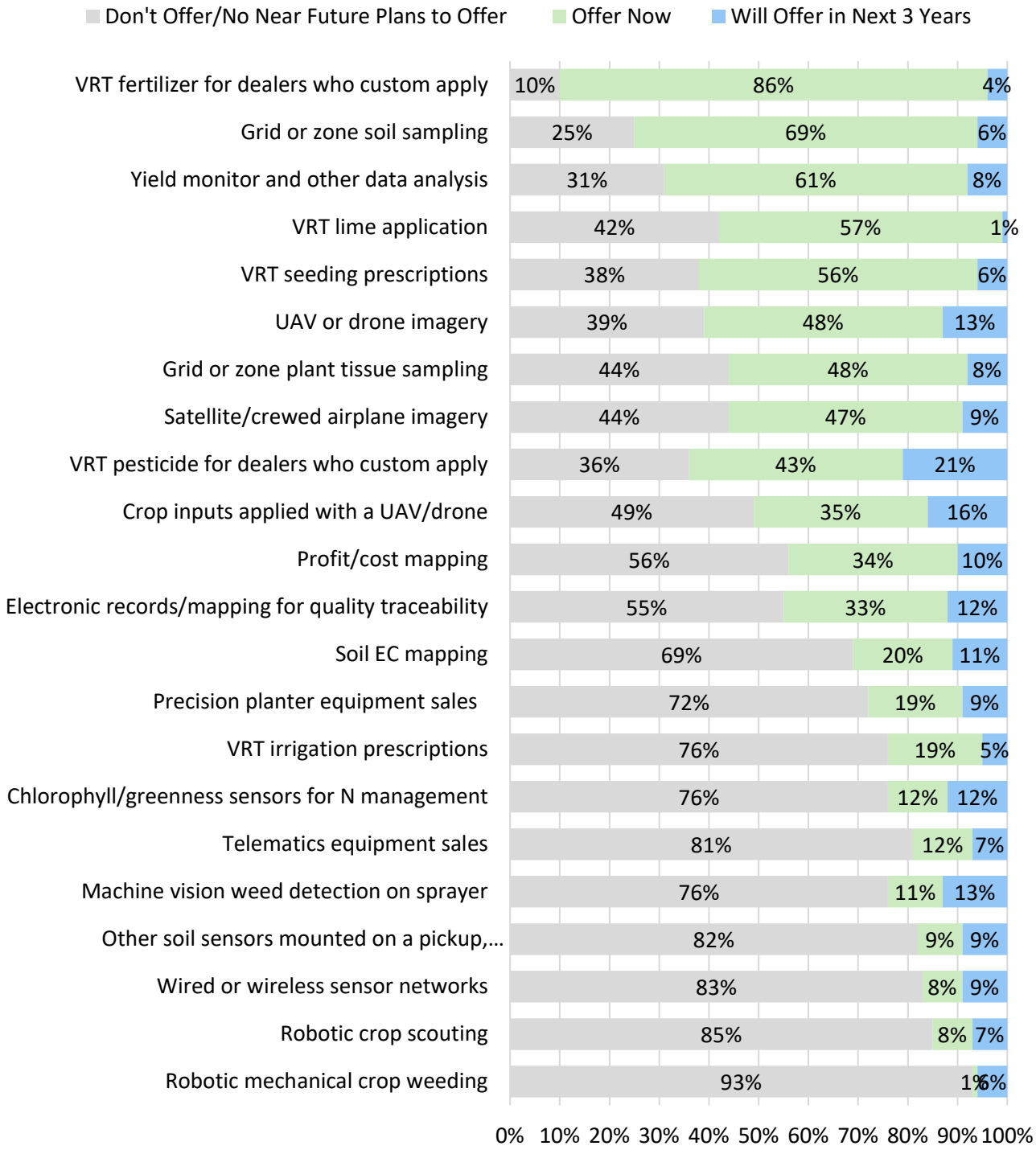

Figure 5, Q7: Dealer offerings of precision services, ranked by current offering.

Variable rate technology (VRT) for fertilizers leads the offerings at 86% of dealers providing this service. This could mean a dealer uses VRT with most or all their fertilizer applications, or just a portion. VRT fertilizer offerings have always been calculated as the percent of all dealers who offer this service. But in 2024 only 58% of dealers indicated they were doing custom fertilizer applications, as indicated by their answers to questions 12 and 14. We can only speculate why there was such a drop in custom applications. Custom application acres were not asked in 2020, 2021, or 2022, so the numbers series cannot be adjusted going back. But custom acres were asked on every survey from 2000 to 2019, and the percent of dealers that were doing any custom application ranged from 78% in 2001 to 94% in 2017. So for 2024 (and onward) the number is the percent of dealers who are doing VRT fertilizer that do any custom fertilizer application, not the percent of all dealers whether they do custom fertilizer application or not.

Two thirds of dealers offer grid or zone soil sampling, a complement to VRT fertilization. Unlike the VRT fertilizer offerings, we report the percentage of all dealers, as dealers could offer soil sampling without also doing custom applications. The next common offerings of dealers are yield monitor and other data analysis at 61%, VRT lime applications at 57%, and VRT seeding recommendations at 56% of dealers. A bit short of half of dealers offer satellite, aerial, and drone imagery, and precision plant tissue sampling. We define aerial as imagery acquired by a crewed airplane. These eight technology offerings in 2024 were the top eight in 2023 also.

To be consistent with fertilizer custom applications, starting in 2024 VRT pesticide offerings of percent of dealers are only for dealers who indicate they custom apply pesticides. Fourty-three percent of dealers custom applying pesticides are currently doing at least some VRT. Over the next 3 years, the technologies respondents are planning the most growth (longest blue bar in Figure 5) are in VRT pesticide application (21% of respondents will add) and crop inputs applied with a UAV/drone (16% will add). 13% of dealers plan to add UAV or drone imagery, and 13% will add machine vision weed detection. 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. The 2027 projections (connected by dotted line) are calculated as the sum of question 7 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 mostly increases from 2007 to 2017 but some leveling off after 2020 and many dropping in 2024.

Around half of dealers are now offering imagery from satellites, airplanes, and more recently UAVs/drones, which increased sharply from 2015 to 2020. The ease with which drones can be flown and images georeferenced and stitched compared to a decade ago are certainly contributing factors. All imagery service offerings are much higher than they were a decade ago, but somewhat below the peak imagery offering in 2022 and 2023.

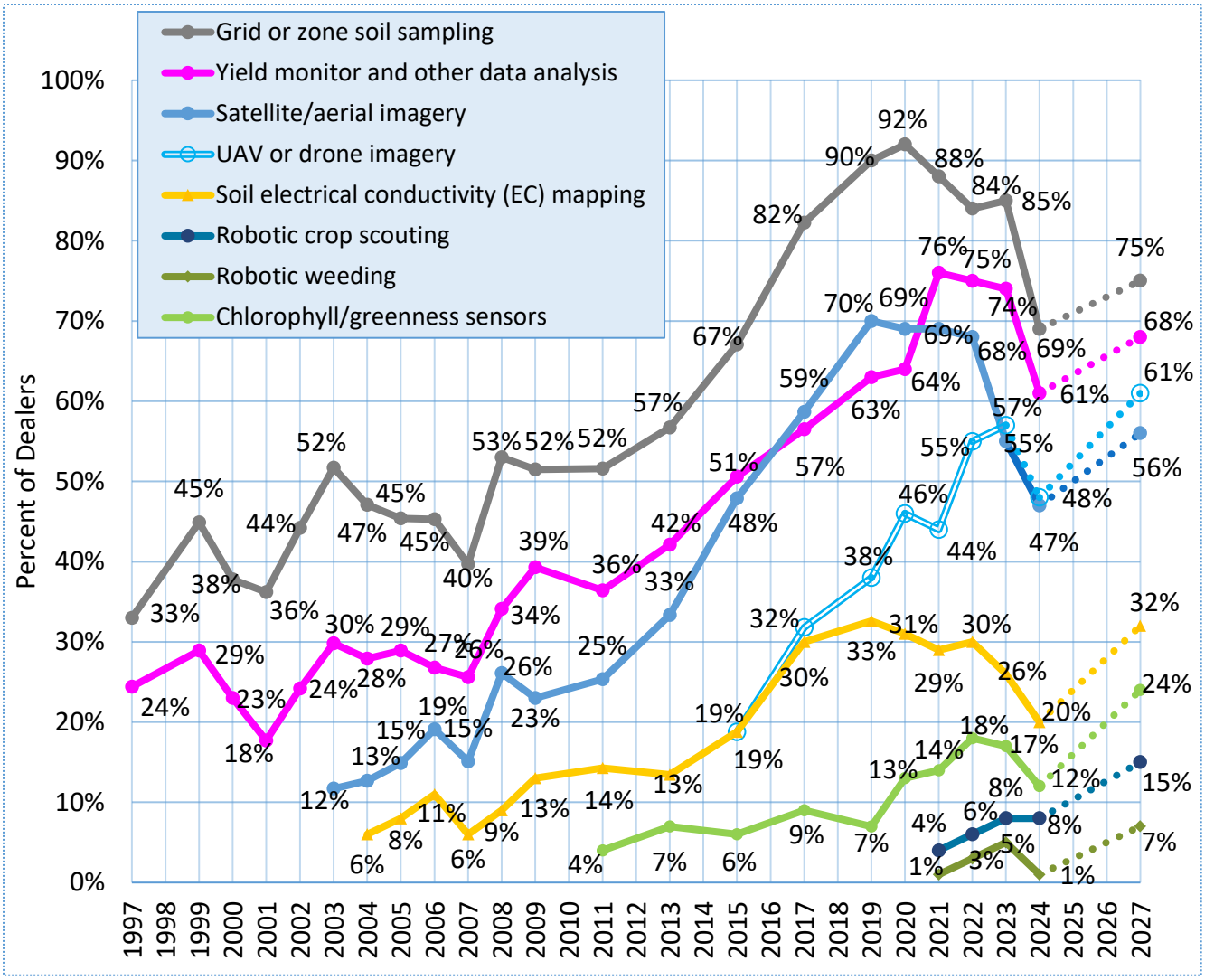

Figure 6, Q7: Dealer offerings of precision services over time, sensing and related services. 2027 are dealer projections.

Though commercially available for many years, most dealers are still not offering soil electrical conductivity (EC) mapping or chlorophyll/greenness sensors such as Greenseeker, CropSpec, or OptRx, and the percent of dealers offering has decreased in the last two surveys. But a few dealers who aren't now 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. 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). 2027 are projections. 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. The numbers shown prior to 2017 are for VRT single fertilizer applications; for 2017 on, the numbers are for any VRT fertilizer application. An assumption was made that any dealer doing multiple fertilizer VRT could also do single fertilizer VRT. And as previously explained, prior to 2024 VRT fertilizer numbers are for all dealers, but for 2024 are only for dealers who indicated they custom apply fertilizers.

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 is higher than a decade ago. Forty-three percent of dealers now offer VRT pesticide applications, but 21% more say they will be doing this in three years. These would include machine vision such as See and Spray from Deere and Precision Planting's Symphony Vision as well as applications varied by soil properties. 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, 22% in 2022, 13% in 2023, and now 21% in 2024. And to be consistent with fertilizer custom applications, starting in 2024 VRT pesticide offering percent of dealers are only for dealers who indicate they custom apply pesticides.

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 detected on the go using machine vision. Thirty-five percent of dealers say they are currently offering crop inputs applied via a UAV/drone, a flying robot, just the fourth time for this question, but over half expect to be offering this by 2027 (Figure 7).

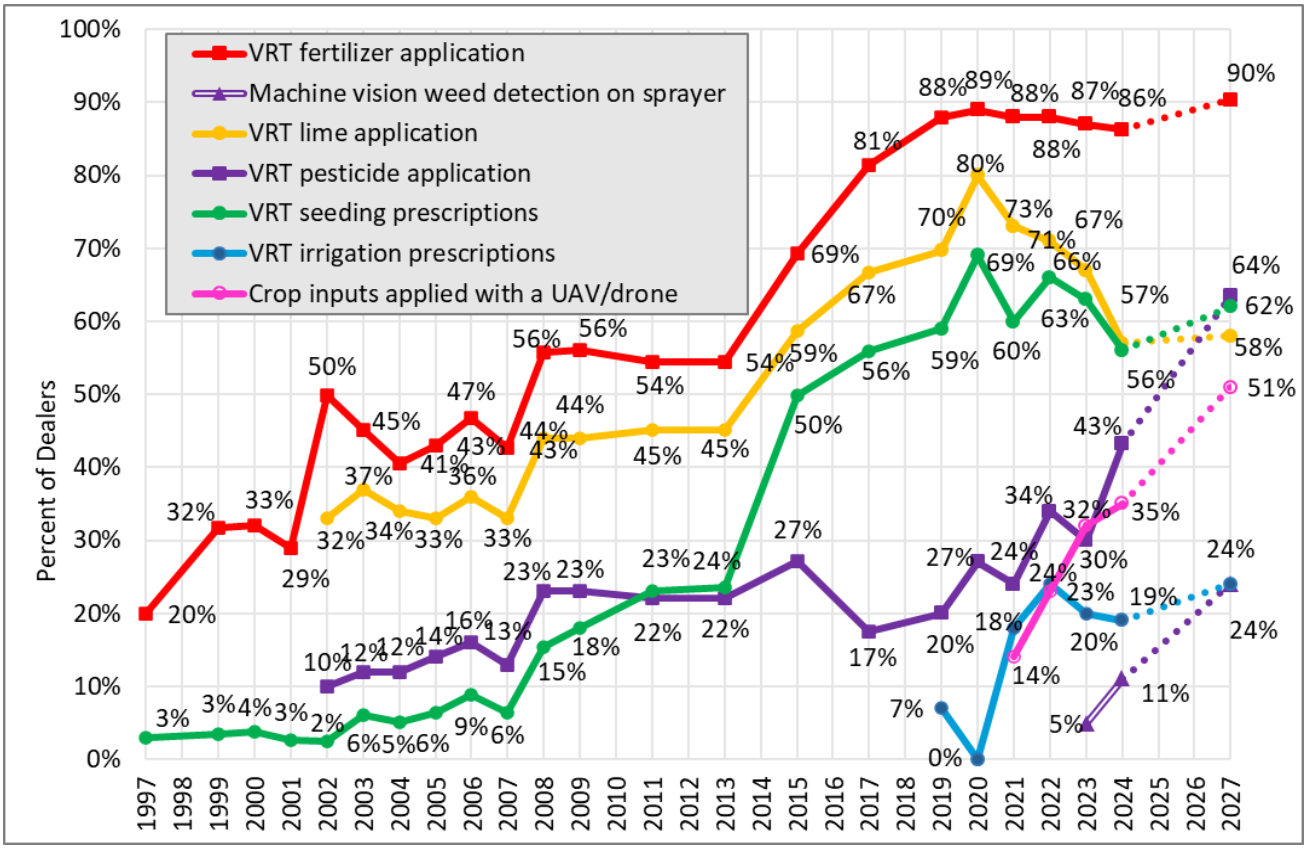

Figure 7, Q7: Dealer offerings of precision services over time, variable rate technologies. Prior to 2023 all numbers are based on all dealers responding. Starting in 2024 VRT fertiizer is only for dealers who indicate they custom apply fertilizers, and starting in 2024 VRT pesticides are only for dealers who indicate they custom apply pesticides. 2027 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 were helping customers was printing maps, such as yield, soil electrical conductivity, and soil maps, but that was on a decline and we dropped that question in 2023. Beyond printing maps, in 2023 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 planting rates.

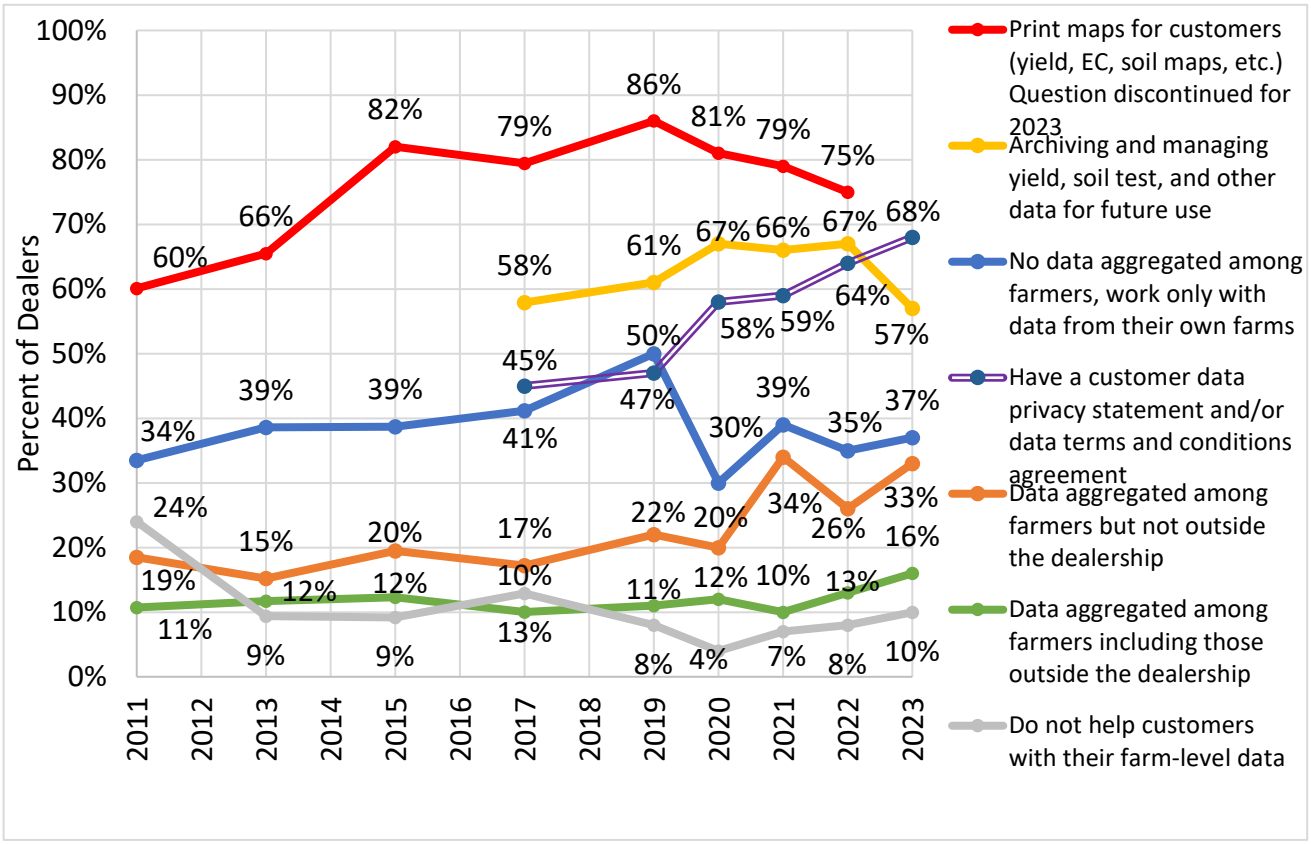

Figure 8, from 2023: Managing farm-level data to assist customers in decision making over time
Question not asked in 2024..

There was a remarkable uptick in crop management decisions from pooled data in the 2017 to 2019 period (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. This question was not asked in 2024.

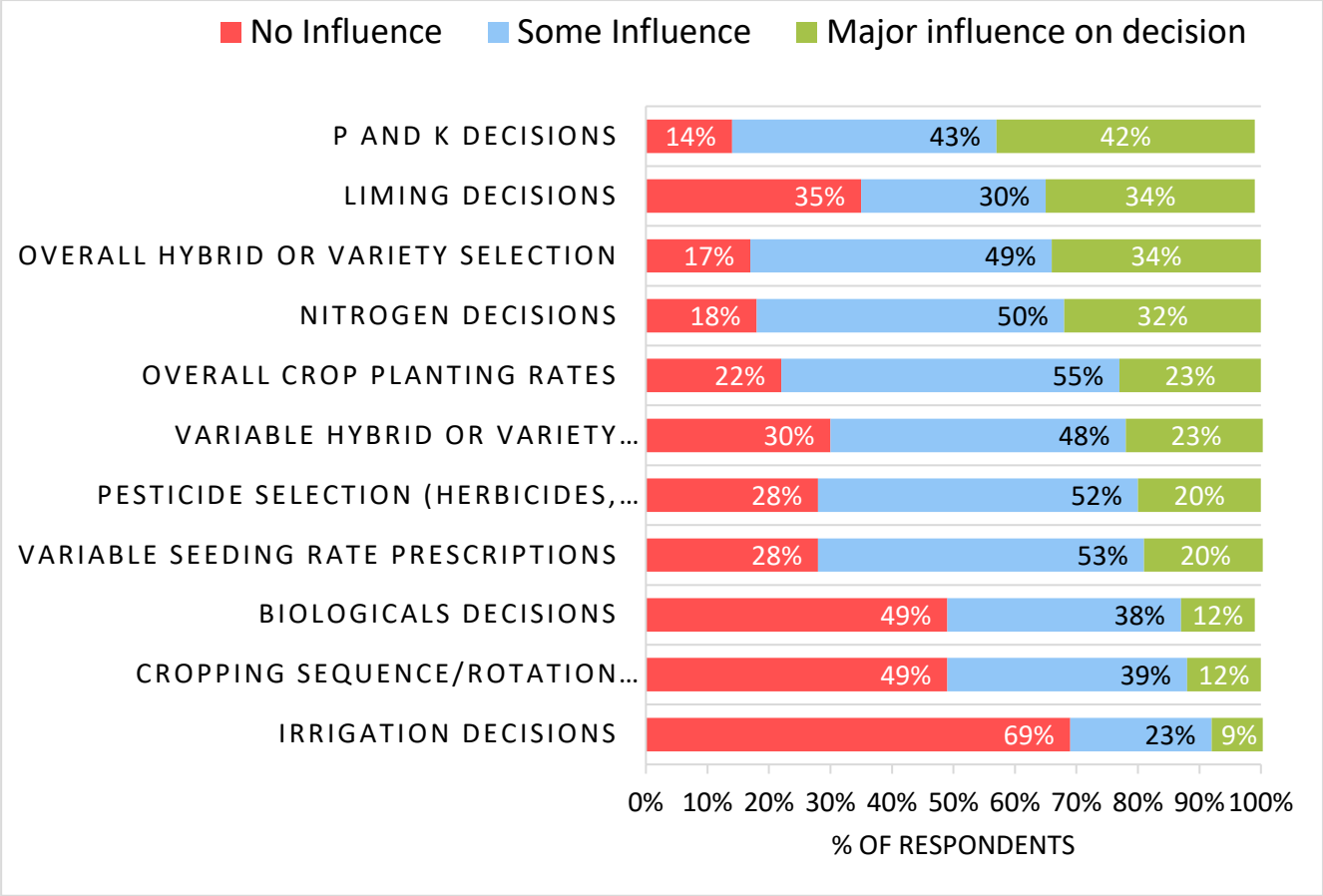

Figure 9, from 2023: Crop management decisions influenced by pooled data from customer's farms, ranked by major influence. Due to rounding, percentage numbers for a technology may not total 100.

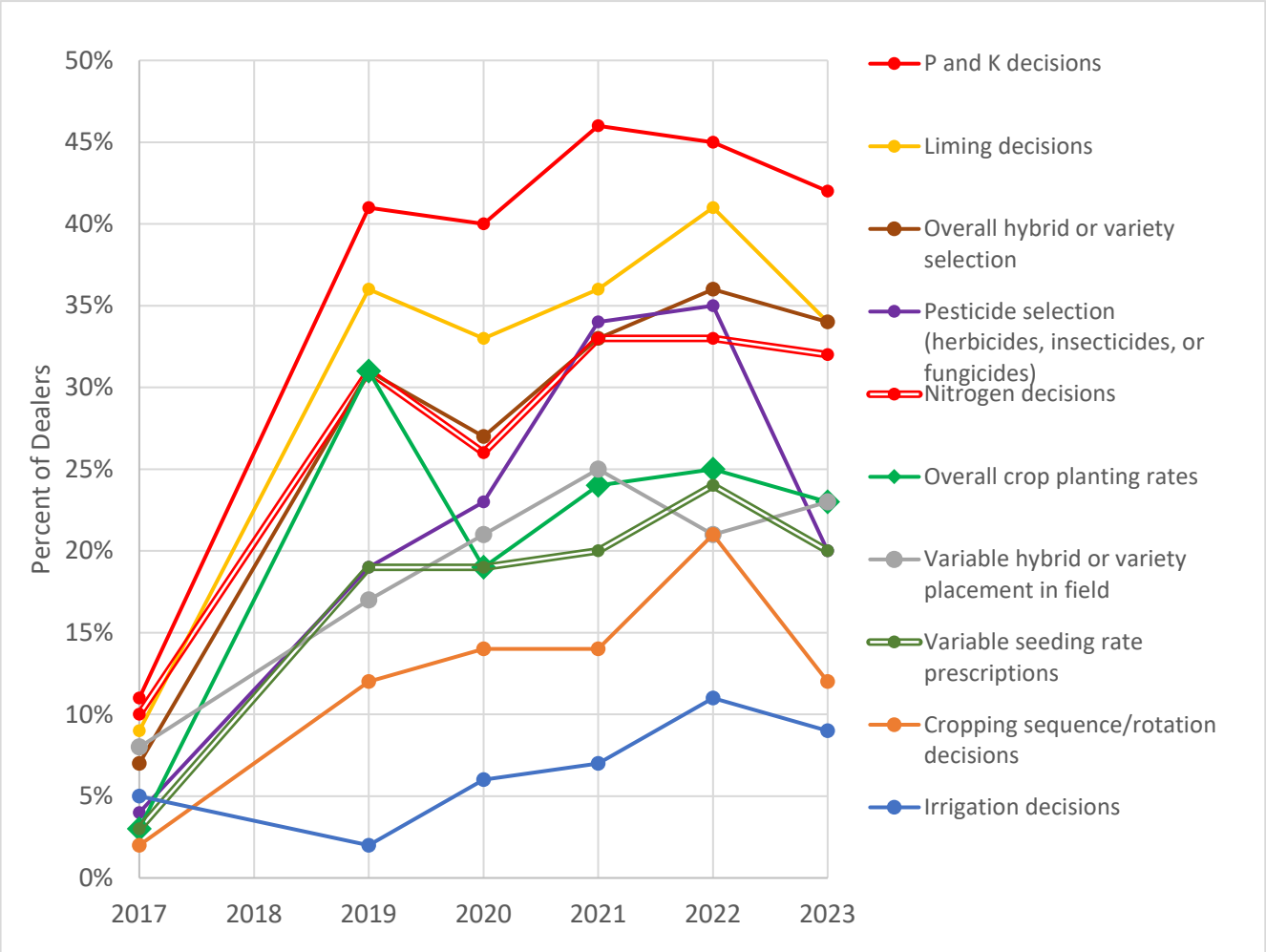

Figure 10, from 2023: Percent of dealers over time indicating data had a major influence on management decisions. There was no survey in 2018.

SOIL SAMPLING PROCEDURES

Most agricultural dealers help producers manage soil nutrients, which commonly has a foundation in grid or zone soil sampling. The location of the soil sample (or subsamples) is 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 were offering precision soil sampling (Figure 6).

In 2023, 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.

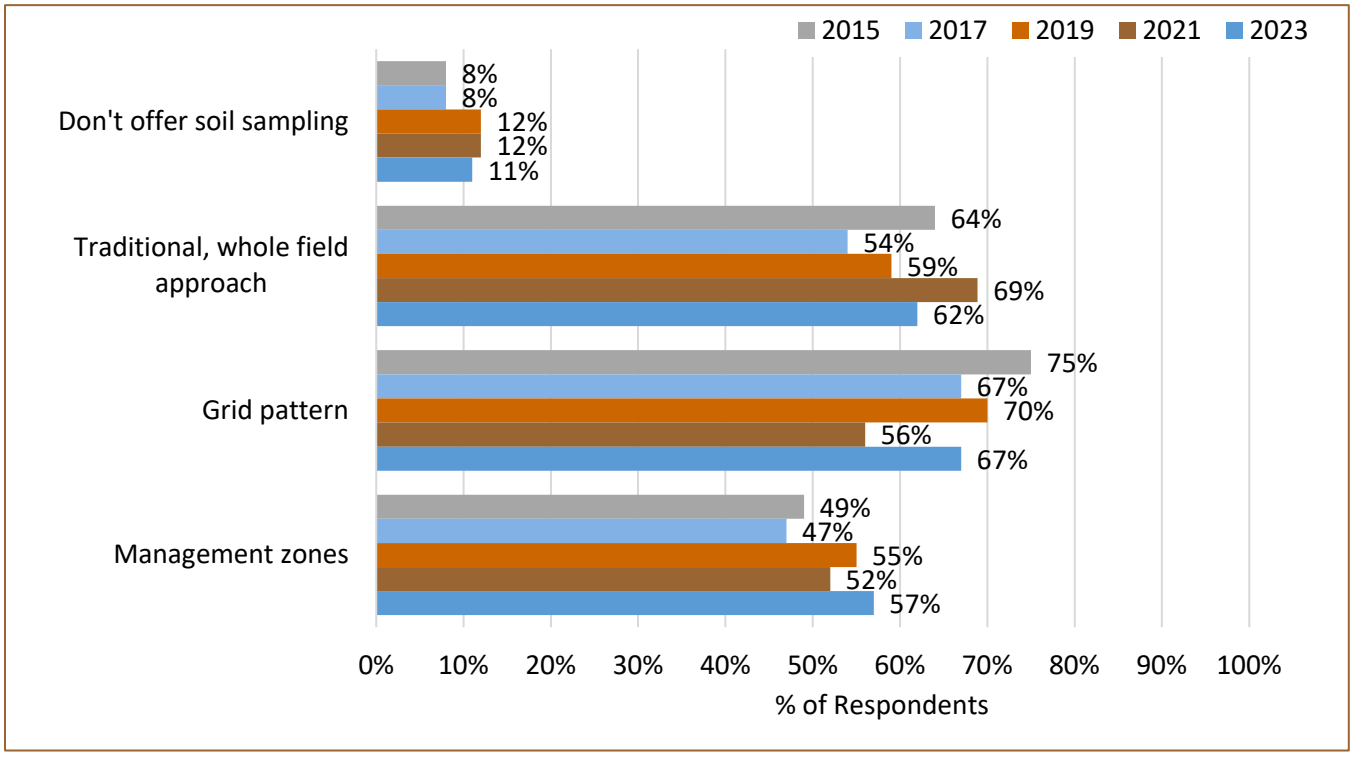

Figure 11, from 2023: Types of soil sampling services offered by retailers. Multiple responses were allowed.

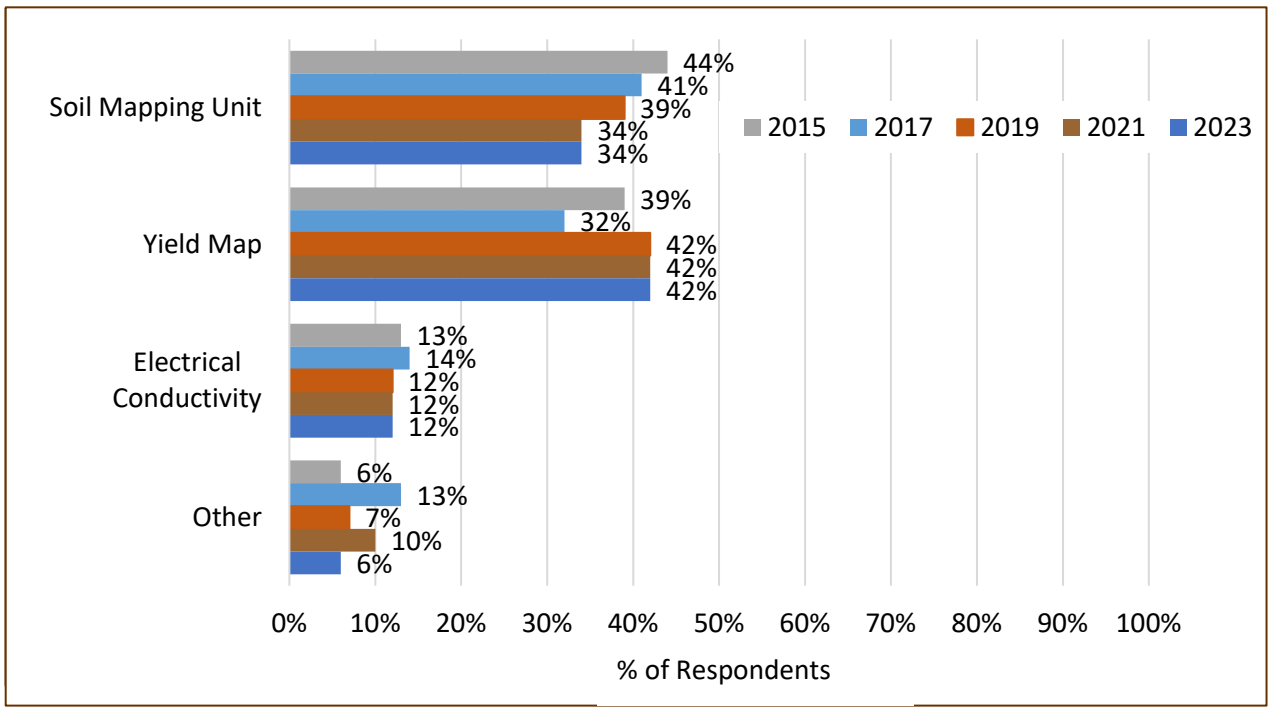

Figure 12, from 2023: Factors used by retailers to determine management zones for precision soil sampling. Due to rounding, percentage numbers each year may not total 100.

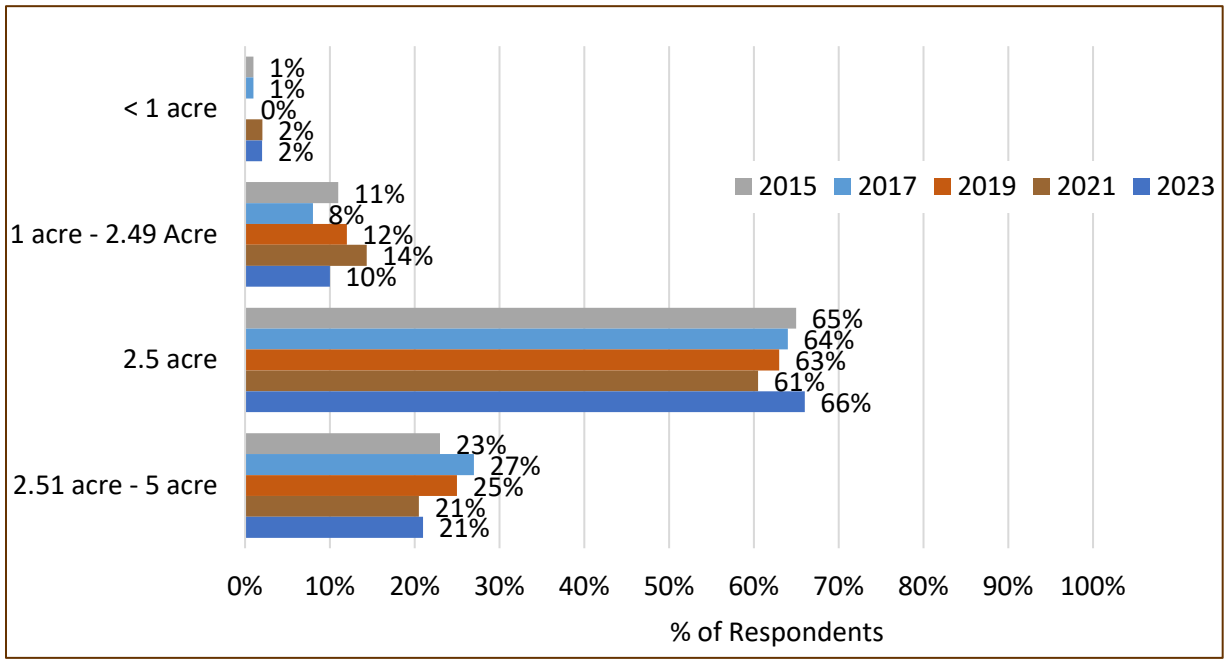

Figure 13, from 2023: Grid sizes used by retailers for precision soil sampling. Due to rounding, percentage numbers by year may not total 100.

DEALER PERCEPTIONS ABOUT AUTOMATION/ROBOTICS

Dealers were asked how they thought automation/robotics might affect their businesses. Automation is already widely used in crop production—for example boom/nozzle controllers and autosteer, but appears poised for greater expansion. Most dealers think that automation/robotics will increase the accuracy of crop input applications (Figure 14, green bars)—indeed it already has with section controllers, and the planter row controllers and variable rate downforce used by their farmer customers. And most dealers say automation will reduce application mistakes. But less than a third of dealers indicate automation will reduce their labor needs associated with crop inputs. To some this may be a surprise, as labor savings is often viewed as the most obvious result of automation—to take a task out of a human's hands that we pay to employ.

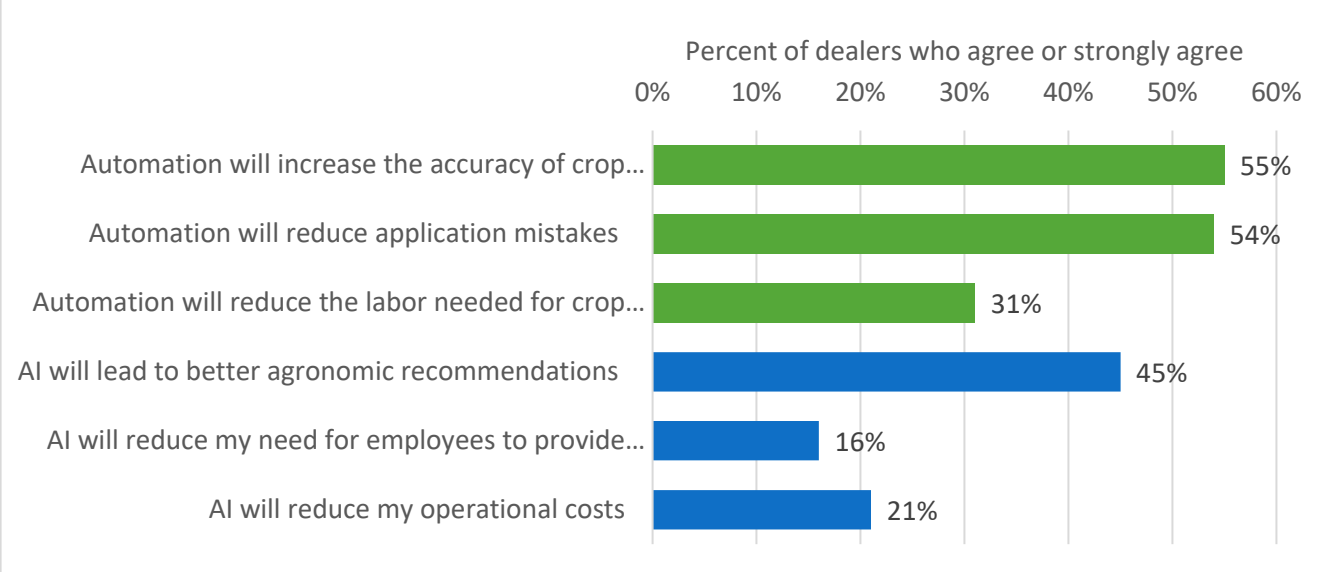

Figure 14, Q10 and Q11: Dealer attitudes about automation (green bars) and artificial intelligence (blue bars).

DEALER PERCEPTIONS ABOUT ARTIFICIAL INTELLIGENCE

Dealers were asked how they thought AI might affect their businesses. Almost half of dealers say AI will lead to better agronomic recommendations (Figure 14, blue bars). That makes good sense, and comes at a good time. It seems we have been at an impasse on agronomic recommendations for many years. With fertilizers, we are following recommendations that in some cases have been around for decades. Many new methods have not had the impact we thought they might—such as greenness/chlorophyll sensors, or electrical conductivity measurements (EC). And we are not even close at making full use of yield maps or field imagery, in measuring field variability then acting upon it. We need that "next thing" that will move us forward. At the same time, few dealers say AI will reduce their need for agronomic expertise, or reduce their operational costs, perhaps by needing fewer workers or being more efficient. Perhaps dealers' thinking aligns with how previous technologies have affected the workplace. Long ago mechanization, computers, pesticides, and other labor-saving devices were each expected to bring in a new era of less work with more time for leisure. Ask any ag retailer if their workload is less than in the past. In many cases workers were just expected to do more or were assigned to other tasks.

CUSTOM APPLICATIONS

Survey respondents made custom applications of herbicides, fungicides, insecticides, and other inputs to their farmer customers on an average 211,949 acres in 2023. Multiple applications to the same acres were counted multiple times. Dealers reported 68% of their fertilizer sales and 59% of their crop protection sales were custom applied. As previously noted, 11% of dealers indicated they offered applications using machine vision weed detection. Six percent of herbicide applications used machine vision weed detection. Table 2 below details technology use on all crop protection (herbicide, fungicide, insecticide) applications:

Table 2, Q17: Technology Use on Crop Protection Applications.

Technology	Percent of acres for dealers who were doing custom application
Manual GPS guidance (light bar)	24%
Automated GPS guidance (autosteer)	80%
Auto sprayer boom section or nozzle control	73%
Variable rate prescription map	27%
Turn compensation	33%

THE BUSINESS OF UAV/DRONE CROP INPUT APPLICATIONS

About one fourth of the dealers reported that they provide UAV/drone application services in-house, and another fourth say they contract this to another company (Table 3). For those providing the services, the average number of crews used was about two, with each having two workers and one or two drones. Dealers said setting up a crew costs an average of around $62,000, to equip, license, and train. And it costs around $13,000 per month to keep each crew running—the variable costs which could include wages, fuel, repairs and maintenance, insurance, etc. This of course needs to be compared to the revenues from these services, and the alternative costs in most cases of owning and operating a ground sprayer or hiring an aerial applicator, each of which involve considerable expense. Dealers offering drone services indicate that around two-thirds of applications are for fungicides on corn, around 13% are herbicide applications in pastures and fencerows, approximately 10% are insecticide applications on corn, and about 6% insecticide applications on soybeans (Question 13). Other applications noted but not exceeding 2% are fungicide applications on soybeans, wheat, and alfalfa, and insecticide application on wheat.

Table 3, Q8 and Q9: The Business of UAV/Drone Applications for Agricultural Dealers.

How UAV/drone services are procured by customers	Percent of dealers
Service provided to customers in-house	27%
UAV/drone service to customers contracted to another company	25%
Customers use UAV/drone companies not affiliated with us	27%
Not aware of inputs applied via UAV/drone in my area	20%

Operations of those offering UAV/drone applications in-house (25 respondents)	Mean
Number of UAV/drone crews per dealer	1.7
Workers per crew	2.2
Drones per crew	1.4
Investment to equip, license and train one crew	$62,000
Monthly variable cost per crew	$13,000

PROFITABILITY OF PRECISION SERVICE OFFERINGS

Dealerships were asked 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 15. This question was not asked in 2023 to help keep the survey length as short as possible, but was in 2024. Most dealers are at least breaking even in 19 of the 23 product or service offerings asked, but dealers are making a profit in just five of the 23.

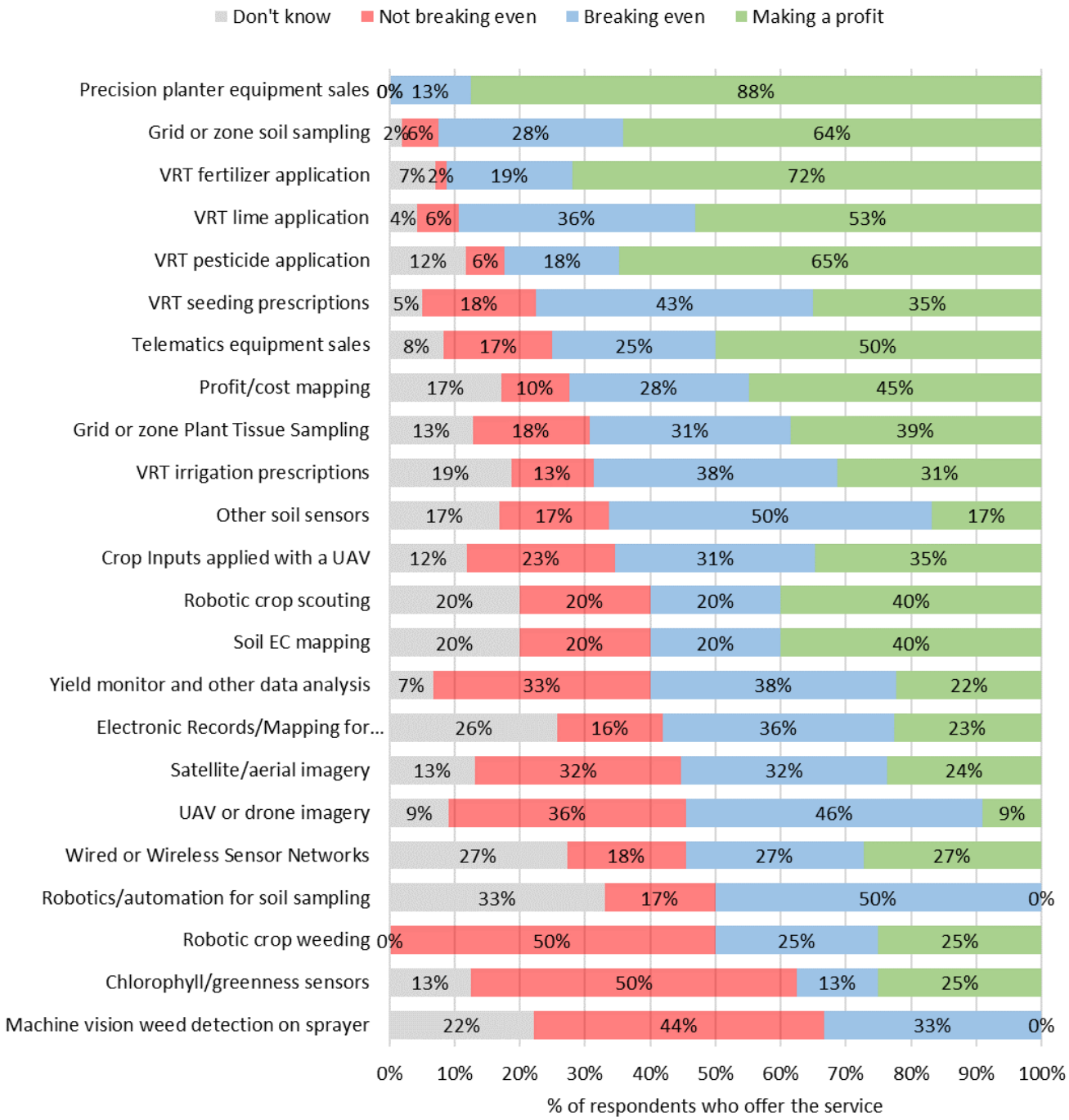

Figure 15, Q18: Profitability, ranked by percent at least breaking even (breaking even plus making profit).

The services where more than half of agri-dealers are making a profit are precision planter equipment sales (88%), VRT fertilizer applications (72% indicate profit), VRT pesticide applications (65%), grid or zone soil sampling (64%), and VRT lime applications (53%). These five offerings stand apart from the others for profitability. The three biggest money losers for dealers are chlorophyll greenness sensors (50% not breaking even), robotic crop weeding services (50% not breaking even), and machine vision weed detection on sprayer (44% not breaking even). Not far behind for not breaking even are UAV/drone imagery (36% not breaking even), helping farmers with their yield monitor and other data analyses (33%), and satellite/aerial imagery (32%).

With many technologies a high percentage of dealers report that they don't know the returns—robotic soil sampling, IoT sensor networks, and electronic records/mapping for traceability the three where profitability is least known.

Figure 16 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.

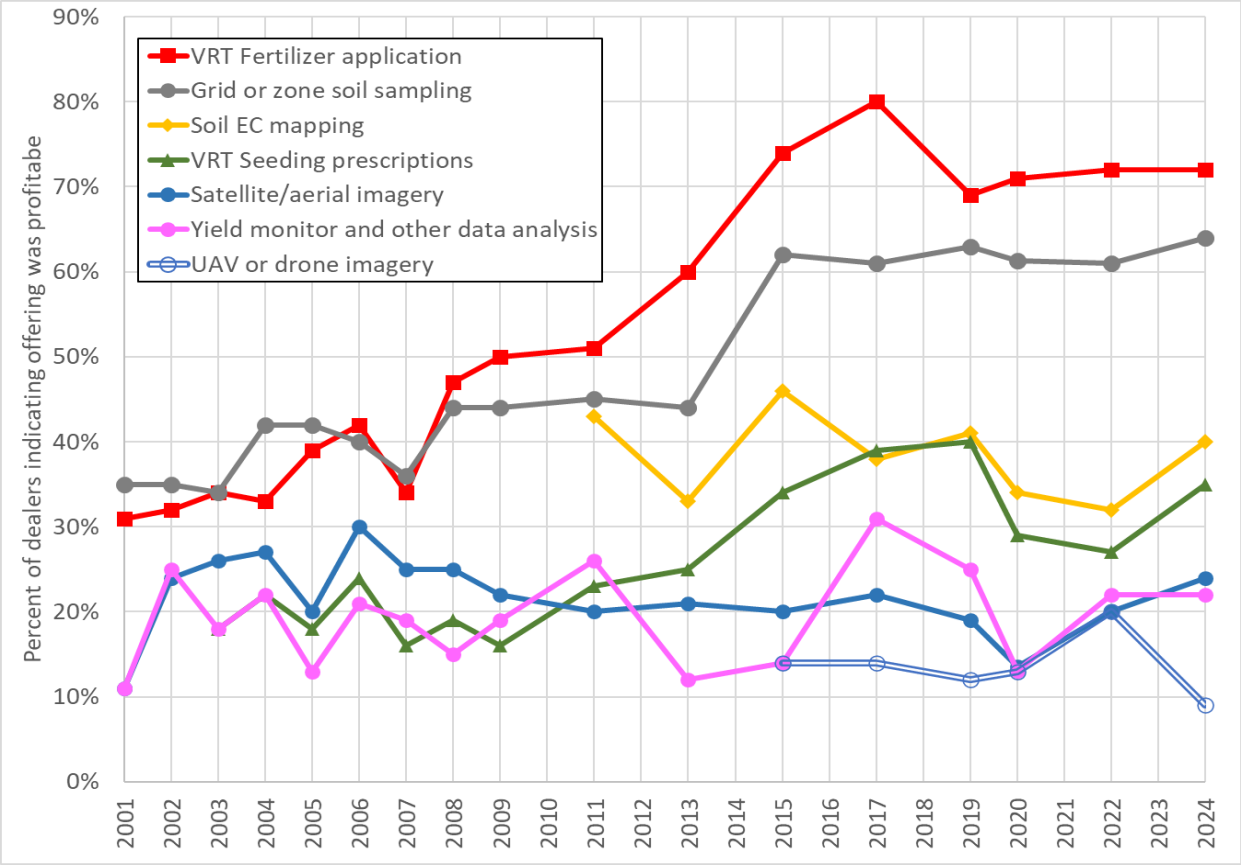

Figure 16: Profitability over time.

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. Respondents reported on the share of acres in their local market area that are utilizing various precision technologies, not the percentages of farmers. Table 4 shows

Table 4, from 2023: 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%

the estimated market area of an array of precision technologies for the last six surveys, ranked most to least for 2023.

There was no survey in 2018, and the question was not asked in 2024. 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 17 and 18, you can see the changes over time in the percent of the market area

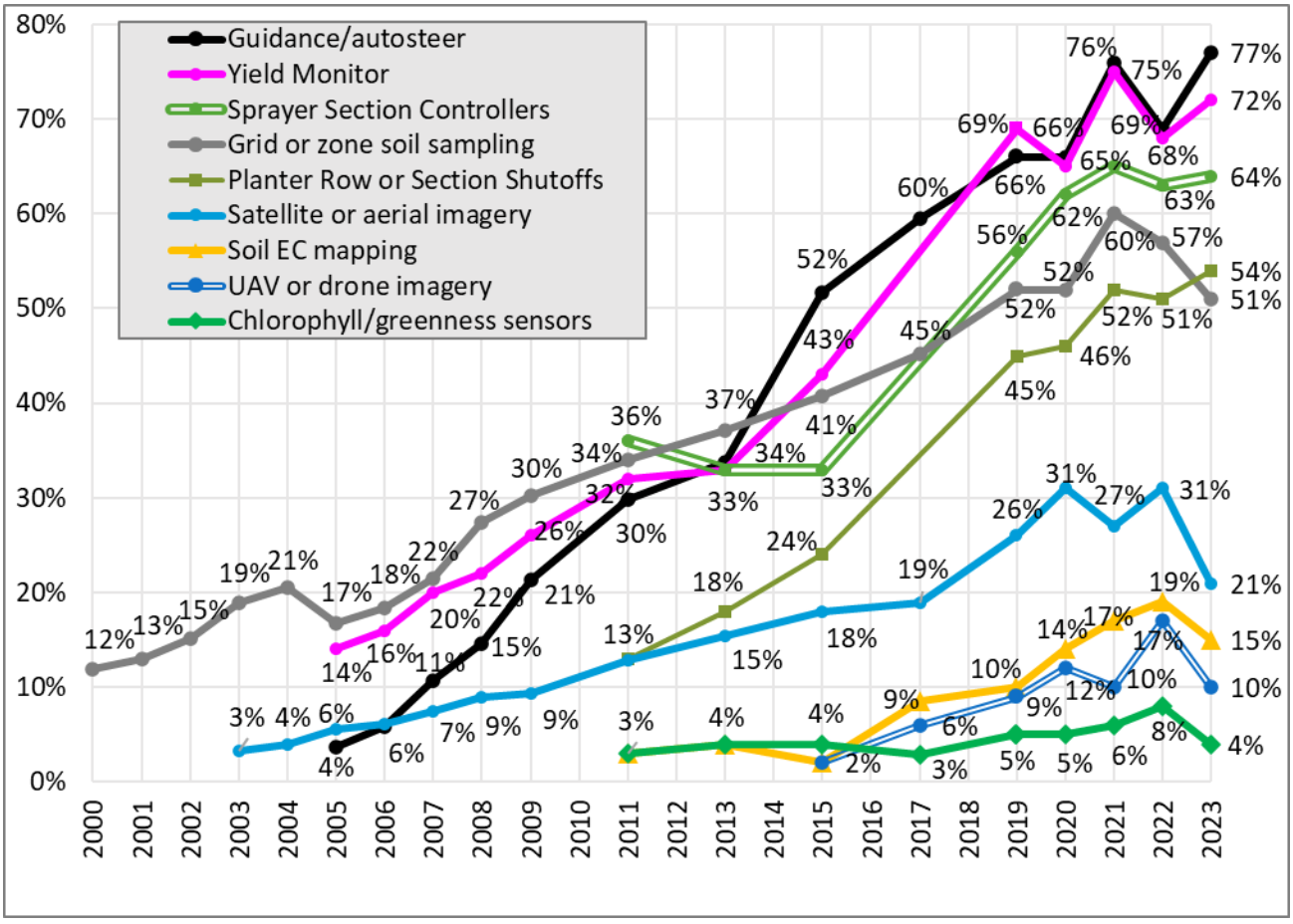

Figure 17, from 2023: Producer use of precision technologies, retailers estimate of their market area. Yield monitor, sprayer section controllers, and planter row/section shutoffs were inadvertently omitted in the 2017 survey.

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 4 or previous reports.

Some notable increases in the last five years were in cloud storage going from 14% in 2017 to 40% of acres in 2023, 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.

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.

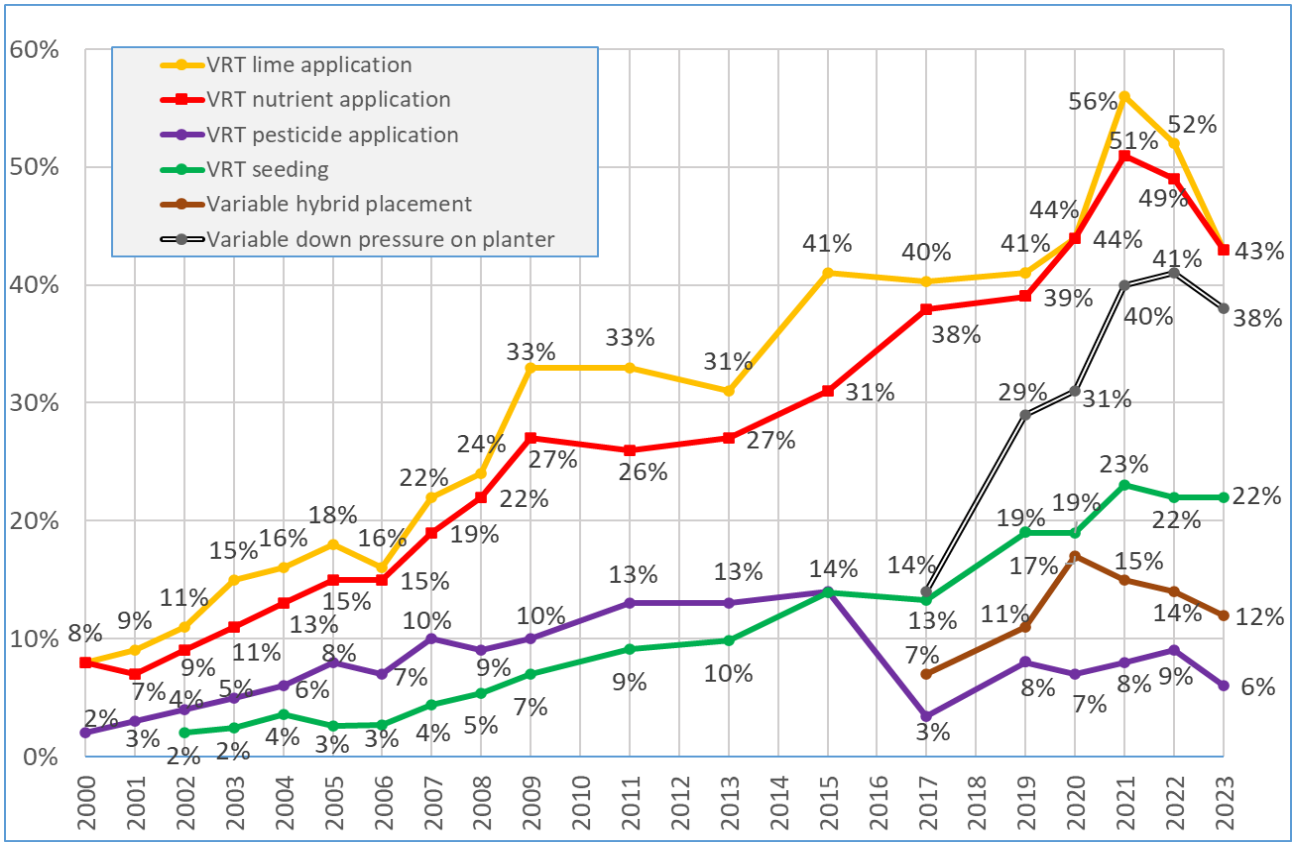

Figure 18, from 2023: Farmer use of variable rate technologies (VRT), market area estimated by retailers.

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. This was asked in 2023, but not 2024. 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, it was not possible to ask about 18 barriers for each technology while keeping the survey concise.

Producer Barriers

Figure 19 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

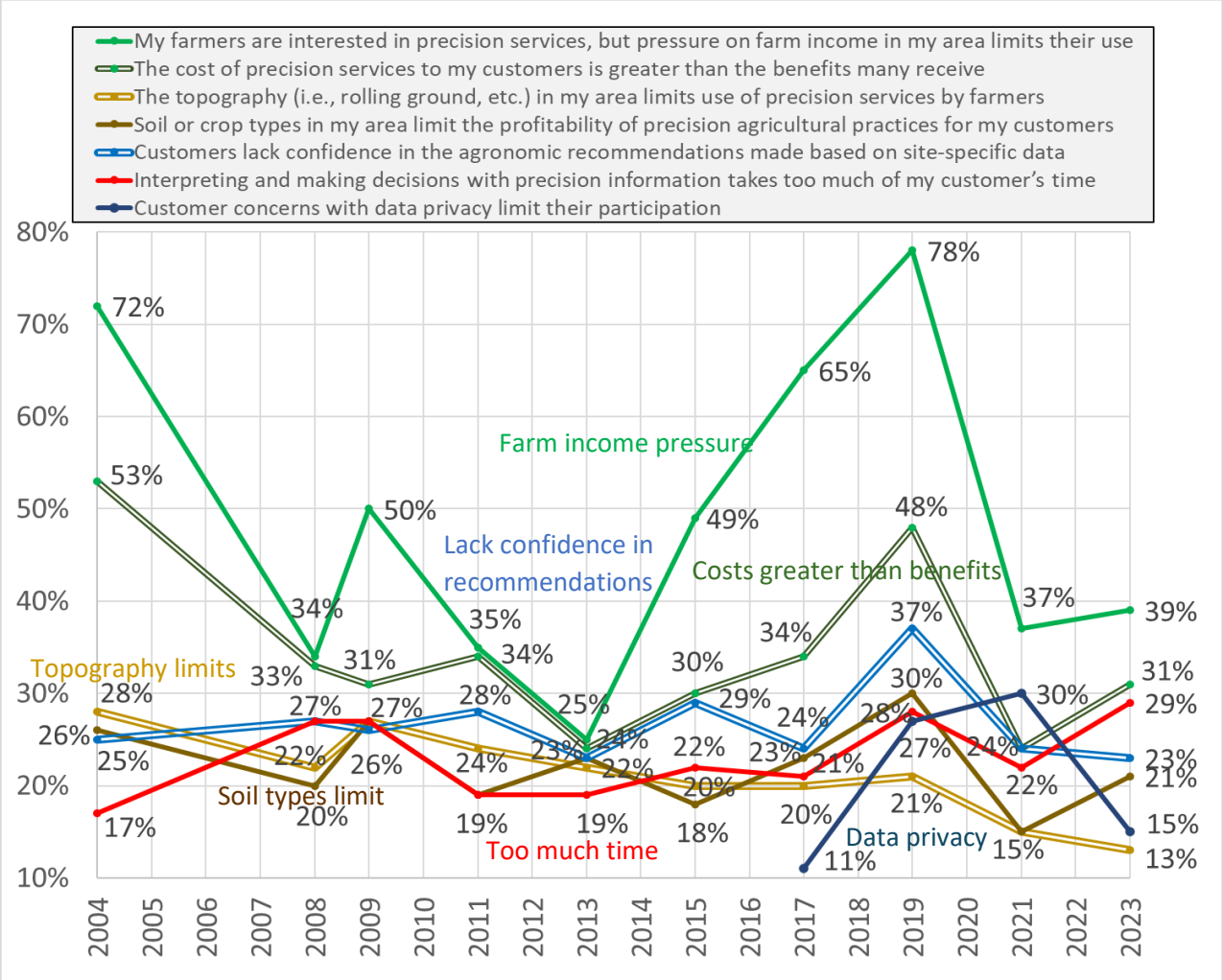

Figure 19, from 2023: Customer issues that create barriers to expansion and growth in precision agriculture.

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 20 and 21, 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.

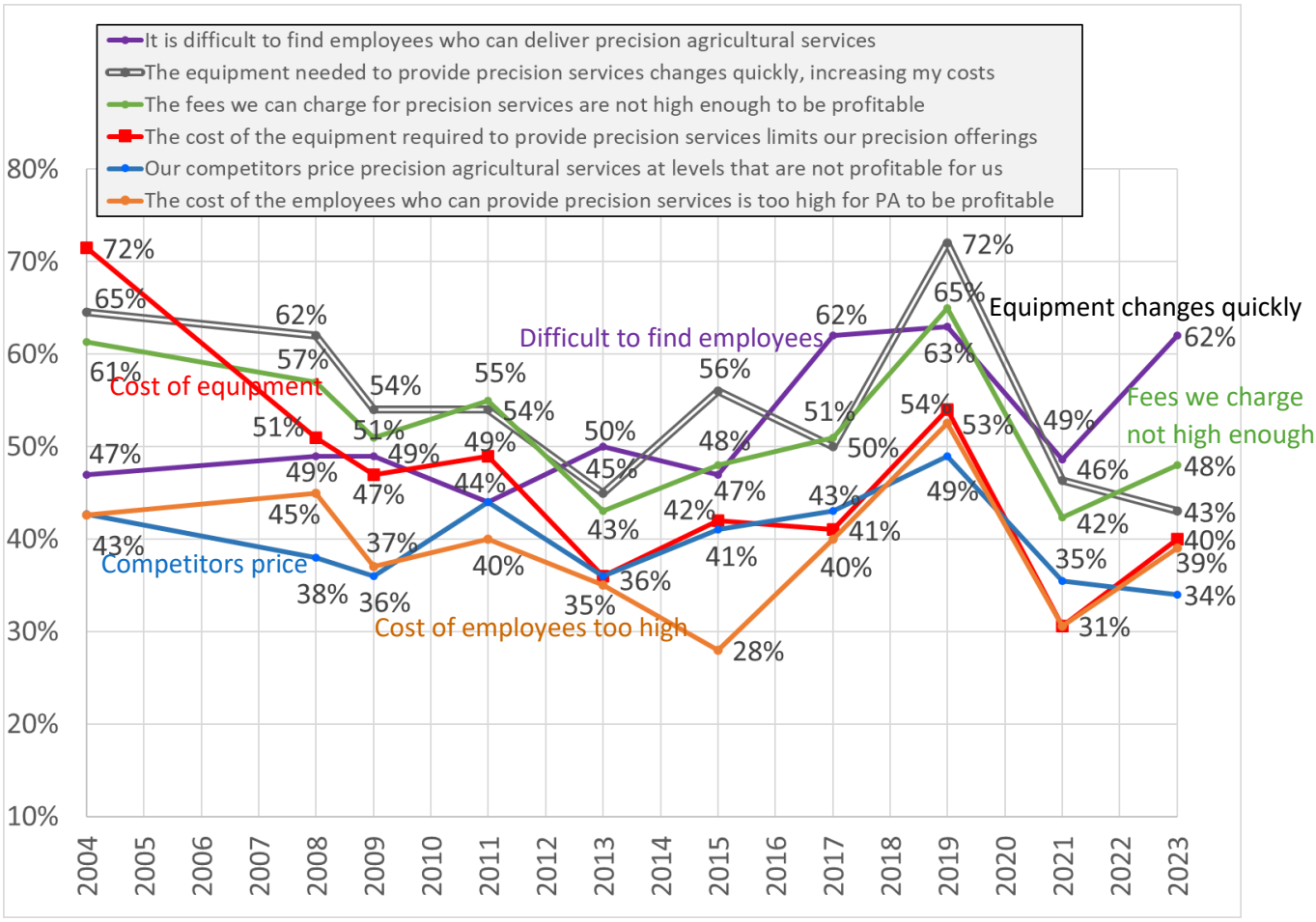

Figure 20, from 2023: Dealer and technology issues that create a barrier to expansion and growth in precision agriculture.

The three biggest barriers to success that dealers identified in 2024 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.

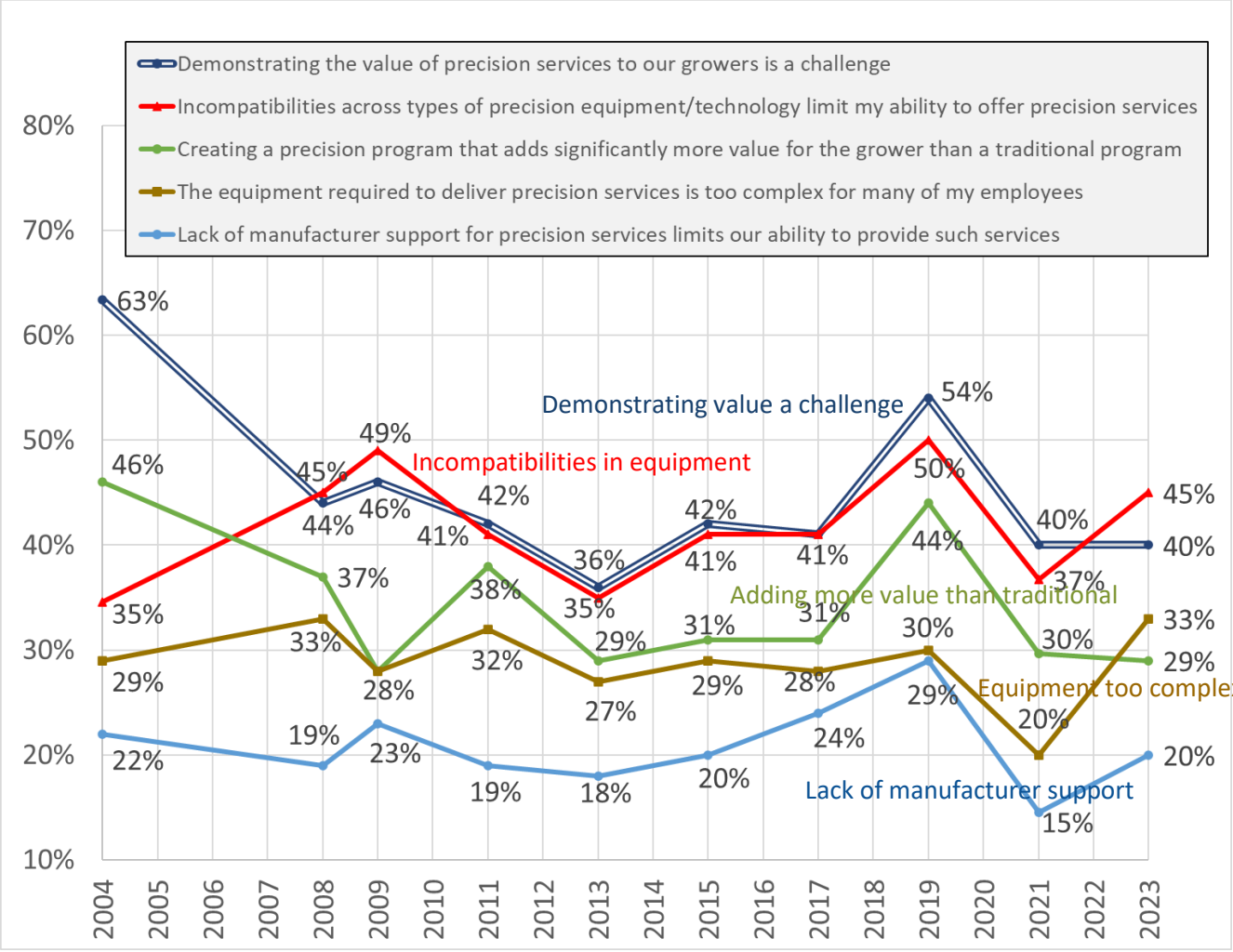

Figure 21, from 2023: More Dealer and technology issues that create a barrier to expansion and growth in precision agriculture.

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.

2024'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 along with VRT fertilizer and lime applications continue as customer offerings at most dealerships, along with helping customers analyze their yield monitor and other data, and making variable seeding recommendations. And while offered as services by most dealerships, these are mostly down since 2000. Grid/done soil sampling has especially decreased, from over 90% of dealers offering to now less than 70%. Along with the corresponding decreases in market area doing VRT fertilizer and liming, we have been questioning the direction these practices have been taking. In the next few years respondents say the greatest areas of growth will be in the numbers of dealers offering VRT pesticide applications and crop inputs via UAV/drones.

As indicated 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 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 pesticides, fertilizers, and other inputs as well as crop prices grow faster than the cost of electronics and controllers and labor 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 much greater than several 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.

Most dealers say automation will increase the accuracy of their input applications and help reduce mistakes, but most do not think automation will reduce their labor needs. Many dealers think artificial intelligence will lead to better agronomic recommendations, but overwhelmingly do not think AI will reduce their labor needs or operational costs.

Dealers are evenly spread on how most UAV/drone input application services are accessed by their customers. About a quarter provide these services in-house, another quarter contract with a company to provide the services, an equal share have customers that use UAV/drone companies not affiliated with their dealership, and about 20% of dealers say they are not aware of inputs applied via UAV/drones in their service areas. For

those dealers providing drone input applications either in-house or contracted, the average number of crews used was about two, with each having two workers and one or two drones. Dealers said the investment for setting up a crew is around $62,000, and costs around $13,000 per month to keep each crew running.

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, and around ten percent are utilizing drone 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 in 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 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

The survey is administered electronically, but the following shows the survey questions in a printable form.

24th Precision Agriculture Services Dealership Survey

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, 2024. **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. For your retail location, what state are you located in?

_____.

7. 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 2027
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	[ ]	[ ]
Robotics/automation for soil sampling	[ ]	[ ]
Crop inputs (seeding, pesticides, fertilizers) applied with a UAV/drone	[ ]	[ ]

8. How are your customers getting most of their UAV/drone application services? [please mark one]

[ ] Service provided to customers in-house, using drones we own and operated by our employees.
[ ] UAV/drone service to our customers contracted to another company.
[ ] Our customers use UAV/drone companies not affiliated with us.
[ ] I am not aware of inputs applied via UAV/drone in my area.

9. Answer the following only if you provide UAV/drone input services, whether in-house or contracted.

How many UAV/drone application crews do you run? ____
How many workers are in each crew? ____
How many drones are in each crew? ____
What is the investment required to equip, license and train one UAV/drone crew? ____
What is the monthly variable cost needed to keep one drone crew in the field including wages, fuel, repairs and maintenance, insurance, etc.? ____

ARTIFICIAL INTELLIGENCE (AI)

10. Please rate the following statements on a scale from 1 (strongly disagree) to 5 (strongly agree).

Artificial intelligence (AI) will lead to better agronomic recommendations
Artificial intelligence (AI) will reduce my need for employees to provide agronomy support and recommendations
Artificial intelligence (AI) will reduce my operational costs

AUTOMATION/ROBOTICS

11. Please rate the following statements on a scale from 1 (strongly disagree) to 5 (strongly agree).

Automation/robotics will increase the accuracy of crop input applications such as pesticides and fertilizers
Automation/robotics will reduce application mistakes
Automation/robotics will reduce the labor needed for crop input applications
Automation/robotics will reduce my operational costs

CUSTOM APPLICATIONS

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 18]*

13. How many acres did you or a contracted company apply crop protection with a UAV/drone in 2023? *(if none, go to 14)* __*acres*

Please indicate type of products and crops of UAV/drone applications. Do not indicate anything less than 2% of applications

____ % of UAV/drone applications are <choose product> applied to <choose crop>
____ % of UAV/drone applications are <choose product> applied to <choose crop>
____ % of UAV/drone applications are <choose product> applied to <choose crop>
____ % of UAV/drone applications are <choose product> applied to <choose crop>

14. In 2023, approximately what percentage of your total fertilizer sales were custom applied? _____%

15. In 2023, approximately what percentage of your total crop protection sales were custom applied? _____%

16. In 2023, approximately what percentage of your total herbicide application acres used machine vision weed detection? _____%

17. In 2023, approximately what percentage of your total crop protection applications (total acres, all products) used:

Manual GPS guidance (light bar) _____%
Automated GPS guidance (autosteer) _____%
Turn compensation _____%
Auto sprayer boom section or nozzle control _____%
Variable rate prescription map _____%

18. For the following services that you offer, currently how profitable is each specific service for your dealership?

	Not breaking even	Breaking even	Making a profit	Don't know	Don't offer this
	please mark only one column per row				
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	[ ]	[ ]	[ ]	[ ]	[ ]
Chlorophyll/greenness sensors for N management	[ ]	[ ]	[ ]	[ ]	[ ]
Precision planter equipment sales	[ ]	[ ]	[ ]	[ ]	[ ]
Telematics equipment sales	[ ]	[ ]	[ ]	[ ]	[ ]
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	[ ]	[ ]	[ ]	[ ]	[ ]
Robotics/automation for soil sampling	[ ]	[ ]	[ ]	[ ]	[ ]
Crop inputs applied with a UAV/drone	[ ]	[ ]	[ ]	[ ]	[ ]

THANKS AGAIN FOR YOUR INPUT!