Analysis of Precision Agriculture

Adoption & Barriers in western Canada

Producer Survey of western Canada

April 2017

Prepared for Agriculture and Agri-Food Canada

by
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1 Introduction

Precision agriculture (PA) is an important element of innovation in the Canadian crop production sector. However, there is currently a lack of up-to-date regional assessment of patterns of use for PA technologies. It is also unclear what socio-economic factors prevent greater uptake of these innovative technologies. The objective of this research project was to determine the various levels of adoption for selected PA technologies on crop farms in western Canada, and to identify some of the barriers to their more widespread use.

Agriculture and Agri-Food Canada (AAFC) contracted Dale Steele (P.Ag.) to conduct this study. Input was gathered from a wide variety of western Canada PA industry stakeholders, provincial government extension specialists, and academics on their practical experiences regarding on-farm adoption of PA innovations. This network of experts, influencers and service providers helped with the design of the questions for the producer survey, which served as the cornerstone for this study. They also aided in promoting that the Analysis of Precision Agriculture Adoption and Barriers in western Canada – Farmer Survey would be conducted between January 9th, 2016 and March 4th, 2017. Grower Associations and the agriculture media were also informed and numerous outreach activities were undertaken by the contractor to encourage farmers to complete the survey.

The results of this Farmer Survey will be added to AAFC's growing body of knowledge on PA and give stakeholders in the western Canada crop sector a benchmark for the status of PA in the prairies. Future studies will be able to reference the 2016 levels.

2 Survey Development & Methodology

The contractor used his knowledge, work experience and professional network in the PA sector in western Canada to develop, conduct and analyze the farmer survey responses.

Prior to the Farmer Survey, a directory of precision agriculture stakeholders was compiled for consultation on the Survey design and to build awareness of the project. Numerous experts, service providers and stakeholders in PA were approached to provide input on the initial draft of the survey questions and to build awareness of the project. The voluntary e-Survey format using Survey Monkey was selected as the web-based platform. All information was collected in compliance with the applicable provisions of Canada's *Access to Information Act* and the *Privacy Act*.

To encompass all aspects of PA, survey respondents were provided with a broad definition to describe the practice of collecting agricultural information with spatial accuracy from a range of devices to enable the site specific management decisions for food production. This definition allowed the survey to capture information on specific equipment or devices using GPS to collect information and the analysis of the data to determine the management strategies affecting crop production.

The Farm Survey included 42 questions which asked producers to consider the tools, technology and practices they were currently using on their farms in western Canada, along with how they find out about PA technologies, the factors that influence whether or not they implement them, and some basic demographic information.

Notice of the survey was emailed to the directory of stakeholders across the western Canada PA community comprised of PA service providers (hardware, agronomic, imagery, Rx, etc.), industry, provincial government extension, AAFC officials, and academics. Information about the Farmer Survey and the e-survey link was provided to 31 grower associations with encouragement for them to share with their farm members.

Grower Associations contacted: Alberta Canola Producers Commission, Alberta Wheat Commission, Alberta Barley Commission, Alberta Federation of Agriculture, Alberta Pulse Growers, Potato Growers of Alberta, Canola Council of Canada, Grain Growers of Canada, Pulse Canada, Alberta Sugar Beet Growers, Prairie Oat Growers Association, Western Barley Growers, Alberta Seed Growers Association, Alberta Corn Committee, Sask Canola, Sask Flax, Sask Barley, Sask Wheat, Sask Pulse Growers, Sask Seed Growers Association, Sask Mustard, Sask Organics, Agricultural Producers Association of Saskatchewan, Manitoba Seed Growers Association, Manitoba Wheat and Barley Growers Association, Manitoba Corn Growers Association, Manitoba Canola Growers, Manitoba Pulse & Soybean Growers Association, Manitoba Flax Growers Association, Keystone Agricultural Producers, Keystone Potato Producers Association, Farming Smarter

Farm media and social media were used to build awareness during the Farmer Survey response window from January 9th to March 4th, 2017 with numerous Twitter messages and re-tweets, Facebook and LinkedIn postings to build awareness and provide the e-survey link across western Canada.

Twitter: The survey Link was posted to the following Twitter addresses and Hashtags: @AlbertaBarley @AlbertaWheat @AlbertaCanola @AlbertaPulse @StaffPGS @abseedpro @abseedgrower @canolacouncil @GrainGrowers @KSAgriculture @SaskPulse @SaskFlax @SaskBarley @SaskCanola @Sk_Wheat @canolacouncil @flaxcouncil @AlbertaAg @AFSC_AB @AAFC_Canada @SKAgriculture @skcropinsurance @MBGovAg @FCCagriculture @AAFC_Canada @realagriculture @MBCooperator @MBFarmJournal @westernproducer @ABFarmerExpress @AGCanadadotcom @MBwheatbarley @mbflax @MbPulseGrowers @MBCornGrowers @CanolaGrowers @Kap_Manitoba @MBAgDays @CattleFeedersAB @albertabeef @SaskPork @RMEHQ @MBAgDays @AlbertaBarley @AlbertaWheat @abseedgrower @AlbertaCanola @AlbertaPulse @AlbertaFedAg **Hashtags:** #westcdnag #precisionag #farmers #agtech #plant16 #plant17 #crops #organic #winterwheat #canola #wheat #barley #winterwheat #crops #calving17 #beef #CropConnect17 #FarmTech17 #agexpo17 #CPS17 #WCCPS17 #CdnAgDay

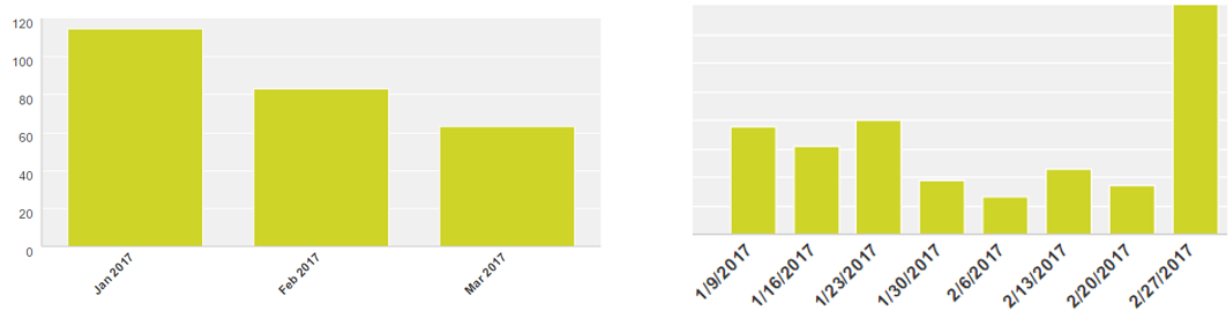
3 Survey Results

During the survey development process and in subsequent literature searches related to PA, it became apparent that a survey to identify the farm usage rates for PA technologies or to identify the broader barriers to PA technology adoption had not been conducted recently across western Canada.

The regional comparisons and detailed analysis of responses can identify trends and differences across demographic and other segments. It is recognized that all survey results can reflect inherent biases in the survey design and format based on the length of the questionnaire, detail sought, paid vs voluntary participation, e-survey vs paper or interview format and predisposition of the survey respondents to complete a survey.

During the Farmer Survey period from January 9th to March 4th, 2017 a total of 261 respondents completed the voluntary e-survey on the Survey Monkey website.

Precision Agriculture - Farmer Survey period : January 9 to March 4, 2017



261 Responses: Survey response rates by Month & by Week during the Farmer Survey period

Awareness of the Farmer Survey was built through articles and mentions in farm media/publications, social media posts (Twitter, LinkedIn, Facebook), email/phone contact with industry, academics, provincial/federal government staff, correspondence to 31 Grower Associations and attendance at 8 major Grower meeting/tradeshows across western Canada.

Data Limitations

The most recent Statistics Canada 2011 Census data indicated there were 96,063 farms in western Canada. There are advantages and disadvantages to each survey method to collect information. The e-survey format, survey topic, demographics of respondents (younger than average and higher than average farm revenue) and survey length may have resulted in inherent bias favoring respondents with a general interest or knowledge of PA. Survey response rates differed from one question to another, which may also have affected the weighting of the results. However, the survey responses provided a suitable distribution across the range of age, farm size, farm revenue, province and region of western Canada.

The relative comparison of statistics and the different formats of other surveys pose challenges to interpreting survey results on a basic level. For example, Statistics Canada 2016 Census of Agriculture results were not available until after this report's completion, so the comparison of 2011 data indicated that the average Canadian farmer was 54 years old and the average Alberta farm was 1168 acres.

As respondents self-reported for this survey on their use of various PA technologies and the costs as compared to the acreage of their farms, results may be somewhat subjective depending on each individual's definition of PA as well as their opinion of what to include in their cost calculations (e.g., equipment costs versus service provider fees, total farm acreage or just crop area, etc.).

Survey Summary – Analysis of Precision Agriculture Adoption & Barriers in western Canada

261 responses were collected in the Farmer Survey representing almost 1 million acres of cropland across western Canada. The Survey period was between January 9th and March 4th, 2017 and reflects the precision agriculture adoption rates from the 2016 crop year.

The survey responses reflect a younger than average farm demographic, operating larger acreage farms which generate higher than average gross revenues and reflect more incorporated farm business operating structures than the average western Canada farm in general.

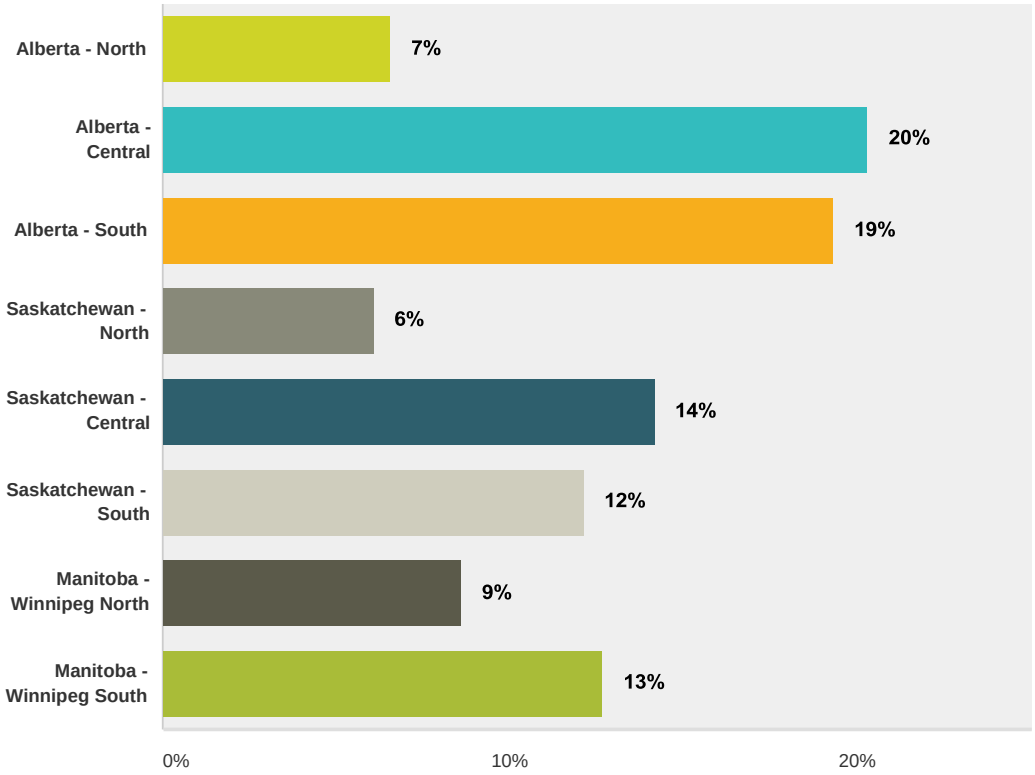
- 98% indicated they have access to DSL, cable or wireless internet
- 98% indicated they use GPS guidance on their farm
- 93% agree or strongly agree that precision agriculture (PA) is useful
- 84% indicated they are currently using PA technologies
- 84% have combine yield monitoring capability
- 83% looked at imagery or maps of farm field(s)
- 81% managed their own farm data
- 79% use GPS Auto-Steer equipment guidance
- 75% intend to use more precision agriculture in the future
- 75% use farm management software on a computer
- 73% use Automatic Sectional Control (ASC) on equipment
- 72% use farm management apps or websites on a smartphone or tablet
- 70% use Automatic Sectional Control (ASC) for spray applications of crop inputs
- 68% use temperature and/or moisture sensors in 25%-100% of their stored grain
- 63% of crop acres were soil sampled
- 60% indicated their combines were equipped with GPS
- 52% were Somewhat/Very Unsatisfied with their internet service & internet speed
- 50% logged & stored combine yield data
- 48% had created Yield Map(s)
- 48% indicated they were using prescription maps and/or variable rate technology
- 45% were somewhat/very unsatisfied with their cellular & cellular data coverage
- 41% looked at in-season Imagery or remote sensing of field(s)
- 39% were not comfortable sharing their farm precision ag data
- 28% looked at in-season satellite imagery of crop
- 21% use free weather info from government networks as their primary weather information
- 10% use a paid weather service as their primary weather information
- 19% looked at in-season UAV/Drone imagery of crop
- 15% are comfortable sharing their farm precision agriculture data with government
- 13% use WI-FI or cellular networks to transfer equipment data
- 2% indicated they do not use any GPS guidance on their farm

On average, survey respondents reported that they spent $6.47 per acre on precision agriculture. The allocation towards hardware, software, service providers and cellular/internet fees is unknown.

3.1 Demographics

Q35 Where is your farm located?

Answered: 197 Skipped: 64



Breakdown of responses by province:

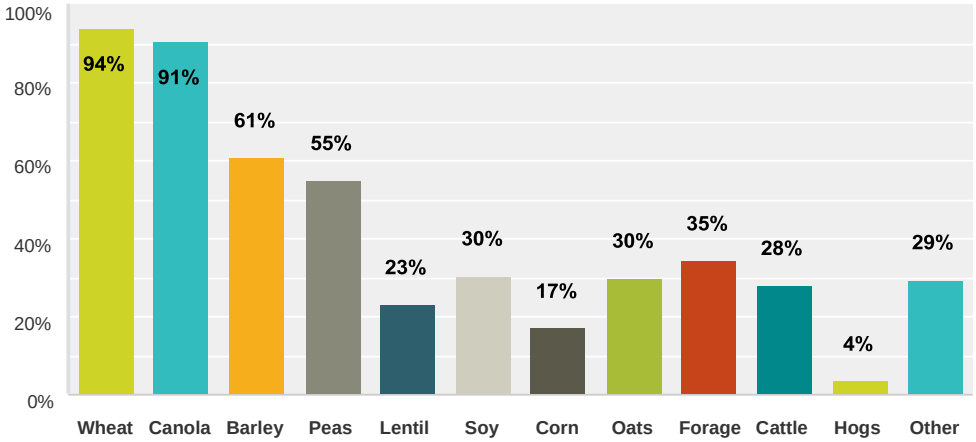
46% from Alberta

32% from Saskatchewan

22% from Manitoba

Q36 What does your farm grow?

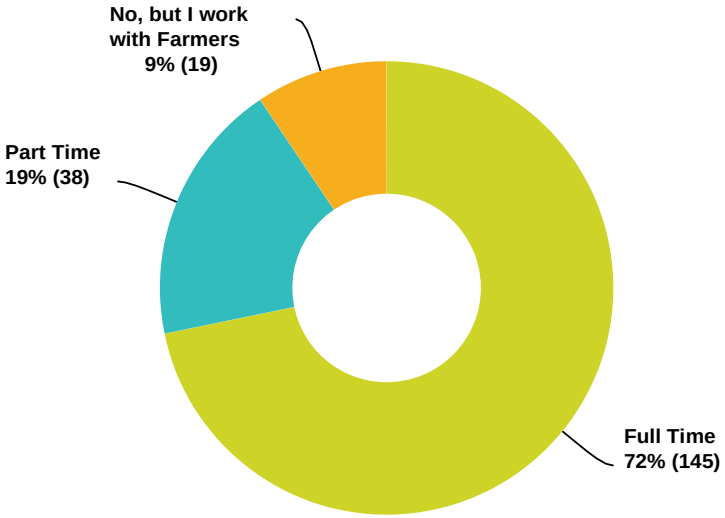
Answered: 197 Skipped: 64



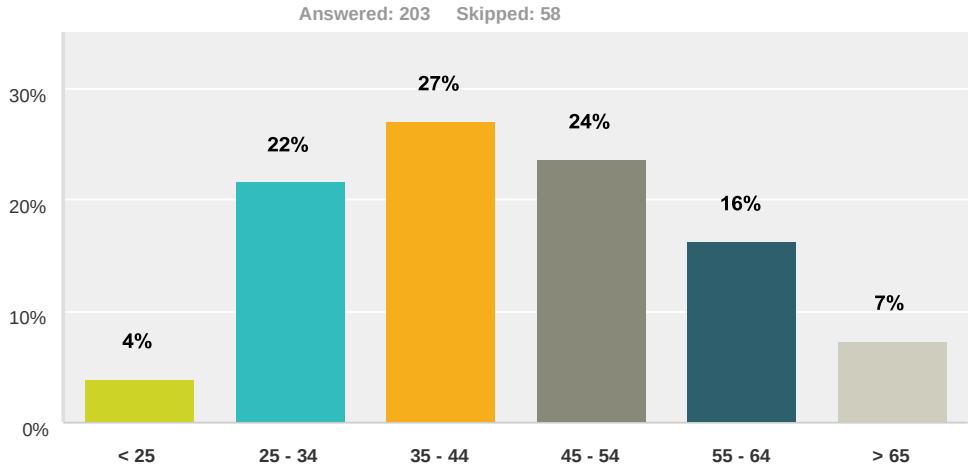
Peas: mainly AB responses, Lentils: mainly SK responses
Soybean & Corn: mainly MB responses, Oats: mainly Central/North responses

Q38 Do you farm?

Answered: 202 Skipped: 59

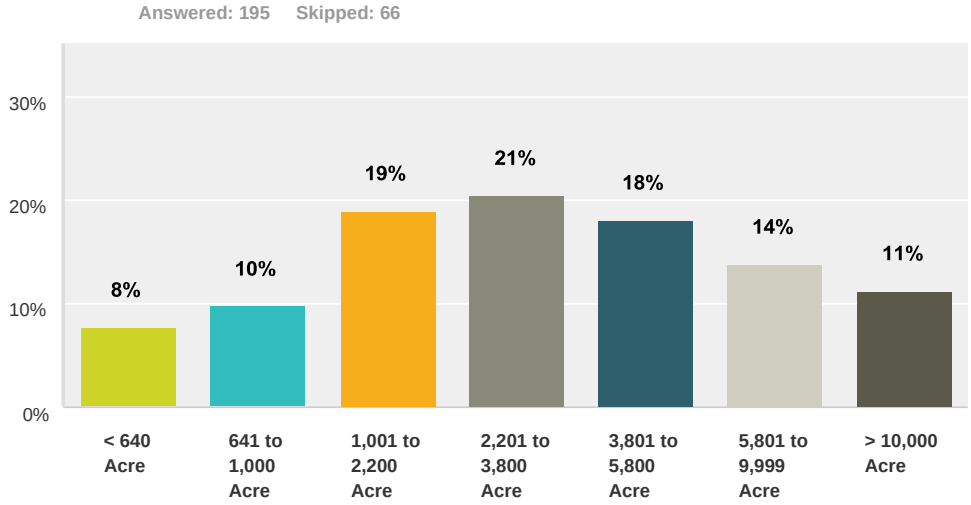


Q39 How old are you?



The average age of the survey respondents was in the 35 to 44 year old category. This is younger than the national average age of 54 years old, according to the 2011 Census of Agriculture.

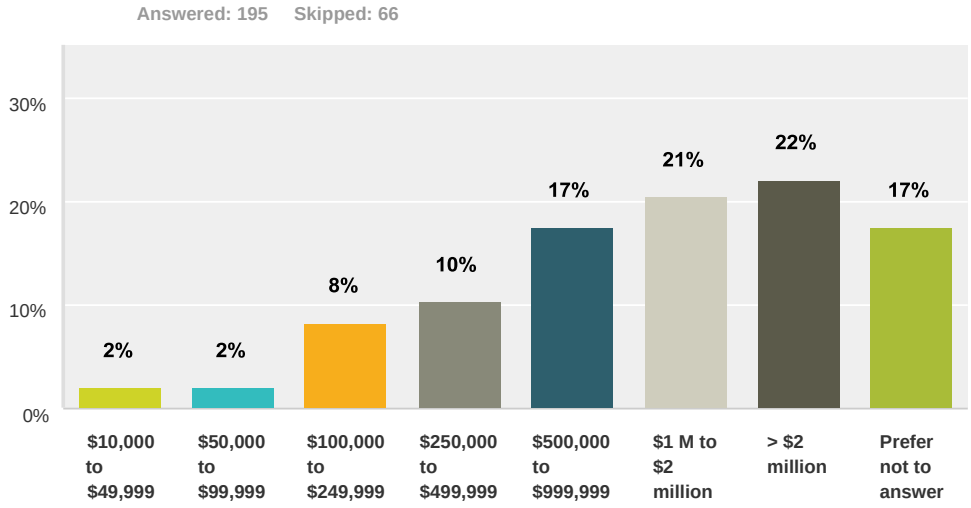
Q40 What is the cropland acreage of your farm operation?



The average acreage of the survey respondents was in the 2201 to 3800 acre category.

Western Canadian farms tend to be much larger than farms in eastern Canada or the mid-west United States. Seven farm acreage and revenue categories were defined in this survey to reflect the diversity of farm size/income levels in western Canada and to allow comparison to other surveys and 2011 Statistics Canada information.

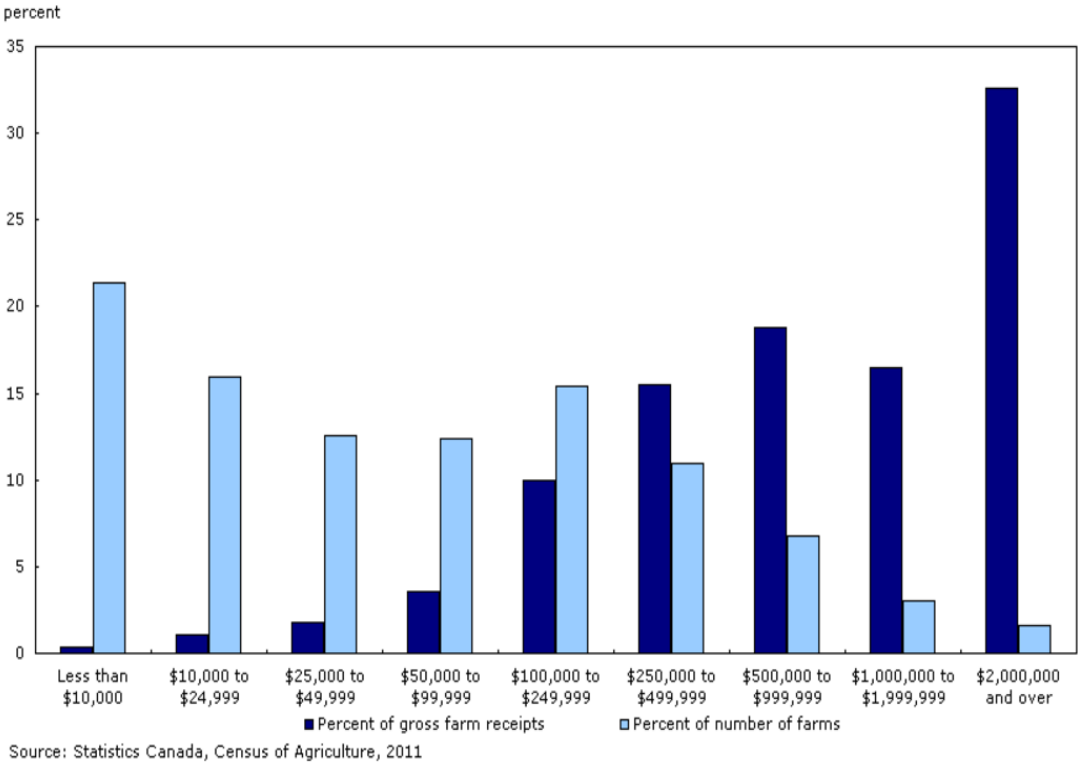
Q41 What is the annual sales revenue of your farm?



The average revenue of the survey respondents was in the $1 million to $2 million category.

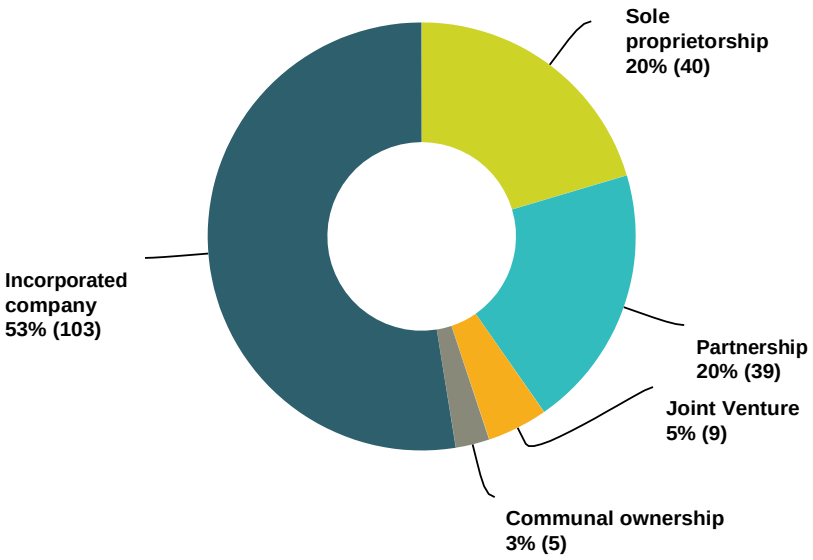
This is higher than the national average compared to the 2011 Census of Agriculture data on the percentage of gross farm receipts by farm revenue category and the percentage of Canadian farms by farm revenue category.

Per cent of gross farm receipts and number of farms (by revenue)



Q42 What is your farm business structure?

Answered: 196 Skipped: 65

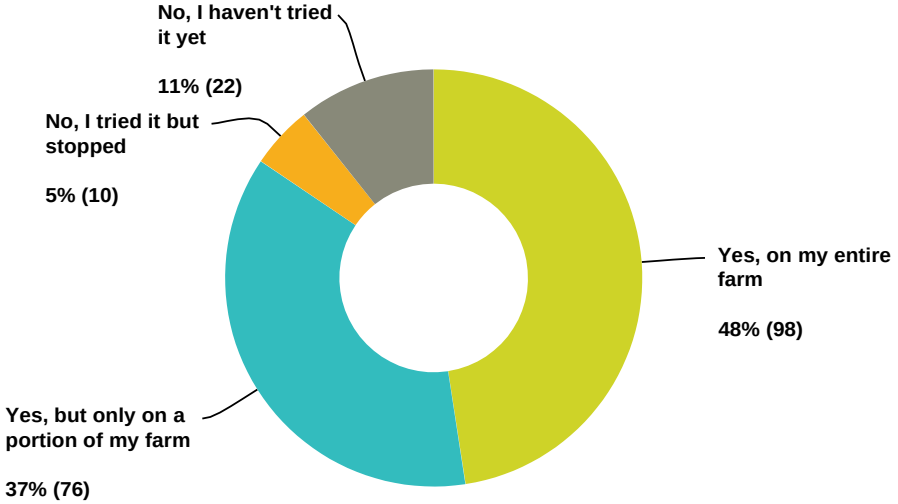


53% of survey respondents indicated an incorporated company as their farm business structure. Hutterite colonies represent a segment of western Canada farms. Statistics Canada 2011 Census of Agriculture indicated 20% of Canadian farms were incorporated. Survey responses from Hutterite colony members could reflect communal ownership, joint ventures or incorporated company based on their interpretation of the question related to their business structure.

3.2 Technology Use

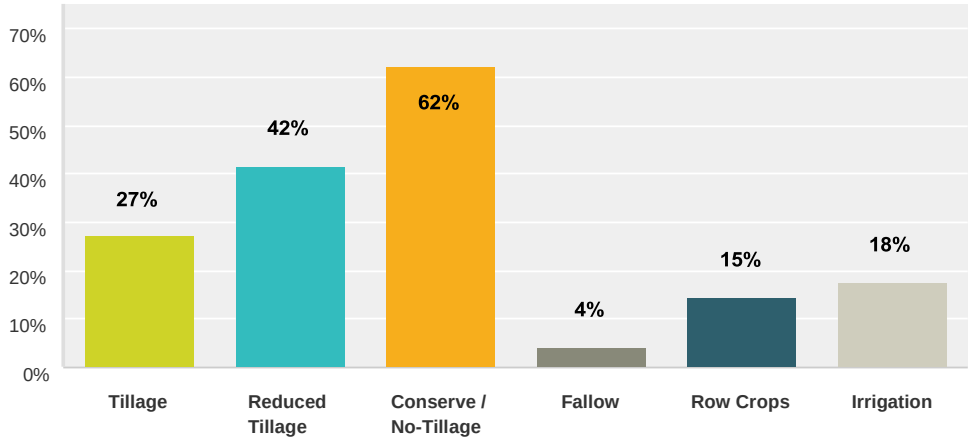
Q8 Is your farm currently using precision agriculture tools and/or services?

Answered: 206 Skipped: 55



Q37 What farming practices did you use in 2016 on your farm? (Check all that apply)

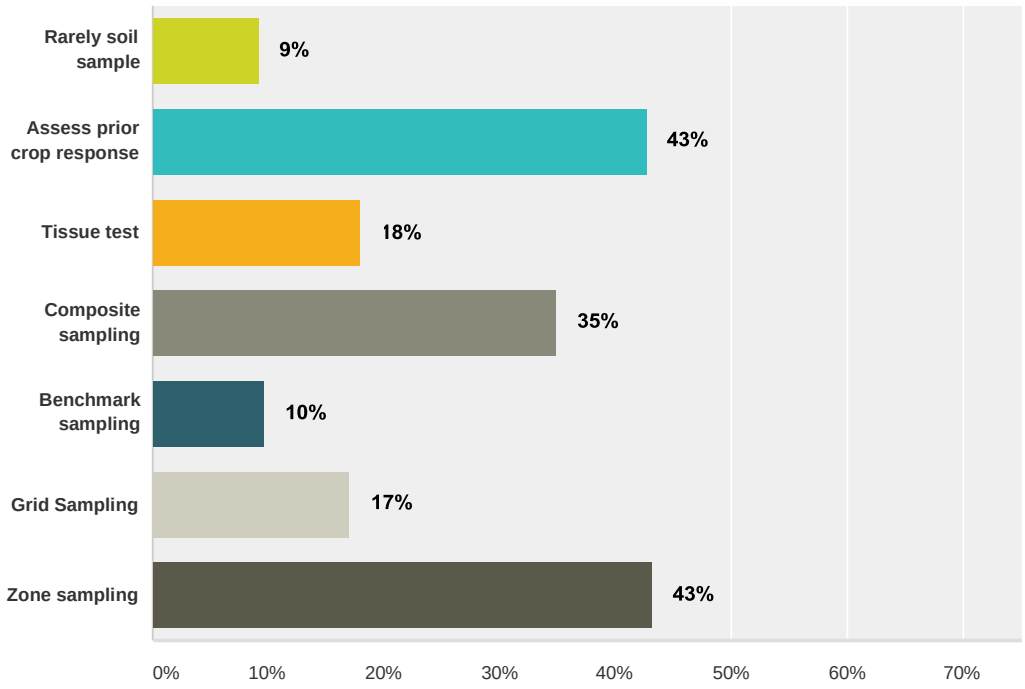
Answered: 197 Skipped: 64



Tillage was specified by a majority of farms with Irrigation and or row crops.

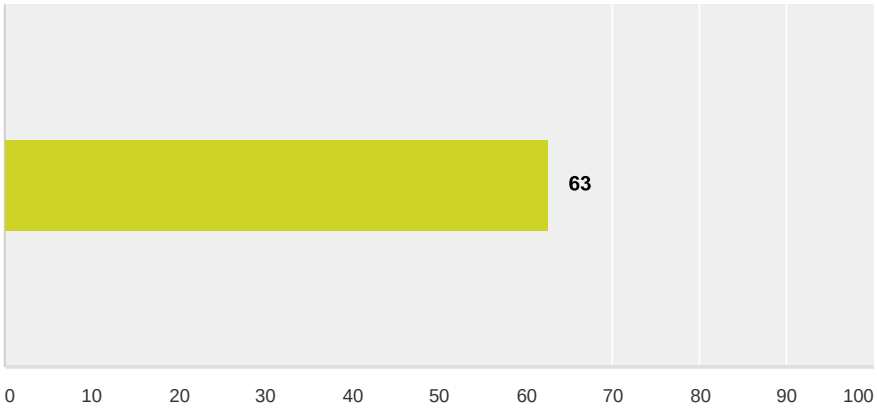
Q12 What are the primary soil nutrient assessment methods you use on your farm? (Check all that apply)

Answered: 206 Skipped: 55



Q13 What percent of your Farm's crop acreage was soil sampled in 2016? (Slide the dot to the % of farm)

Answered: 190 Skipped: 71

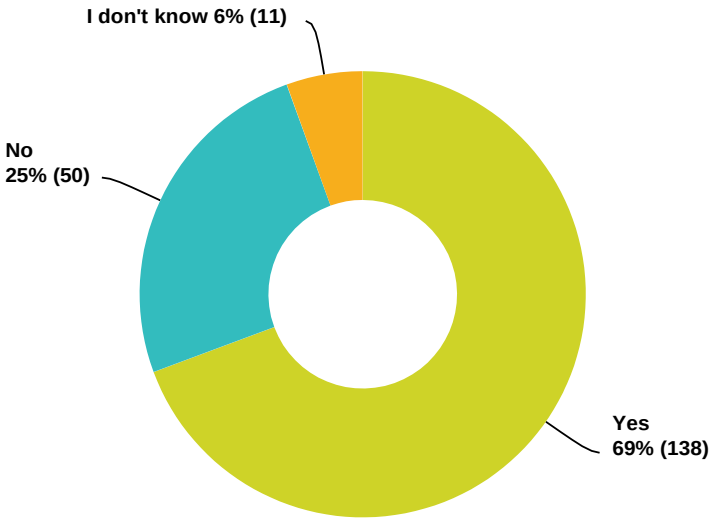


63% of survey respondents' crop acres represents about 600,000 acres sampled in 2016.

It is common practice for adjacent fields with the same crop rotation to be managed together, which minimizes the need for higher sampling intensity.

Q14 Did someone capture the GPS coordinates of the soil sampling and/or plant tissue sampling locations in the field to enable future sampling from the same location in the field?

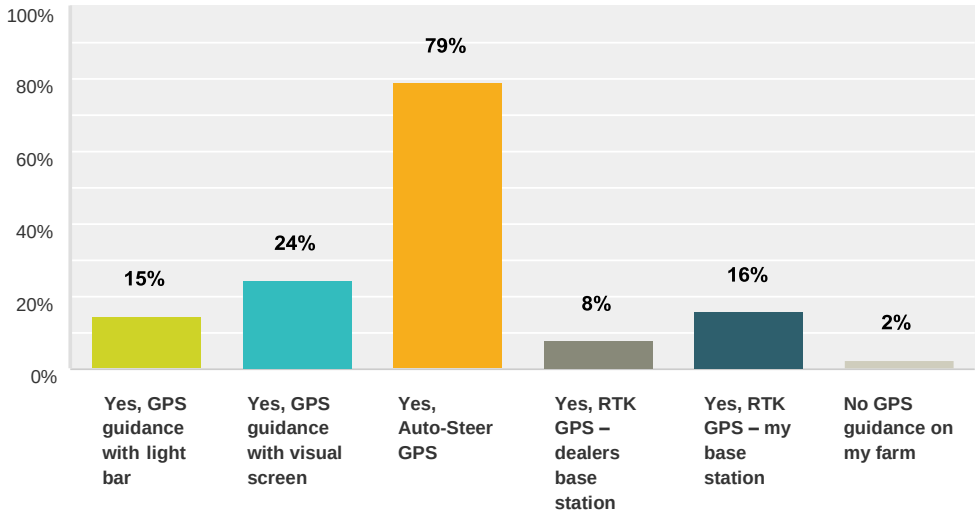
Answered: 199 Skipped: 62



GPS coordinates of soil/tissue sampling determine the spatial location within the fields to permit future sampling of the same location.

Q15 Do you use GPS guidance systems for your farm operation? (Check all that apply)

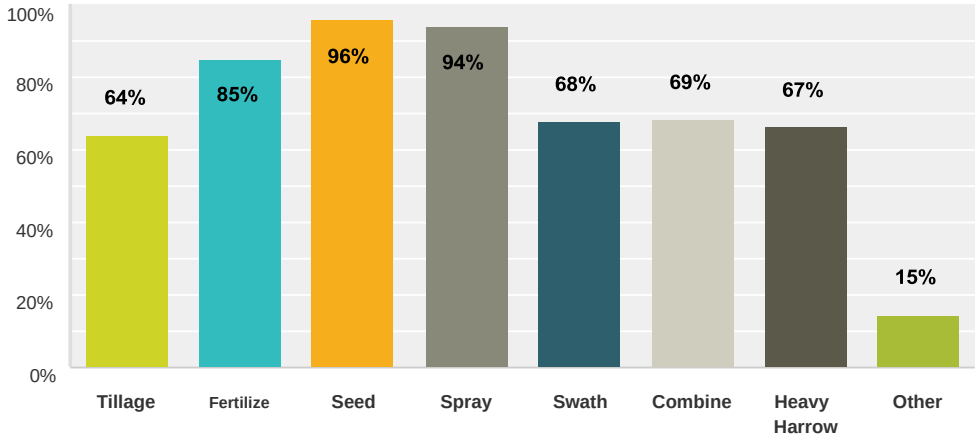
Answered: 205 Skipped: 56



Only 2% of respondents indicated No GPS guidance on their farms. The term GPS guidance can encompass free Apps or very accurate systems costing up to $40,000 per unit. Agricultural equipment manufacturers began to pursue GPS technology in the early 1990s and by 1998, John Deere presented a differential GPS system that provided 1-2 meter accuracy to assist farmers. Relatively speaking, the adoption of GPS guidance for farm equipment occurred very rapidly as the technology advances reduced the cost and improved the accuracy of GPS guidance in agriculture. Today's real-time kinematic (RTK) devices provide centimetre level accuracy.

Q16 For which of the following farm operations do you use GPS guidance? (Check all that apply)

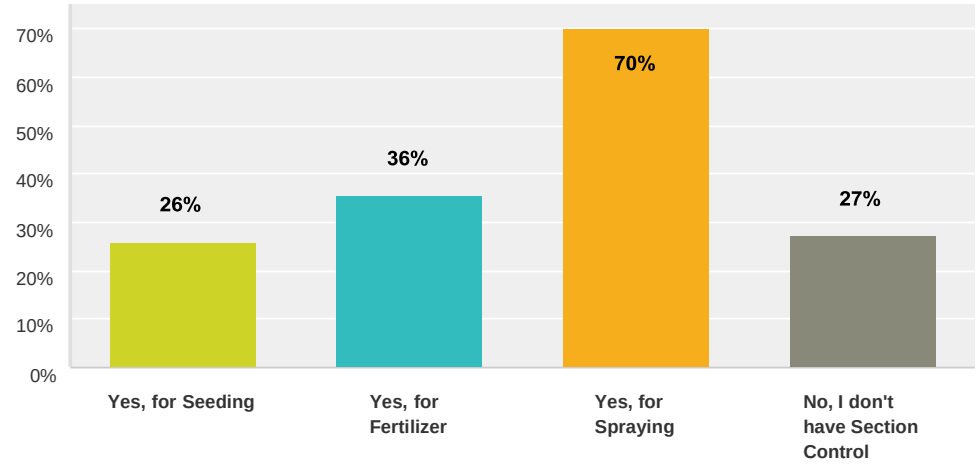
Answered: 204 Skipped: 57



GPS guidance has been widely adopted across western Canada farms in the past decade. Some of the other uses for GPS cited by respondents include land rolling, manure application and drainage.

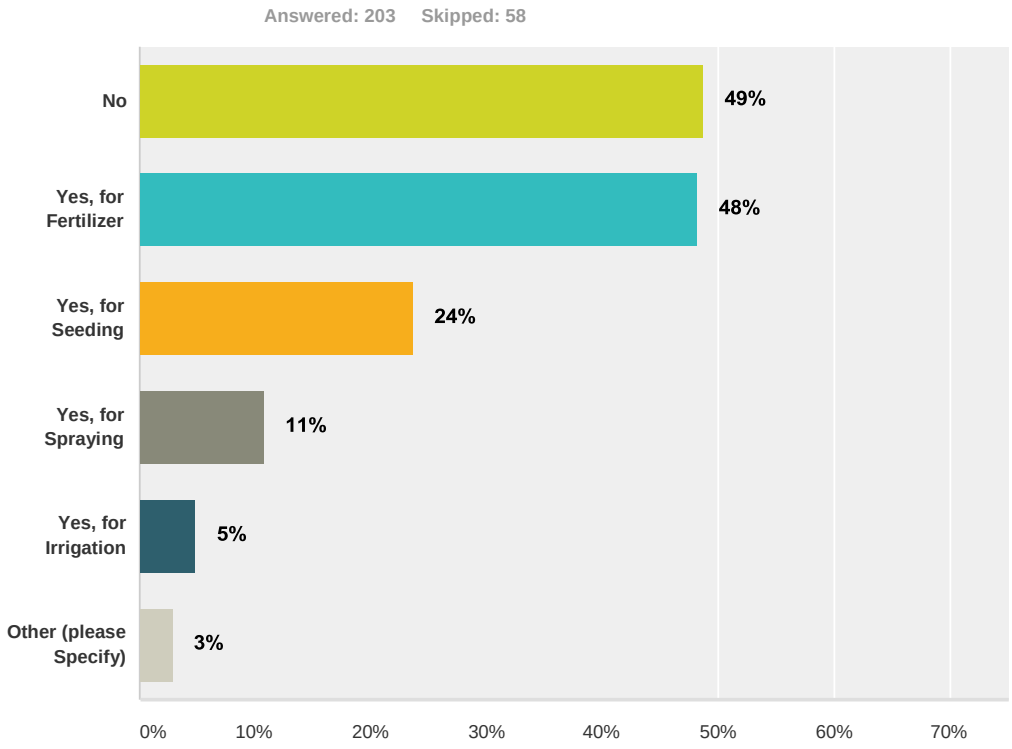
Q17 Did you use Automatic Section Control (ASC) to automatically turn On/Off the equipment booms or nozzle sections and/or planter units in 2016 for these activities?

Answered: 202 Skipped: 59



Automatic Sectional Control (ASC) uses GPS positioning to reduce the over-application of crop inputs by automatically turning off equipment sections or individual sprayer nozzles as they pass over previously treated areas. In the past 5 years, western Canada farms have been rapidly adopting Automatic Sectional Control (ASC) for spray applications and to a lesser degree on seeding and fertilizer applications.

Q18 Did you use Prescription Maps and/or Variable-Rate Technology (VRT) to apply variable rates or unique rates to your fields in 2016 for any of the following?

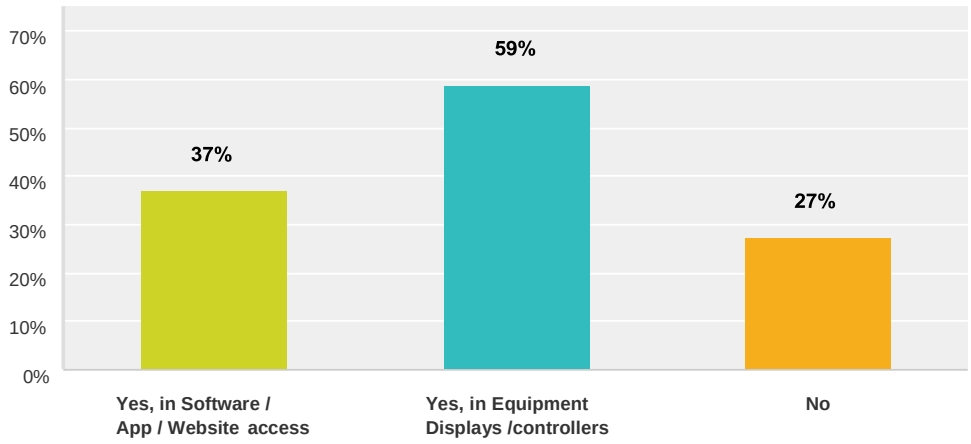


Variable Rate Technology (VRT) describes any technology which enables farmers to vary the rate of crop inputs applied within a field. It refers to the use of more than one application rate of a crop input within a field, multiple application rates are prescribed based on the unique areas within the field using precision agriculture tools.

Prescription Maps (Rx Maps) refer to the electronic data file which automatically directs the farm equipment to apply specific product rates in prescribed areas of a field. The Rx Maps are equipment specific file formats that automatically direct the equipment to apply specific crop inputs, and are often used in conjunction with auto-steer guidance.

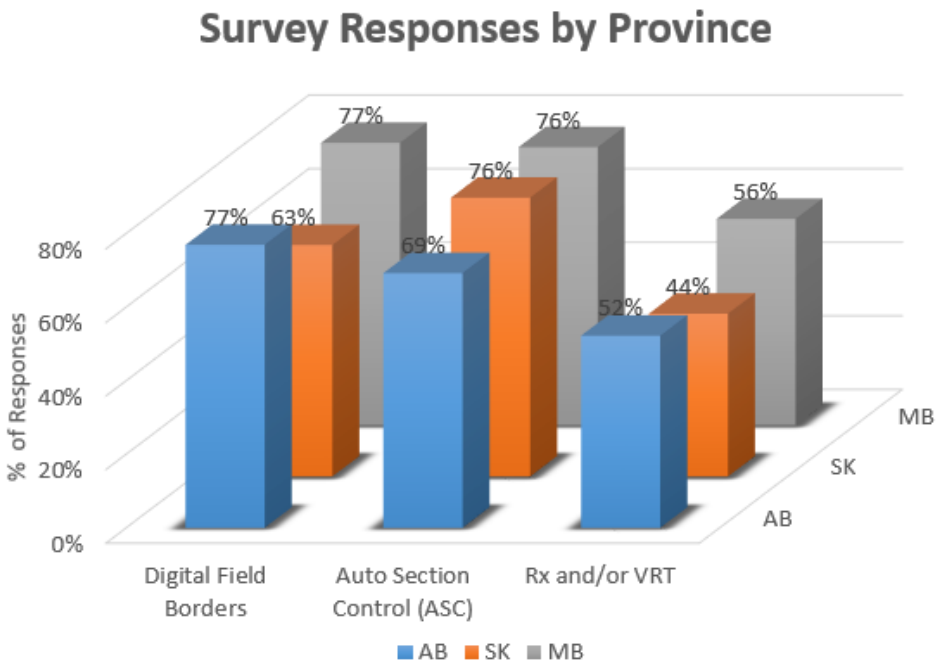
Q19 Do you have Digital Field Borders or electronic Field Boundaries of your farm fields?

Answered: 204 Skipped: 57

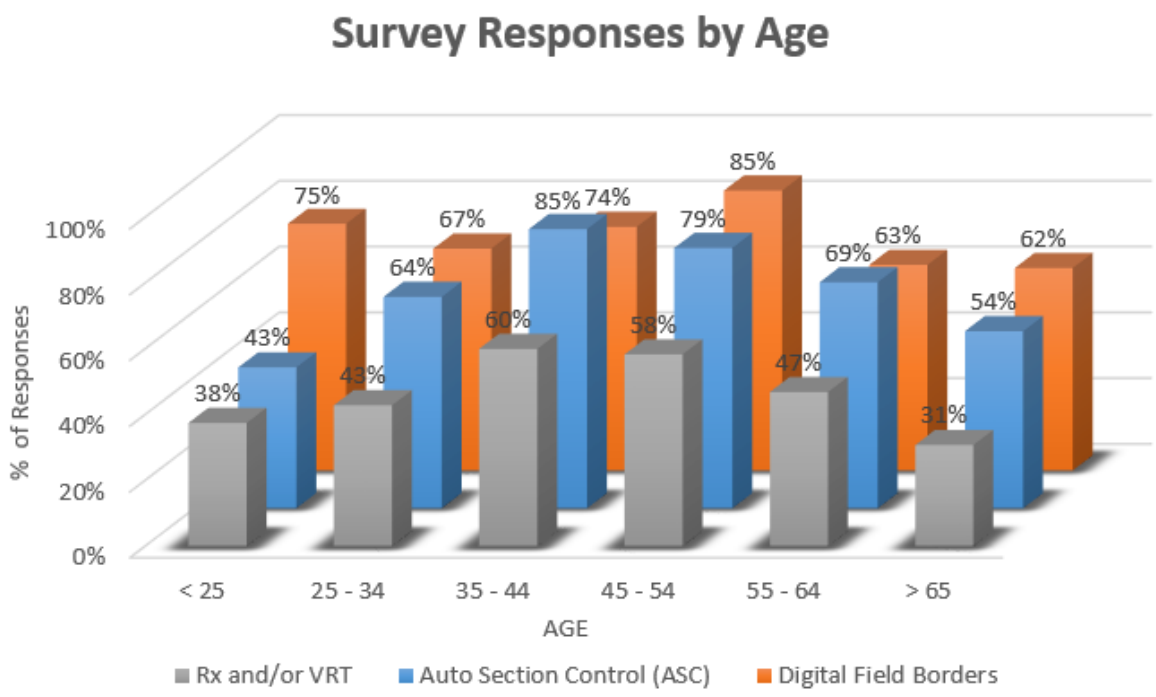


Digital Field Borders of Field Boundaries define the field area and obstacles or non-crop areas within the field. Digital Field Borders can be created in the field or created remotely with geospatial information system (GIS) software and imagery. Geospatial accuracy of the digital field borders can vary based on methods and techniques used and they are useful for equipment operation and geospatial analysis of field data. There are specific equipment file formats and shapefile formats used by different equipment.

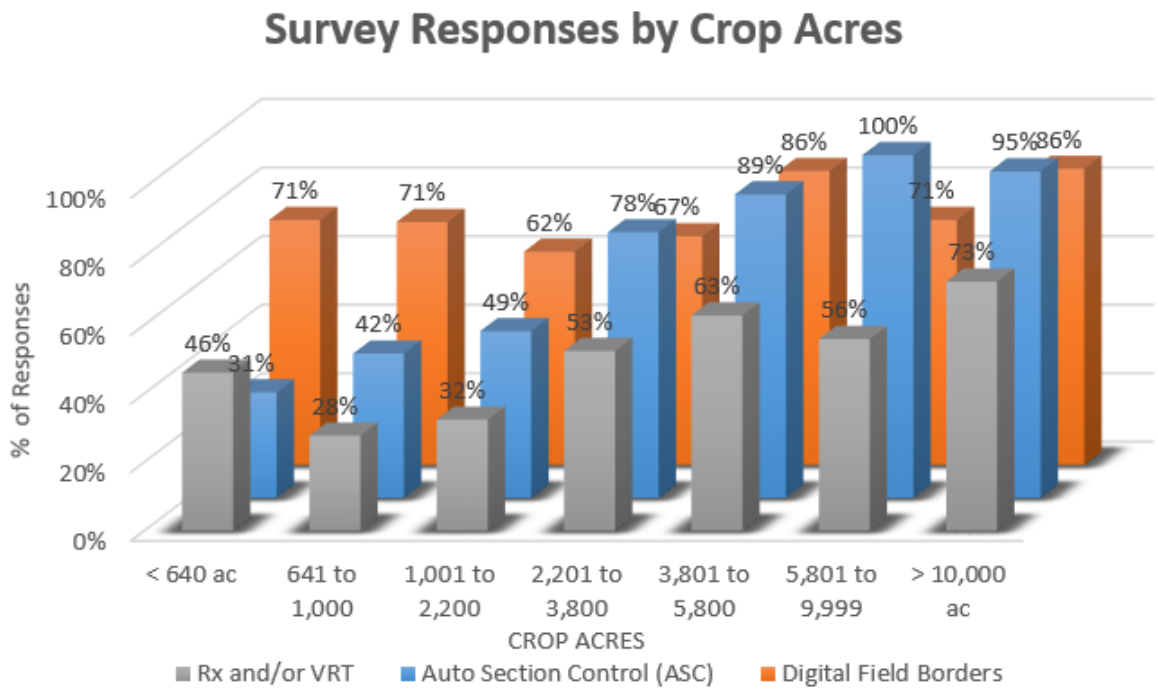
Demographic analysis of Survey Questions 17, 18, 19



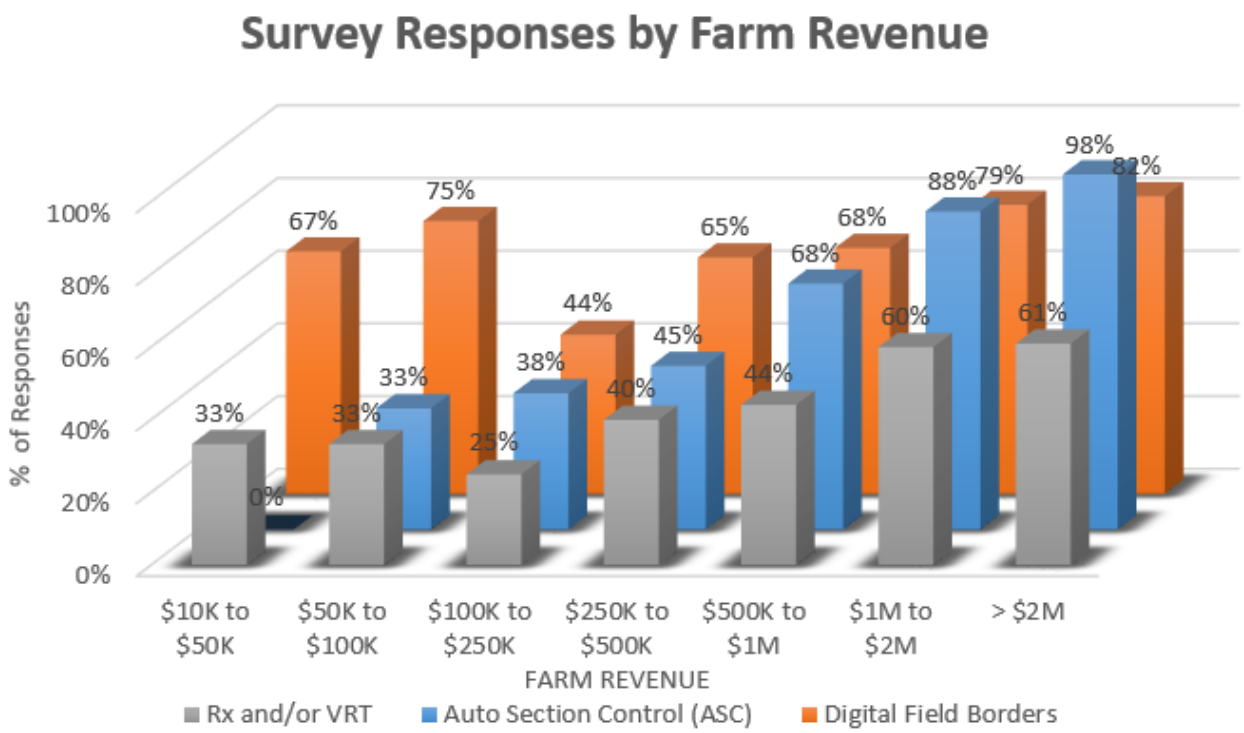
Adoption rates of these PA tools appear similar between provinces.



Younger and older farmers appear to have slightly lower adoption rates, perhaps due to the life cycle of farm expansion.

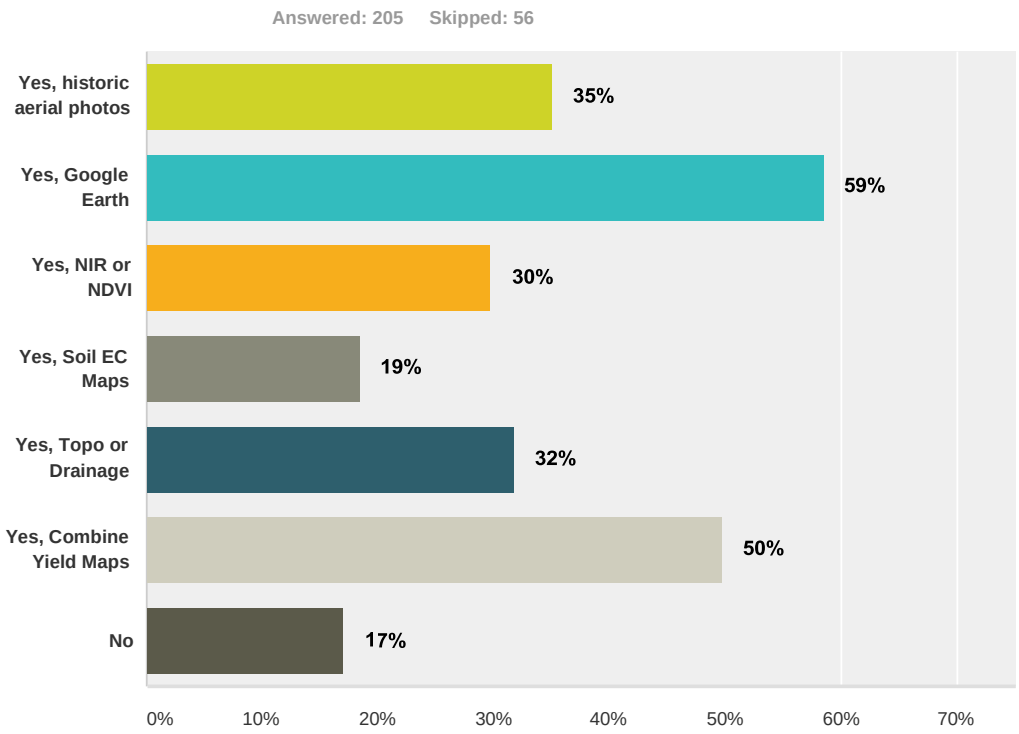


In general, larger acreage farms indicated higher adoption rates for these PA technologies.



Higher revenue farms indicated higher adoption rates for these PA technologies.

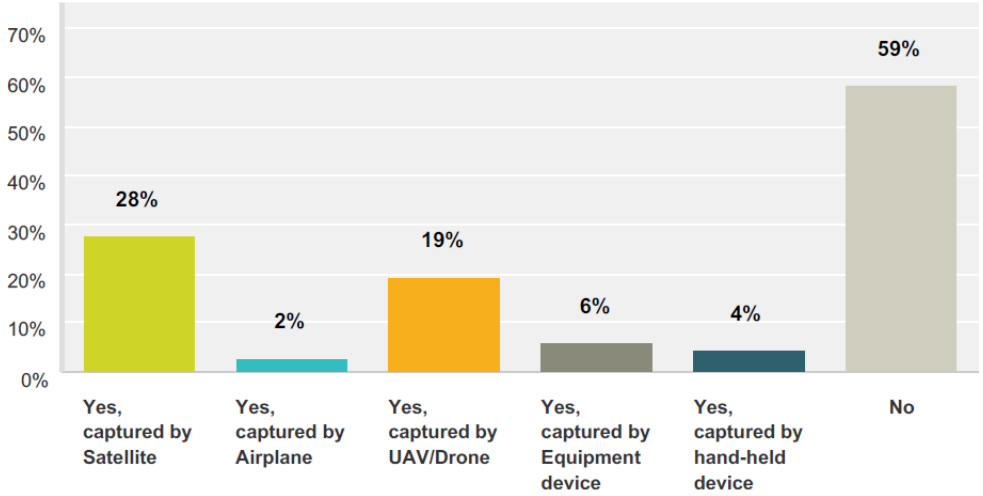
Q20 In 2016, did you look at Imagery or Maps of your farm fields? (Check all that apply)



Historic pictures and images of farmland and specific timeframes of crop development can provide information on the natural features and man-made features of the land. Maps provide a spatial reference to display many kinds of historic and current information.

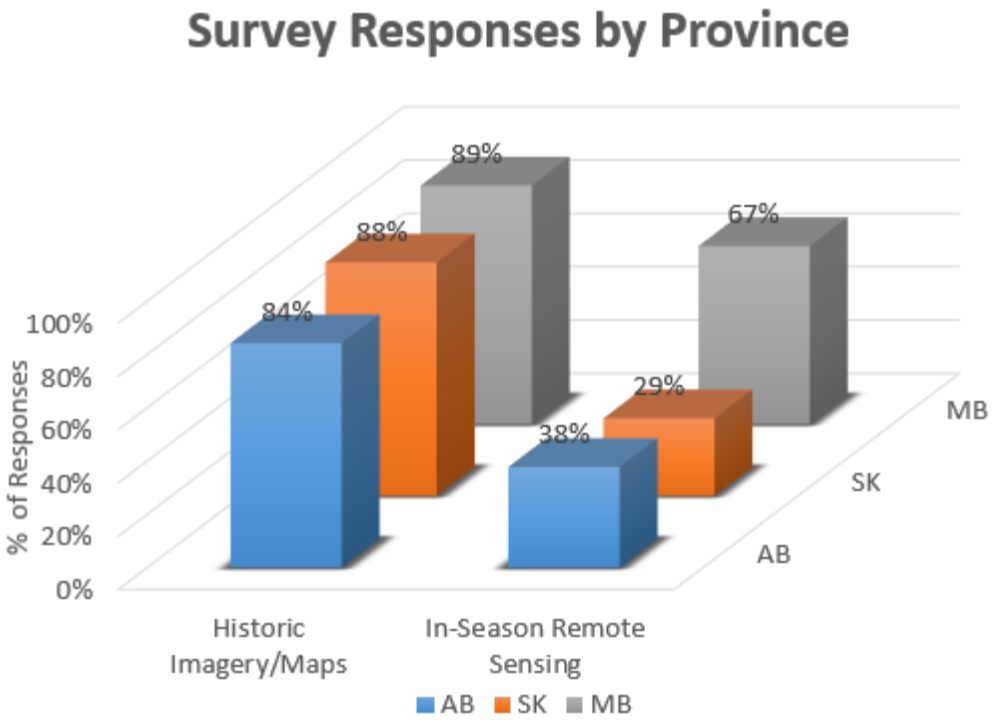
Q21 In 2016, did you look at In-Season Crop Imagery or Remote Sensing of your crops and fields? (Check all that apply)

Answered: 203 Skipped: 58

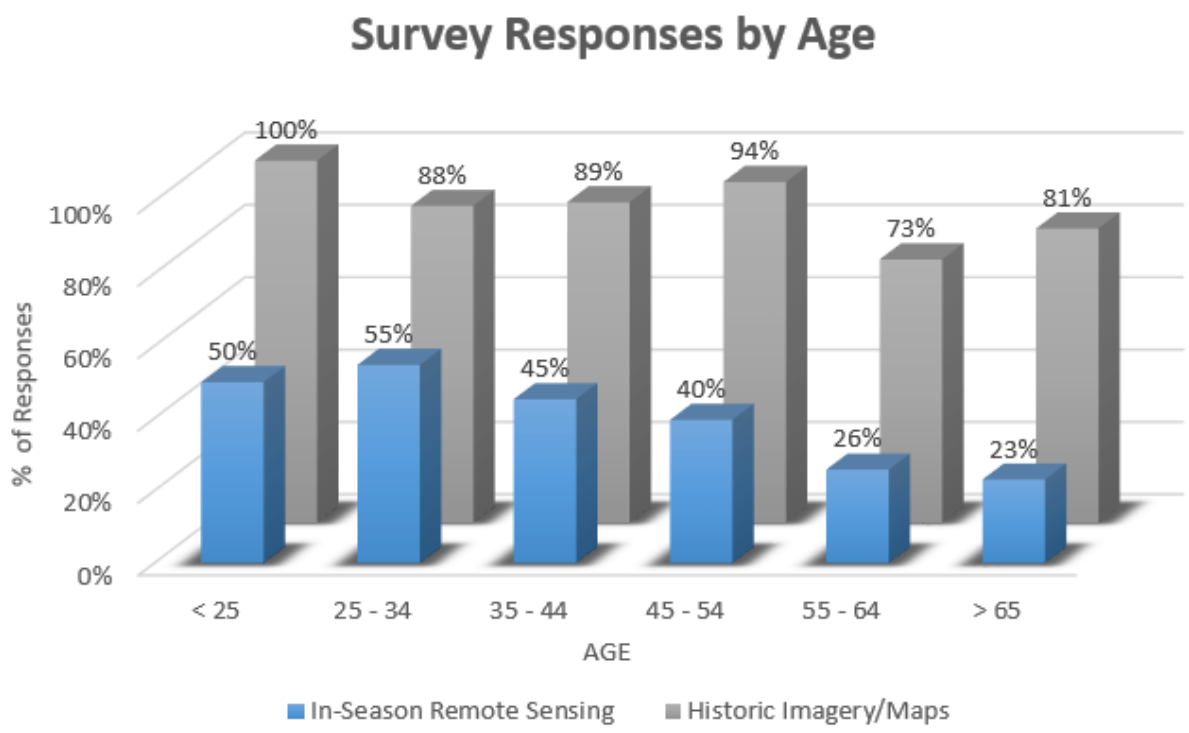


In-Season Crop Imagery or Remote Sensing of fields may involve True Color (RGB) or Near Infra-Red (NIR, NDVI) to assess vegetation. These types of imagery generally contain more actionable data than simple aerial phots and help to guide site-specific management by showing variations within a field which are invisible to the human eye. Each of the platforms used to capture imagery can have different accuracy, sensors, resolutions, re-visit times and processing methods. Numerous satellite constellations collect agricultural data such as Landsat, RapidEye and Sentinel networks. Use of UAV/Drones use in agriculture has grown quickly in the past three years.

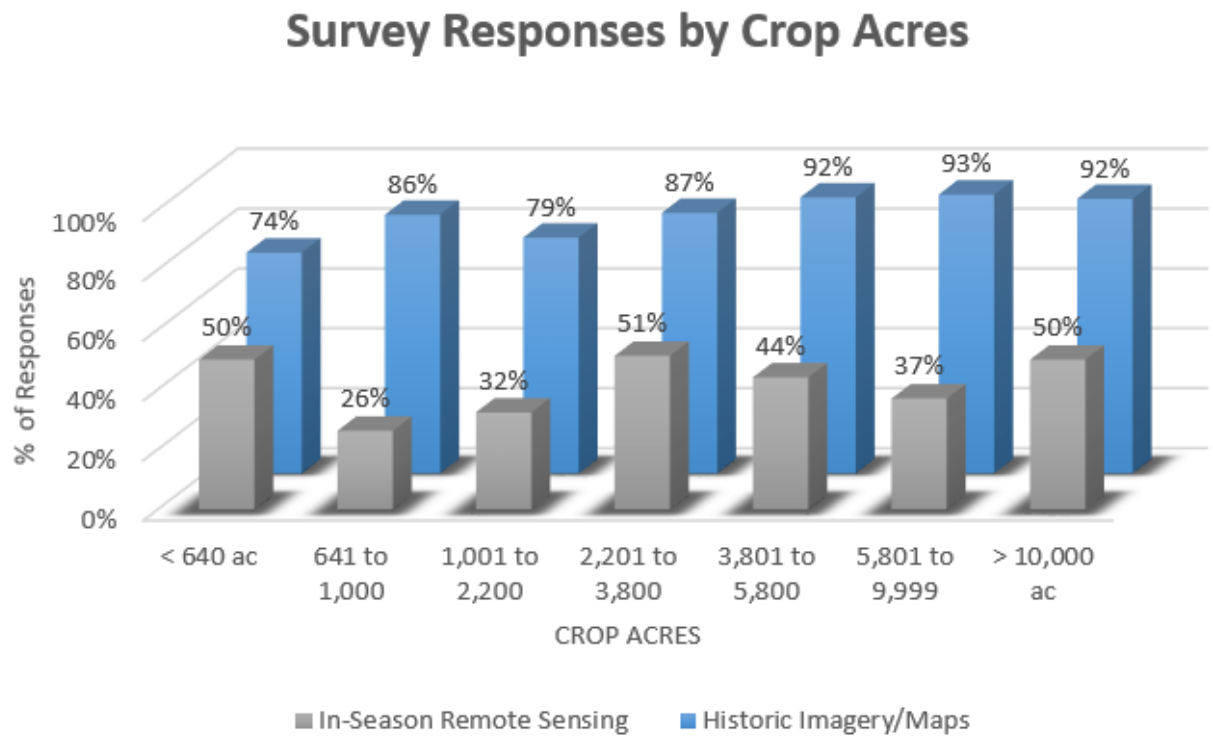
Demographic analysis of Survey Questions 20, 21



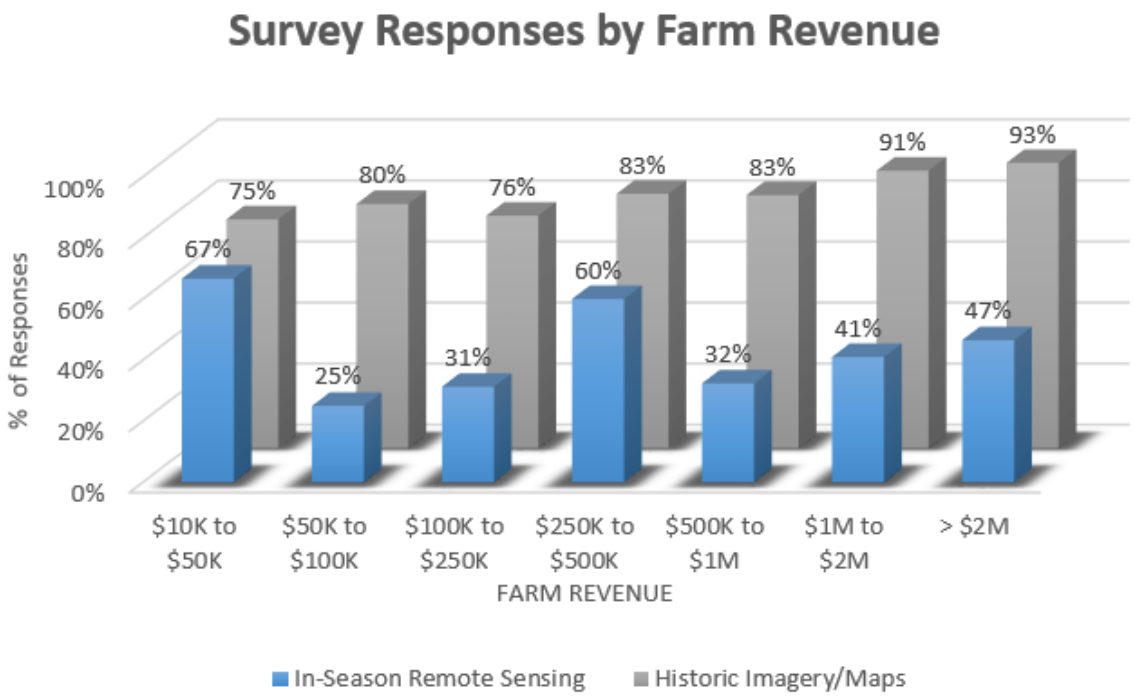
Adoption rates of these PA tools appear similar between provinces, with Manitoba responses showing significantly higher use of in-season remote sensing.



Older producers indicated lower adoption rates of in-season remote sensing compared to younger farmers.



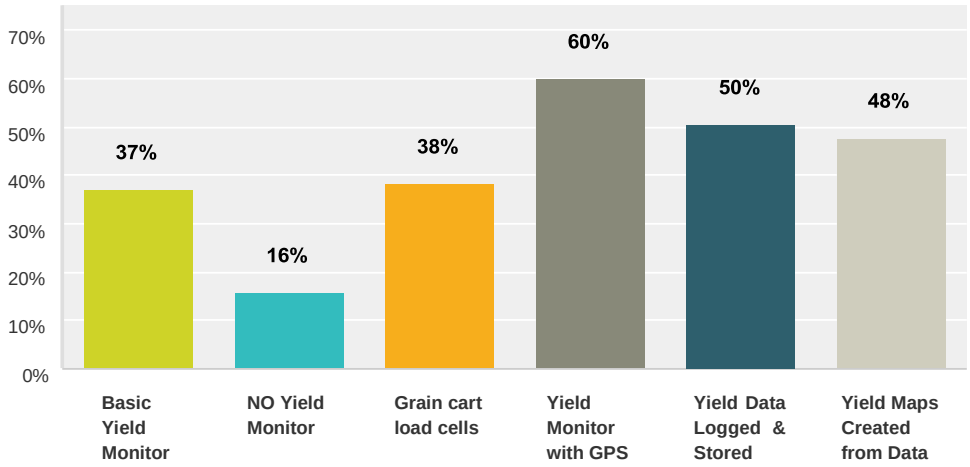
The use of in-season remote sensing was not determined by farm size. Larger farms indicated higher usage rates for historic imagery and maps.



The use of in-season remote sensing was not determined by farm revenue. Higher revenue farms indicated higher use rates for historic imagery and maps.

Q22 In 2016, the combine(s) that harvested your fields...
(Check all that apply)

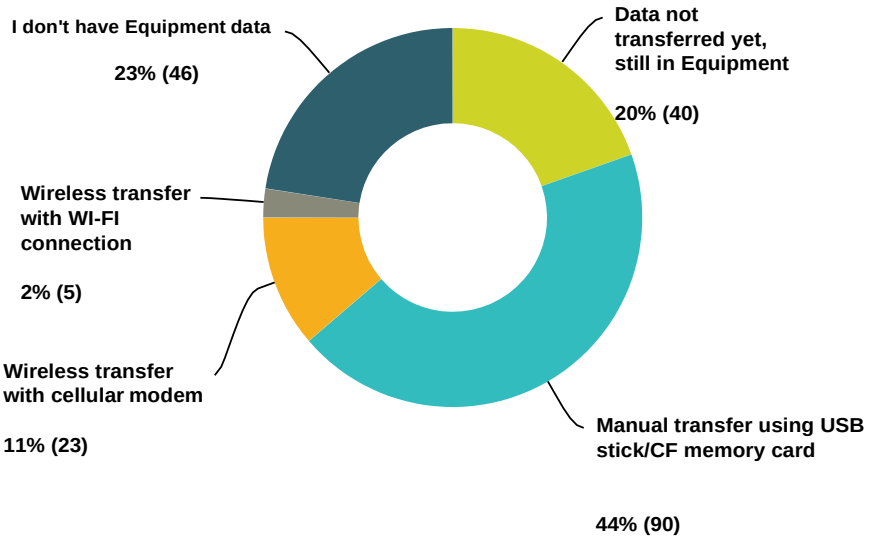
Answered: 202 Skipped: 59



84% of responses appear to have combine(s) with some yield monitoring capability and 60% of the combine yield monitors equipped with GPS.

Q23 How did you transfer your yield data or equipment data from the farm equipment to a computer?

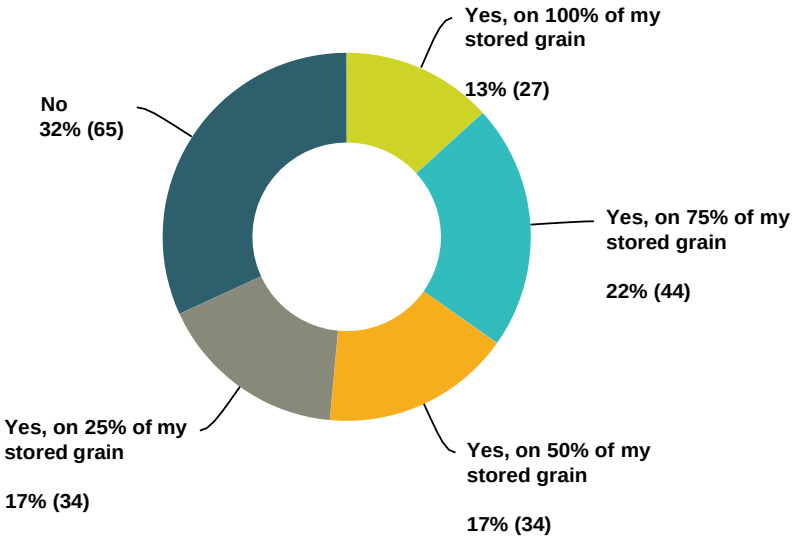
Answered: 204 Skipped: 57



13% of respondents refer to equipment/telematics using Wi-Fi or cellular networks to transfer equipment data. 20% indicated they had not transferred the equipment data by January/March.

Q24 Does your farm have Temperature and/or Moisture sensors to monitor the stored grain in bins?

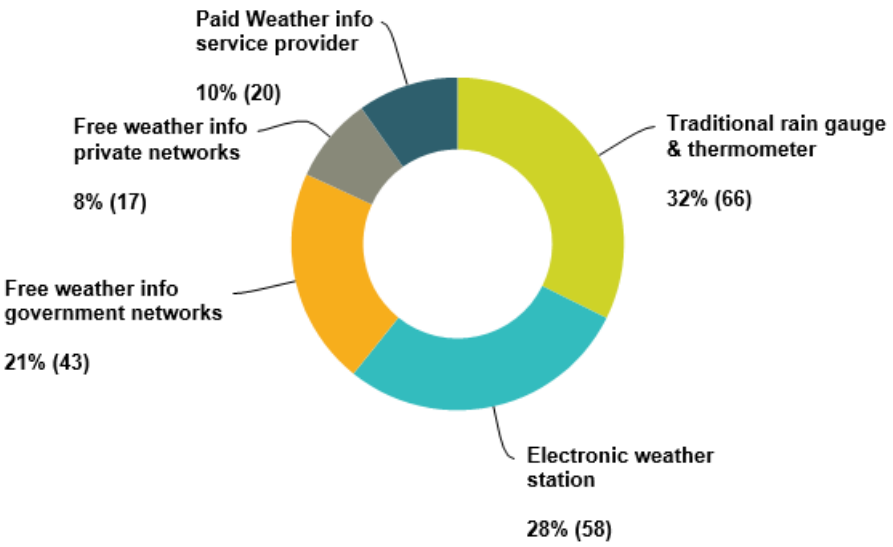
Answered: 204 Skipped: 57



68% utilize Temperature and/or Moisture sensors in 25%-100% of the stored grain.

Q25 What is your primary method to record weather information for the farm?

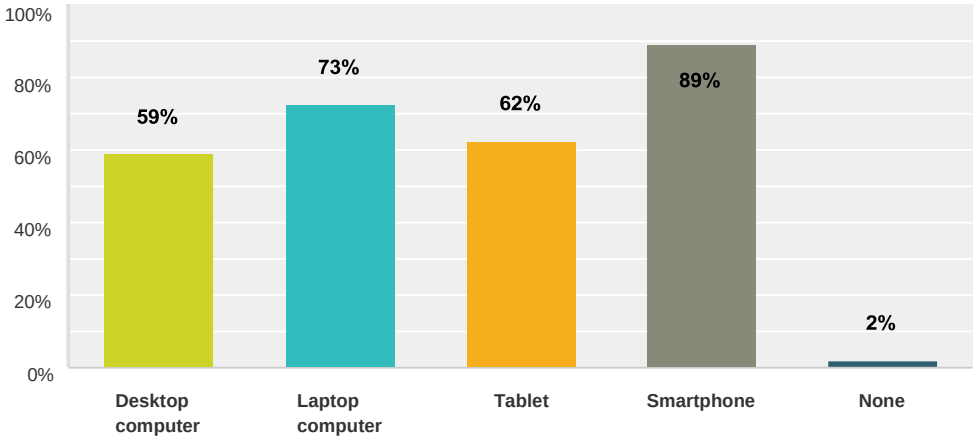
Answered: 204 Skipped: 57



21% use free weather information from government networks and 10% use a paid weather service as their primary weather information.

Q26 Which of these tools do you use for farm business management? (Check all that apply)

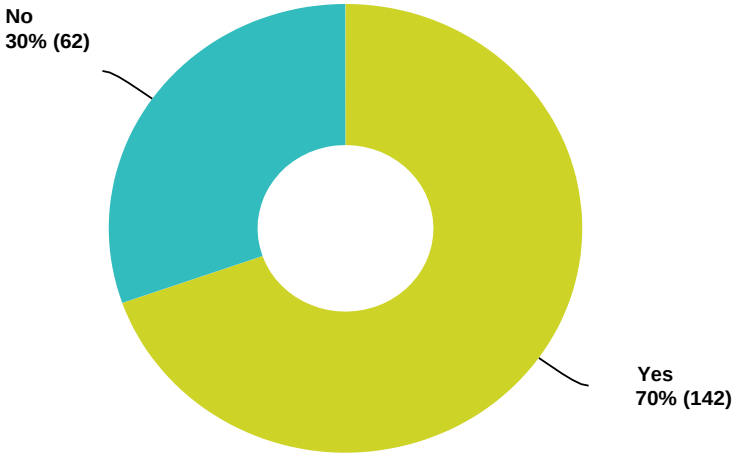
Answered: 204 Skipped: 57



Many farms use multiple devices with smartphones being the most popular at 89%.

Q27 Do you use farm management software on your computer?

Answered: 204 Skipped: 57

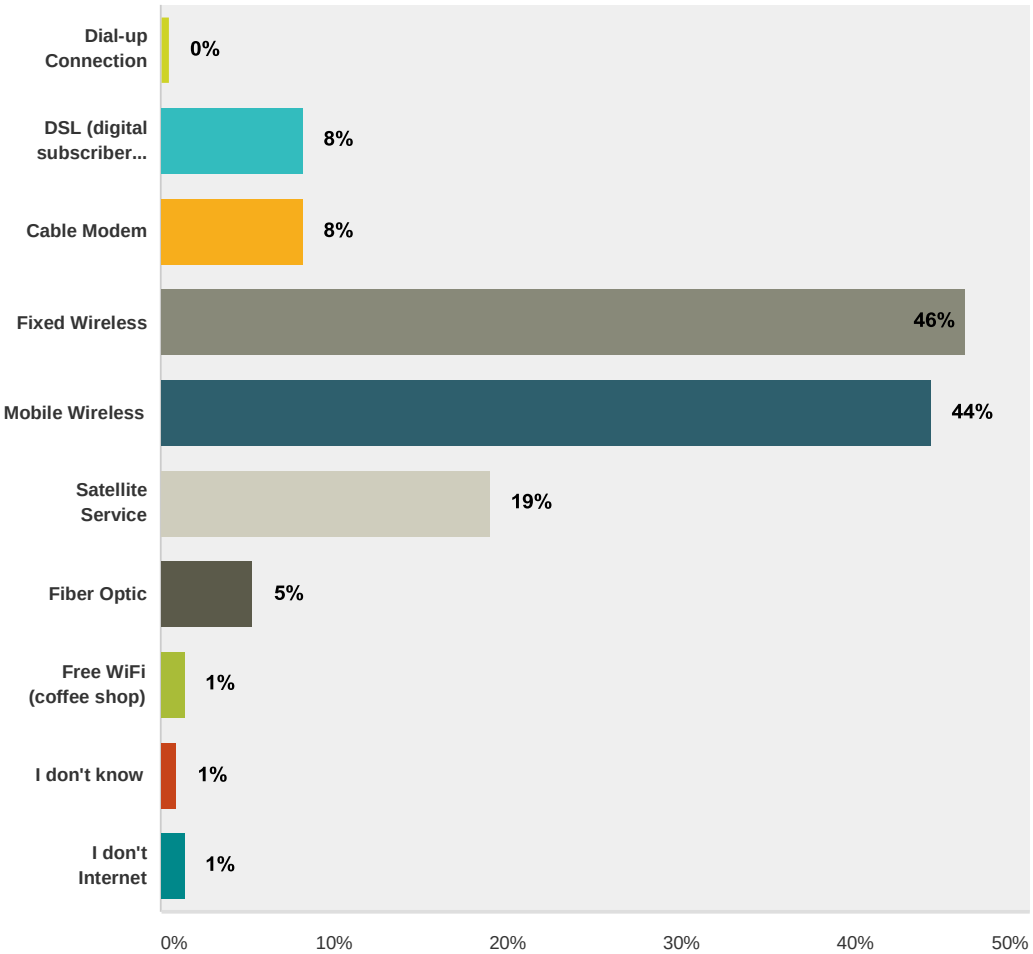


Top 6 responses for farm management software suppliers:

1. Farm Credit Canada
2. Trimble
3. Do it Yourself tools
4. Ag Leader -SMS
5. Farmers Edge
6. John Deere

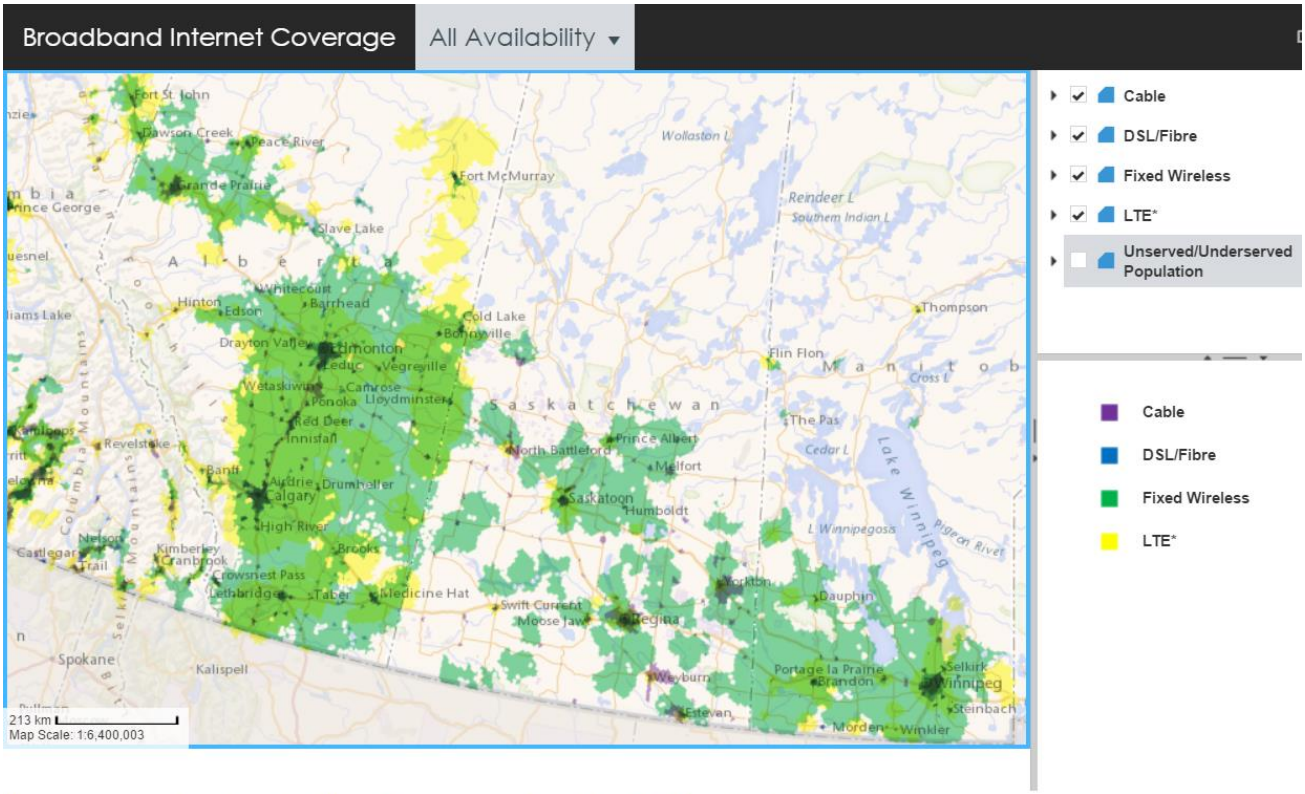
Q28 How do you connect to the Internet for your farm business?

Answered: 205 Skipped: 56



Wireless internet was most common, but internet speed can vary dramatically.

Below is a map showing various levels of internet service across the prairies.

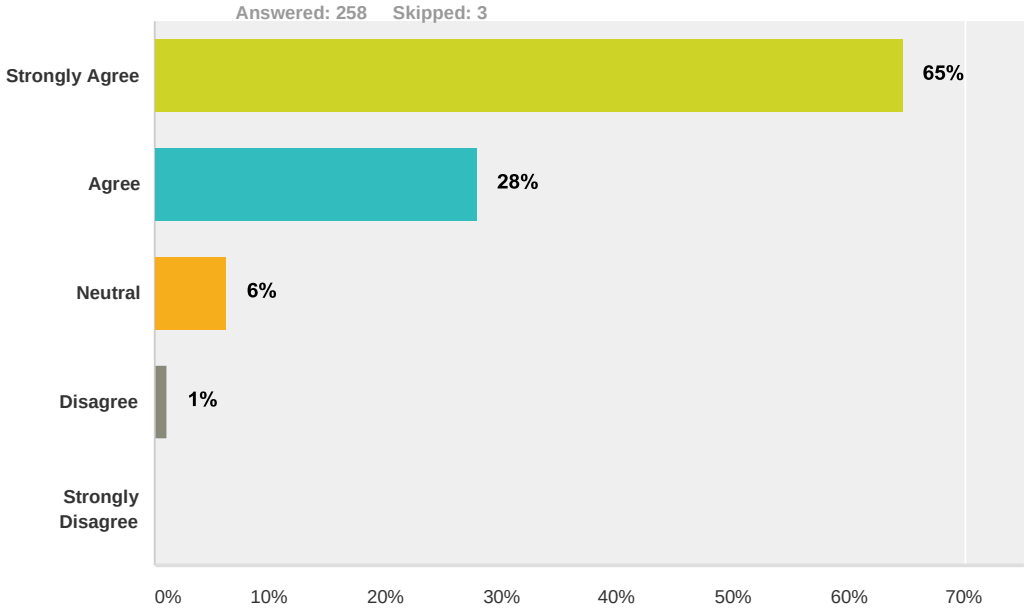


*Internet speeds at or above the CRTC's targets may not be achievable throughout the entire LTE coverage area.

http://www.crtc.gc.ca/eng/internet/internetcanada.htm

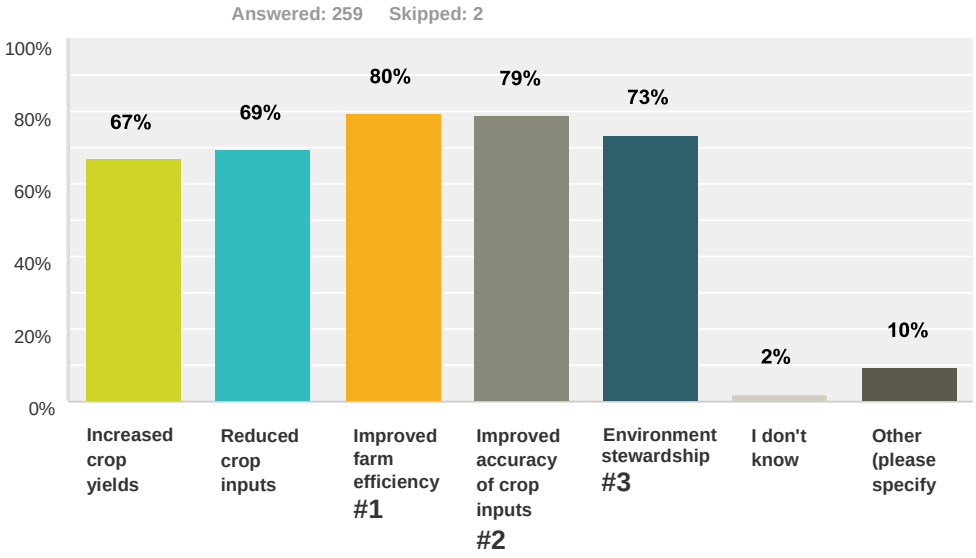
3.3 Factors influencing adoption

Q1 Do you believe precision agriculture is useful?



93% Agree or Strongly Agree that precision agriculture is useful. The definition of precision agriculture has evolved beyond GPS guidance to include new technology segments such as remote sensing with UAV/drones and "big data" analysis of multiple streams of farm data. This question contains an inherent variable as the response depends on the respondent's interpretation of what precision agriculture is in their mind.

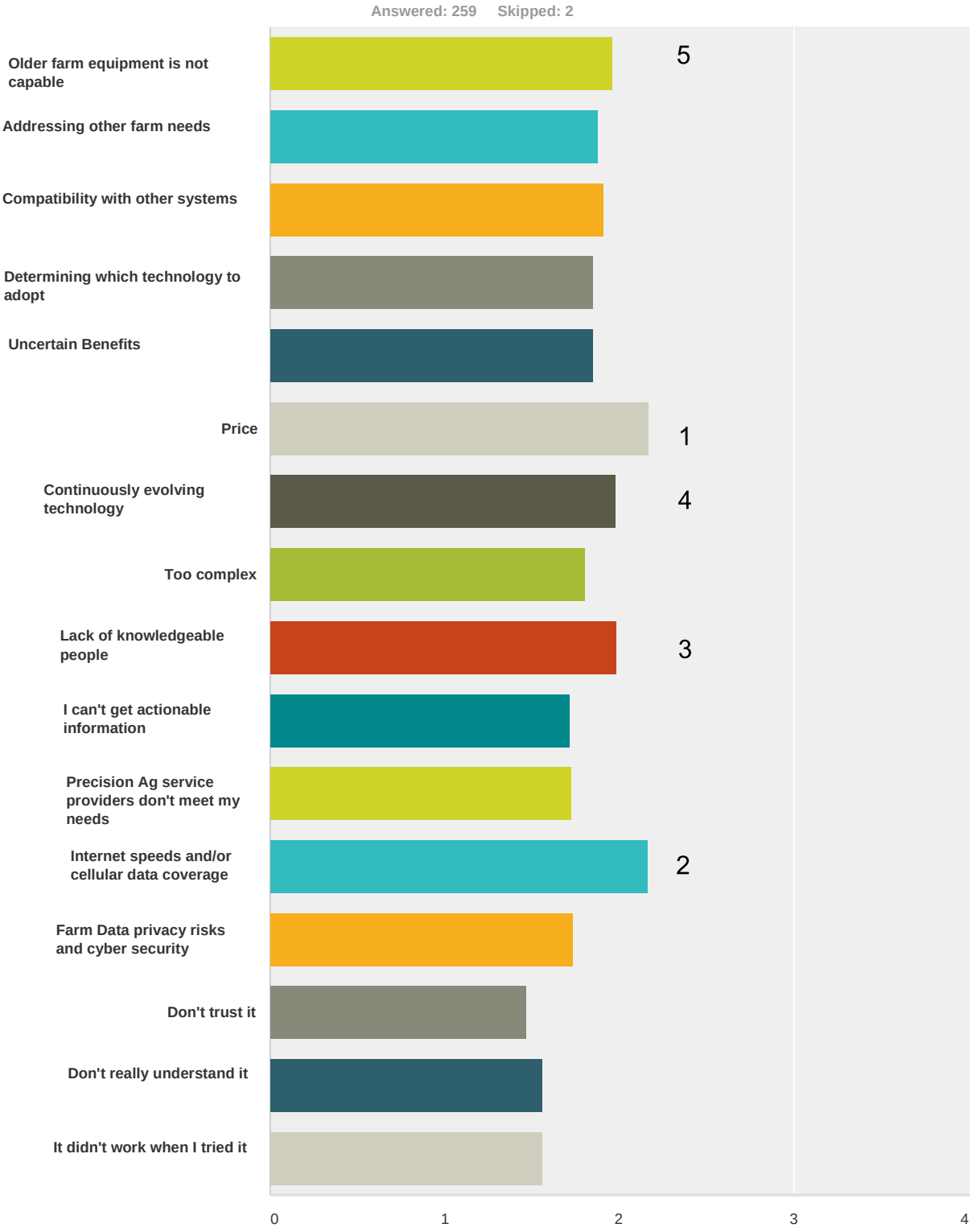
Q2 What are the primary benefit(s) of precision agriculture? (Check all that apply)



Q3 How important are the following reasons for using precision agriculture technology on the farm? (Rank only the reasons that you consider)

Q3 ranking was determined by the cumulative total of responses assigned a 3 for Very Important, 2 for Somewhat Important and 1 for Not Very Important.

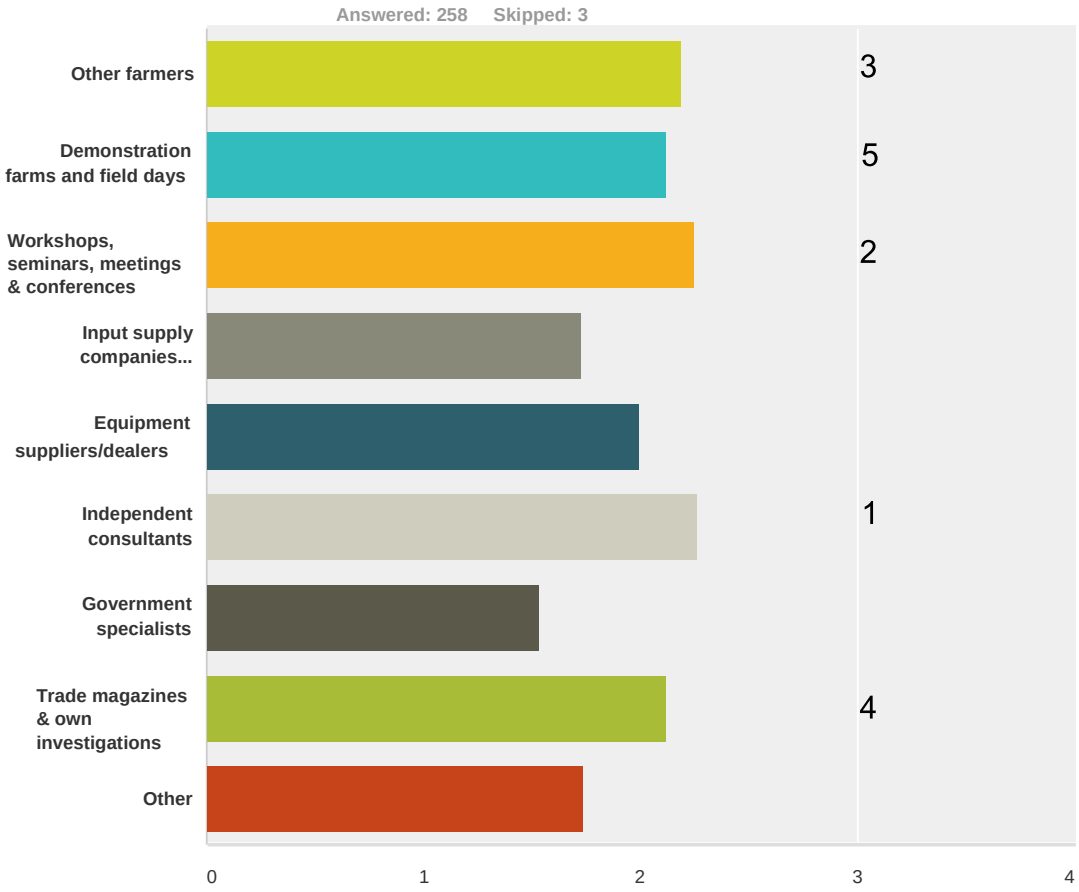
Q4 What in your view, are the Barriers or Limitations affecting farm adoption of precision agriculture technology? (Rank only the items you consider as barriers)



Q4 ranking was determined by the weighted average of responses assigned a 3 for Significant Barrier, 2 for Barrier and 1 Small Barrier.

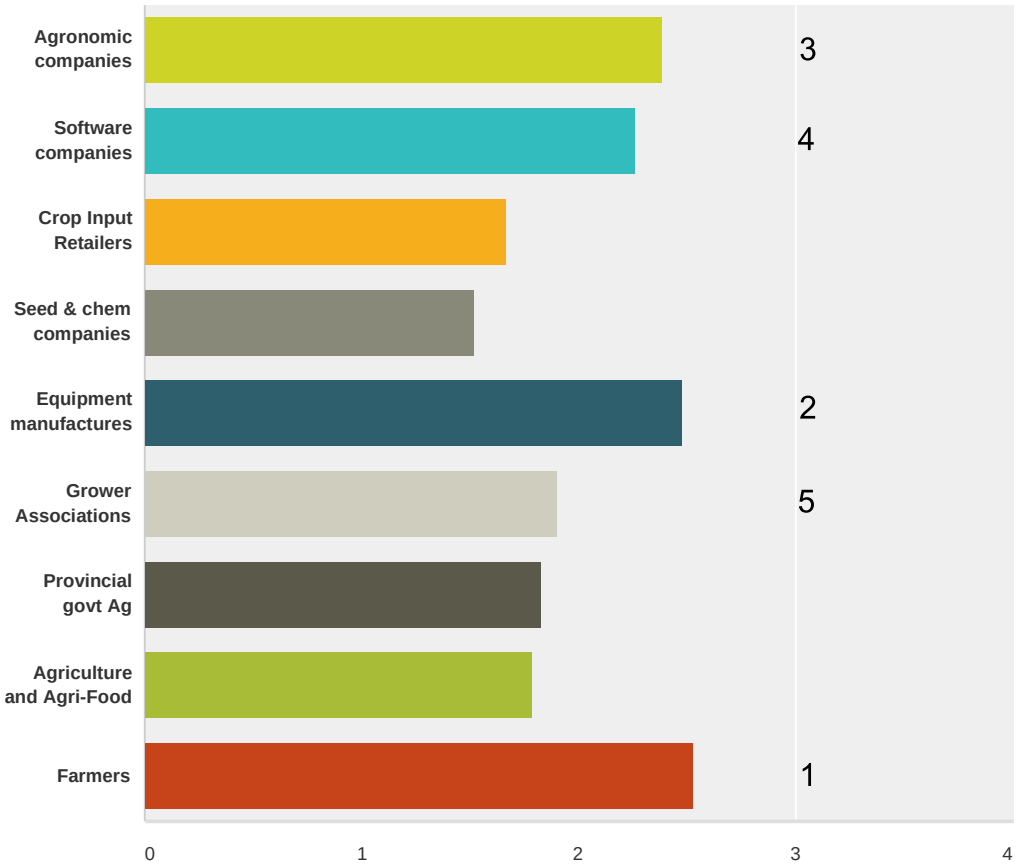
Price of PA applications tends to be an important consideration with producers, but what portion of the PA barrier is hardware, software or services-related is difficult to determine. If the tangible benefits to PA adoption are uncertain, then the price equation becomes more important. The #2 Barrier is Internet speeds and/or cellular coverage, as the collection, transfer and analysis of farm data rely on cellular or internet.

Q5 How do you find out about new or improved products, processes or practices? Or find out about precision agriculture technologies? (Rank only the sources you utilize)



Q6 Who should lead in the development of precision agriculture tools to meet farmers' needs? (Rank only the sources you consider should lead the development)

Answered: 258 Skipped: 3



Not surprisingly, for farmers to adopt a technology, it must first meet their needs. Most farm innovations were conceived on-farm and then commercialized by companies.

Q7 What should be the role of government in precision agriculture now and in the future?

Answered: 175 Skipped: 86

Key words identified by Survey Monkey

Top seven themes expressed in the survey response comments to Q7:

1. Incentives to encourage PA adoption
2. Standardize processes to measure results in PA
3. Unbiased verification
4. Research to support best practices
5. Technology support to enable rural infrastructure & encourage desired adoption
6. Education
7. Don't disrupt the marketplace signals

Of note, the response rate for Q7 was low (only 175 out of a possible 261 respondents answered), perhaps because this was an open-ended question or perhaps this is an indicator of the lesser importance placed on the government role when it comes to PA. Survey responses ranged from suggesting government stay out of agriculture policy to providing incentives to encourage specific farm practices. The question and responses do not specify which level of government, funding formula or method of involvement is best suited. Many producers are aware of initiatives such as Growing Forward and Crop Insurance which involve government funding.

In addition to Q7, a number of survey questions touched indirectly on the role of government in PA. For example, the results of Q5 show that, among several potential sources of information on PA technologies, western Canada producers rely the least on government specialists for their information on improved products, processes or practices. When it comes to sharing PA data with those outside of their farm, the results of Q34 show that only 15 per cent of respondents feel comfortable sharing their data with government and would be much more likely to share it with relatives, other farmers or neighbours, university researchers or crop input suppliers. When asked about who should lead in the development of PA tools to meet farmer's needs (Q6), once again government ranked low in terms of importance - falling behind farmers, equipment manufacturers, agronomic service companies, software development companies, and grower associations.

Q9 How much did your farm spend on precision agriculture in 2016? ($ without decimals or non-numeric characters)

Answered: 155 Skipped: 106

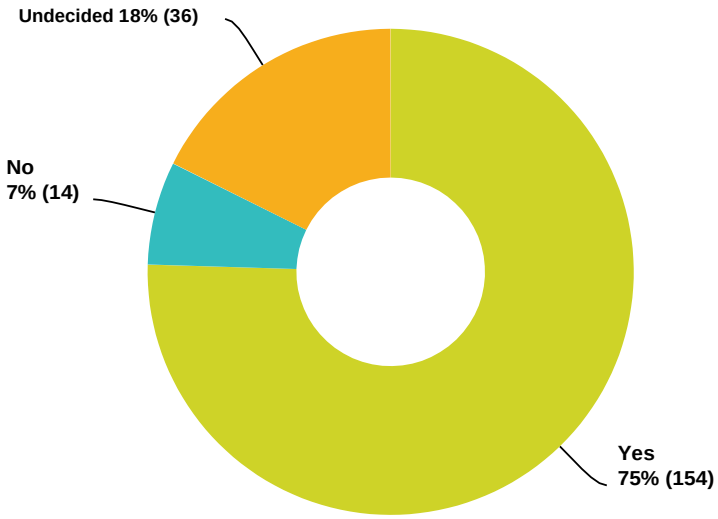
Answer Choices	Average Number	Total Number	Responses
Total Dollars	$ 23,974	$ 3,404,259	142
$ Per Acre	$ 6.74		126
Total Respondents: 155			

Average farm spending on PA based on survey responses was $6.74 per Acre
Analysis by province: Alberta: $8.24/Acre, Saskatchewan: $5.26/Acre, Manitoba: $6.12/Acre

Total Dollars and Dollars per Acre represent the respondents' perceptions of their farm spend. Responses could represent whole farm or part farm PA services and may or may not include equipment hardware, depreciation, internet/cellular fees, etc.

Q10 Do you intend to use more precision agriculture tools in the future?

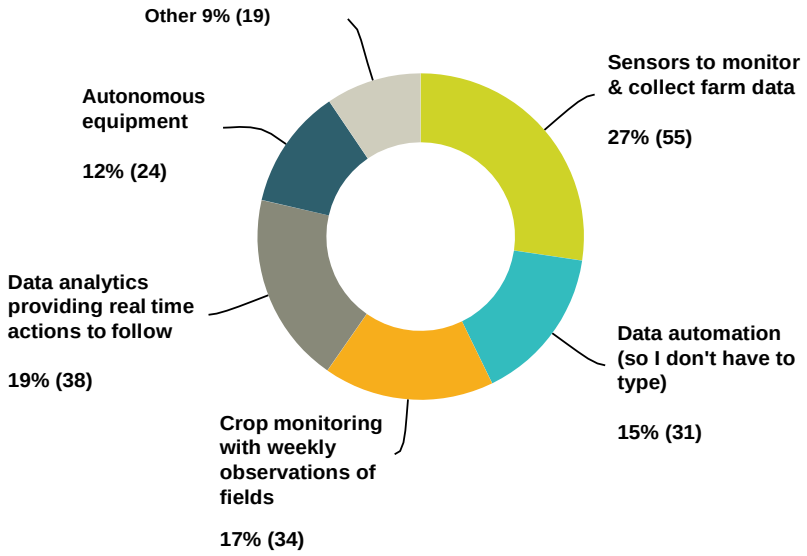
Answered: 204 Skipped: 57



Responses provide a benchmark of precision agriculture spending in 2016 and the positive intent to use more PA tools in the future.

Q11 Over the next 2 years, what area of technology would benefit your business the most?

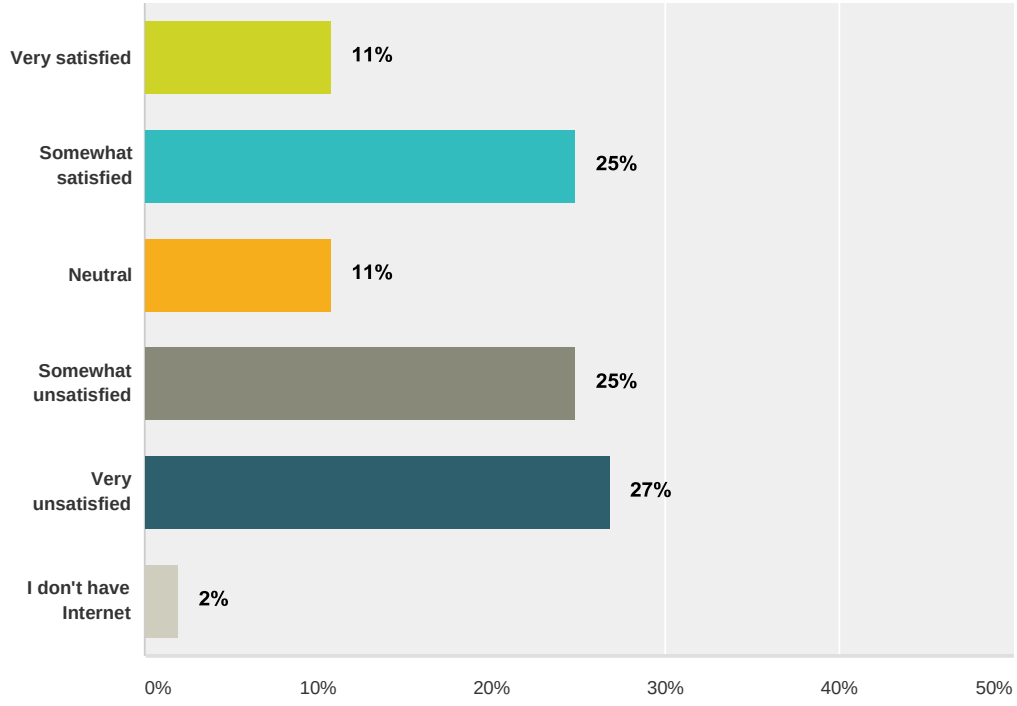
Answered: 201 Skipped: 60



Responses to Q11 indicate a desire for new technology that is not currently available commercially and not widely used.

Q29 How satisfied are you with the internet service & internet speed on your farm?

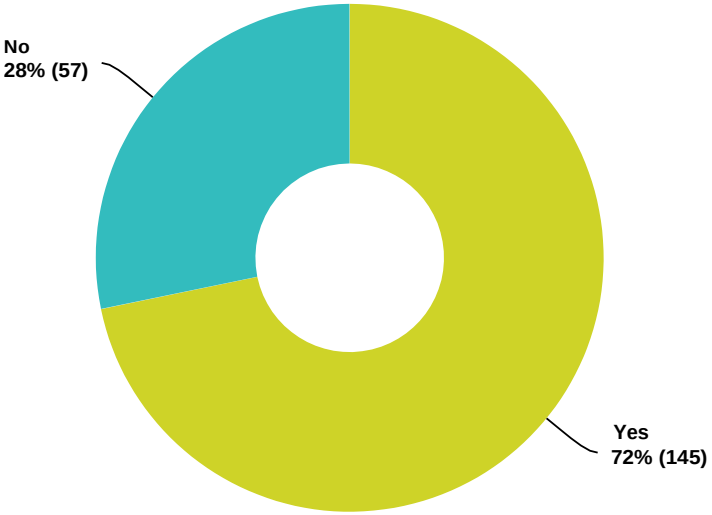
Answered: 205 Skipped: 56



52% of survey responses were Somewhat unsatisfied or Very unsatisfied with their internet service and internet speed.

Q30 Do you use farm management Apps or Websites on your Smartphone or Tablet?

Answered: 202 Skipped: 59

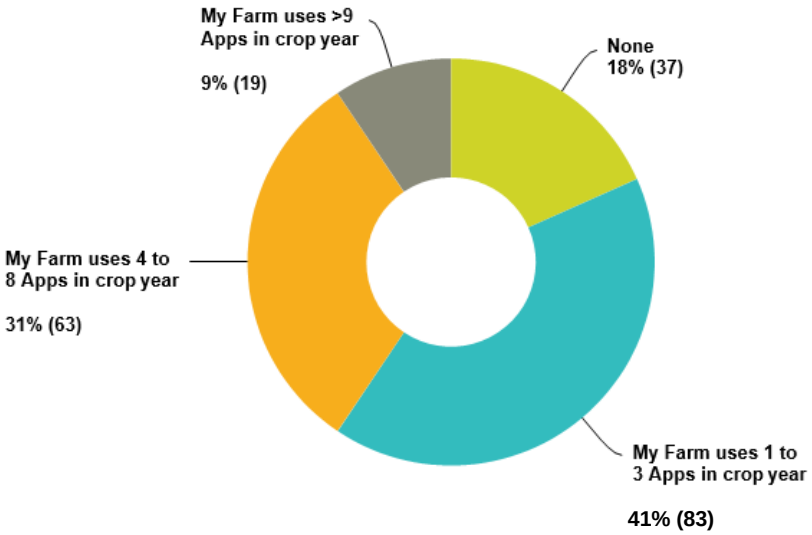


Top 5 responses for farm management Apps or Websites:

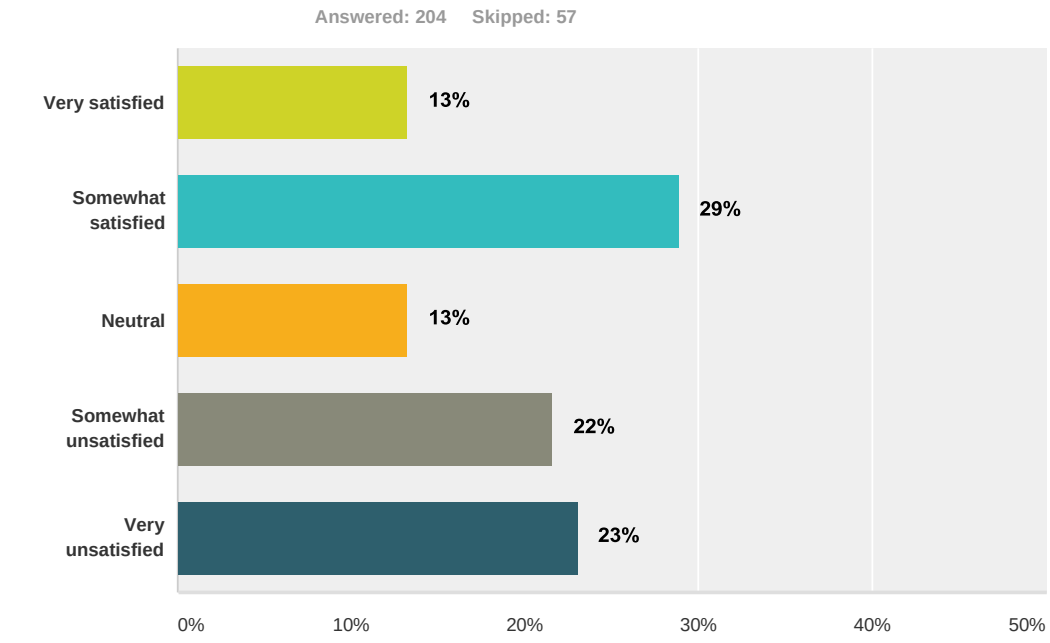
1. Trimble
2. Farm Credit Canada
3. Farmers Edge
4. John Deere
5. Decisive Ag

Q31 How many Smartphone/ Tablet Apps or Programs do you use in your farm operations and management?

Answered: 202 Skipped: 59

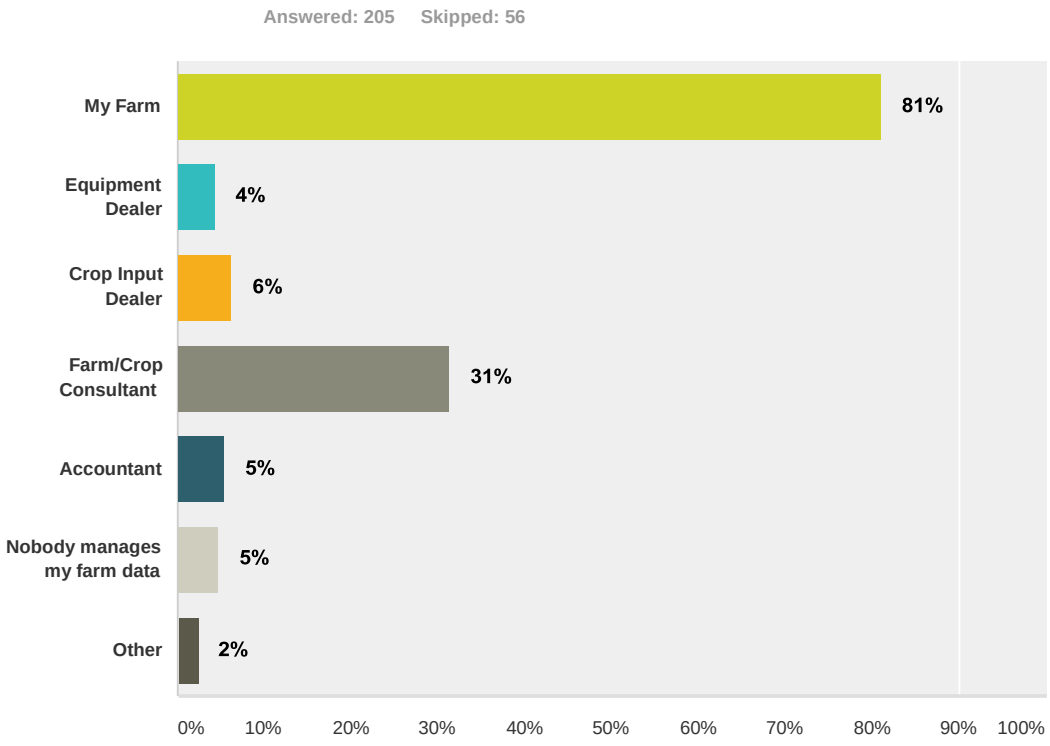


Q32 How satisfied are you with the cellular coverage & cellular data coverage on your farm?



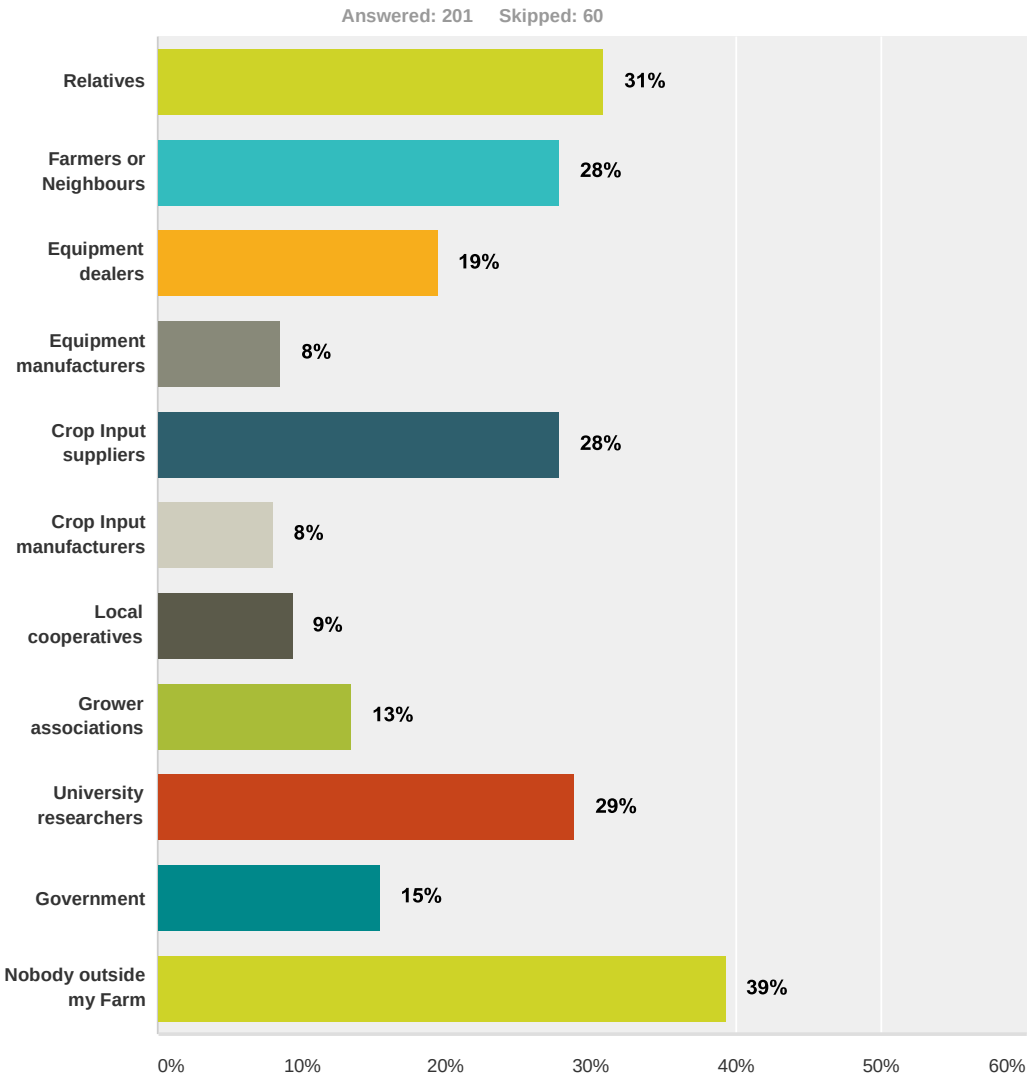
45% of survey responses were Somewhat unsatisfied or Very unsatisfied with their cellular coverage and cellular data.

Q33 Who manages your farm data? Farm data can include Field records, Field borders, Laboratory results, As-applied data, Prescription Maps, Yield data and Accounting information. (Check all that apply)



Larger acreage farms indicated a higher use of Farm/Crop Consultants and Equipment Dealers to manage their farm data.

Q34 Who do you feel comfortable sharing your farm precision ag data with? (Check all that apply)



Top 5 responses of Who you feel comfortable sharing your farm precision ag data with:

1. Nobody outside my farm
2. Relatives
3. University researchers
4. Crop input suppliers
5. Farmers or neighbours

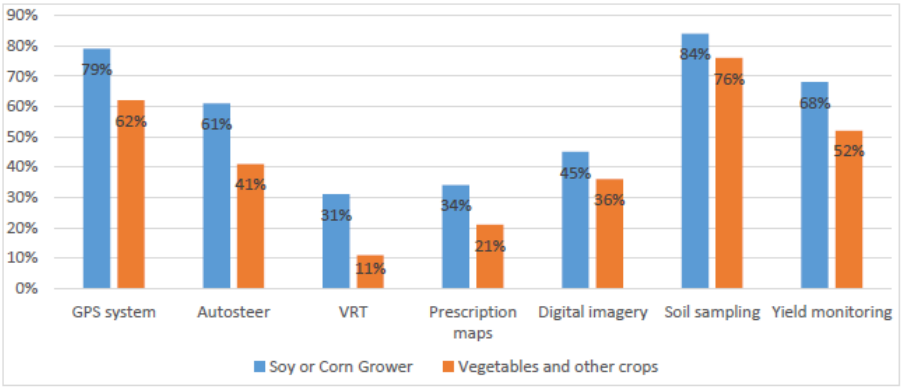


Figure 15. Crops Grown and Use of PA
Note: n=63

4 Barriers to Adoption in western Canada.

Survey question 4 asked respondents what they consider as the barriers or limitations affecting farm adoption of precision agriculture technology. Respondents were provided with 16 choices for ranking the items which the respondent considered as barriers to them.

The Top five barriers to PA adoption in the survey responses were:

- Price
- Internet speeds and/or cellular coverage
- Lack of knowledgeable people
- Continuously evolving technology
- Older farm equipment

5 Conclusions

PA is comprised of a wide segment of tools and technologies and it appears that the adoption of PA tools and technologies in western Canada is strong based on the survey responses.

All farms are selective in their use of crop inputs, striving to apply them accurately, making management decisions and measuring results. GPS guidance of farm equipment appears to now be universally adopted with 98% of respondents using GPS for guidance and the rapid adoption of more accurate forms like Auto-Steer and Automatic Sectional Control. Many of the sensors to monitor weather and crops are now in place and the tools to measure the soils, water, vegetation and yields are fully understood. Each year, more of the farm equipment fleet is capable of capturing data and the systems become more user friendly and reliable for technicians and precision agronomists to process the data into actionable outcomes for the farmer.

The ongoing development of the PA infrastructure is also required to enable the efficient transport of the inputs and outputs of agricultural production. These inputs and outputs are data, information and knowledge. In rural areas, the development of railway, highway and road infrastructure has enabled the efficient transport of the inputs and outputs of agricultural production in western Canada and the speed of the movement to and from the farm is a critical part of price competitiveness.

An emerging issue in PA is the lack of developers focused on agriculture to create the software, platforms and applications that reduce the data complexity to provide actionable information to meet stakeholder needs.

6 References:

- Stats Canada 2011 http://www.statcan.gc.ca/eng/ca2011/index
- CRTC http://www.crtc.gc.ca/eng/internet/internetcanada.htm
- USDA released a report on Farm Profits and Adoption of Precision Agriculture www.ers.usda.gov
- CropLife magazine and Purdue University conducted the 17th Survey of Precision Agriculture Service Dealerships. 2015 Purdue survey results: http://agribusiness.purdue.edu/precision-ag-survey

7 Appendix: Survey Response Detail

Q1 Do you believe precision agriculture is useful?

Answer Choices	Responses	
Strongly Agree	**65%**	167
Agree	**28%**	72
Neutral	**6%**	16
Disagree	**1%**	3
Strongly Disagree	**0%**	0
Total		**258**

Q2 What are the primary benefit(s) of precision agriculture? (Check all that apply)

Answer Choices	Responses	
Increased crop yields	**67%**	174
Reduced crop inputs	**69%**	180
Improve farm efficiency	**80%**	206
Improved accuracy of crop inputs	**79%**	204
Environment stewardship	**73%**	190
I don't know	**2%**	5
Other (please specify)	**10%**	25
Total Respondents: 259		

Q3 How important are the following reasons for using precision agriculture technology on the farm? (Rank only the reasons that you consider)

	Not Very Important	Somewhat Important	Very Important	Total
Reduce Crop Input Costs	**7.91%** 20	**35.57%** 90	**56.52%** 143	253
Increase Yields	**6.80%** 17	**26.00%** 65	**67.20%** 168	250
Improved Time Mgmt	**9.24%** 23	**35.74%** 89	**55.02%** 137	249
Improved Equipment & Labour Efficiency	**7.06%** 18	**32.94%** 84	**60.00%** 153	255
Ability to Farm More Acres	**25.51%** 62	**46.09%** 112	**28.40%** 69	243
Better Crop Input Mgmt	**2.73%** 7	**22.27%** 57	**75.00%** 192	256
Stewardship & Sustainability	**7.97%** 20	**33.47%** 84	**58.57%** 147	251
Environmental Benefits	**9.56%** 24	**39.04%** 98	**51.39%** 129	251

Q4 What in your view, are the Barriers or Limitations affecting farm adoption of precision agriculture technology? (Rank only the items you consider as barriers)

	Small Barrier	Barrier	Significant Barrier	Total	Weighted Average
Older farm equipment is not capable of precision agriculture	**30.65%** 76	**42.34%** 105	**27.02%** 67	248	1.96
Addressing other farm management needs ahead of precision ag	**31.25%** 75	**49.17%** 118	**19.58%** 47	240	1.88
Compatibility with systems currently used on the farm	**30.13%** 72	**48.95%** 117	**20.92%** 50	239	1.91
Determining which technology to adopt	**37.34%** 90	**40.66%** 98	**21.99%** 53	241	1.85
Uncertain Benefits	**39.06%** 91	**37.34%** 87	**23.61%** 55	233	1.85
Price	**23.29%** 58	**36.55%** 91	**40.16%** 100	249	2.17
Continuously evolving technology	**27.35%** 64	**47.01%** 110	**25.64%** 60	234	1.98
Too complex	**37.92%** 91	**44.58%** 107	**17.50%** 42	240	1.80
Lack of knowledgeable people	**31.22%** 74	**38.40%** 91	**30.38%** 72	237	1.99
I can't get Actionable information from PA	**41.10%** 90	**45.66%** 100	**13.24%** 29	219	1.72
Precision Ag service providers don't meet my needs	**43.50%** 97	**40.36%** 90	**16.14%** 36	223	1.73
Internet speeds and/or Cellular coverage issues	**28.45%** 68	**26.78%** 64	**44.77%** 107	239	2.16
Farm Data privacy risks and cyber security	**45.41%** 104	**34.93%** 80	**19.65%** 45	229	1.74
Don't trust it	**62.02%** 129	**28.85%** 60	**9.13%** 19	208	1.47
Don't really understand it	**56.40%** 119	**30.81%** 65	**12.80%** 27	211	1.56
It didn't work when I tried it	**57.21%** 115	**29.35%** 59	**13.43%** 27	201	1.56

Q5 How do you find out about new or improved products, processes or practices? Or find out about precision agriculture technologies? (Rank only the sources you utilize)

	Not Useful	Useful	Very Useful	Total	Weighted Average
Other farmers	**9.02%** 22	**62.70%** 153	**28.28%** 69	244	2.19
Demonstration farms and field days	**11.20%** 27	**65.56%** 158	**23.24%** 56	241	2.12
Workshops, seminars, meetings or conferences	**6.40%** 16	**62.00%** 155	**31.60%** 79	250	2.25
Input supply companies (feed/seed dealers, crop input companies)	**38.59%** 93	**50.21%** 121	**11.20%** 27	241	1.73
Equipment suppliers/dealers	**22.67%** 56	**54.66%** 135	**22.67%** 56	247	2.00
Independent consultants	**15.74%** 37	**42.13%** 99	**42.13%** 99	235	2.26
Government specialists	**54.35%** 125	**37.39%** 86	**8.26%** 19	230	1.54
Trade magazines and own investigations	**15.81%** 37	**55.98%** 131	**28.21%** 66	234	2.12
Other	**42.74%** 50	**41.03%** 48	**16.24%** 19	117	1.74

Q6 Who should lead in the development of precision agriculture tools to meet farmers needs? (Rank only the sources you consider should lead the development)

	Less Important	Somewhat Important	Important	Total	Weighted Average
Agronomic companies	**10.92%** 26	**38.66%** 92	**50.42%** 120	238	2.39
Software companies	**14.72%** 34	**44.59%** 103	**40.69%** 94	231	2.26
Crop Input Retailers	**50.00%** 110	**32.73%** 72	**17.27%** 38	220	1.67
Seed & chem companies	**58.29%** 123	**31.75%** 67	**9.95%** 21	211	1.52
Equipment manufactures	**8.57%** 21	**34.69%** 85	**56.73%** 139	245	2.48
Grower Associations	**32.88%** 73	**44.59%** 99	**22.52%** 50	222	1.90
Provincial govt Ag	**39.91%** 89	**37.22%** 83	**22.87%** 51	223	1.83
Agriculture and Agri-Food	**44.50%** 97	**32.11%** 70	**23.39%** 51	218	1.79
Farmers	**7.11%** 17	**33.05%** 79	**59.83%** 143	239	2.53

Q7 What should be the role of government in precision agriculture now and in the future?

Q8 Is your farm currently using precision agriculture tools and/or services?

Answer Choices	Responses	
Yes, on my entire farm	**48%**	98
Yes, but only on a portion of my farm	**37%**	76
No, I tried it but stopped	**5%**	10
No, I haven't tried it yet	**11%**	22
Total		**206**

Q9 How much did your farm spend on precision agriculture in 2016? ($ without decimals or non-numeric characters)

Answered: 155 Skipped: 106

Answer Choices	Average Number	Total Number	Responses
Total Dollars	$ 23,974	$ 3,404,259	142
$ Per Acre	$ 6.74		126
Total Respondents: 155			

Q10 Do you intend to use more precision agriculture tools in the future?

Answer Choices	Responses	
Yes	**75%**	154
No	**7%**	14
Undecided	**18%**	36
Total		**204**

Q11 Over the next 2 years, what area of technology would benefit your business the most?

Answer Choices	Responses	
Sensors to monitor & collect farm data	**27%**	55
Data automation (so I don't have to type)	**15%**	31
Crop monitoring with weekly observations of fields	**17%**	34
Data analytics providing real time actions to follow	**19%**	38
Autonomous equipment	**12%**	24
Other	**9%**	19
Total		**201**

Q12 What are the primary soil nutrient assessment methods you use on your farm? (Check all that apply)

Answer Choices	Responses	
Rarely soil sample	**9%**	19
Assess prior crop response	**43%**	88
Tissue test	**18%**	37
Composite sampling	**35%**	72
Benchmark sampling	**10%**	20
Grid Sampling	**17%**	35
Zone sampling	**43%**	89
Total Respondents: 206		

Q13 What percent of your Farm's crop acreage was soil sampled in 2016? (Slide the dot to the % of farm)

Answer Choices	Average Number	Total Number	Responses
	63	11,910	190
Total Respondents: 190			

Q14 Did someone capture the GPS coordinates of the soil sampling and/or plant tissue sampling locations in the field to enable future sampling from the same location in the field?

Answer Choices	Responses	
Yes	**69%**	138
No	**25%**	50
I don't know	**6%**	11
Total		**199**

Q15 Do you use GPS guidance systems for your farm operation? (Check all that apply)

Answer Choices	Responses	
Yes, GPS guidance with light bar	**15%**	30
Yes, GPS guidance with visual screen	**24%**	50
Yes, Auto-Steer GPS	**79%**	162
Yes, RTK GPS – dealers base station	**8%**	16
Yes, RTK GPS – my base station	**16%**	33
No GPS guidance on my farm	**2%**	5
Total Respondents: 205		

Q16 For which of the following farm operations do you use GPS guidance? (Check all that apply)

Answer Choices	Responses	
Tillage	**64%**	131
Fertilize	**85%**	173
Seed	**96%**	196
Spray	**94%**	192
Swath	**68%**	139
Combine	**69%**	140
Heavy Harrow	**67%**	136
Other	**15%**	30
Total Respondents: 204		

Q17 Did you use Automatic Section Control (ASC) to automatically turn On/Off the equipment booms or nozzle sections and/or planter units in 2016 for these activities?

Answer Choices	Responses	
Yes, for Seeding	**26%**	52
Yes, for Fertilizer	**36%**	72
Yes, for Spraying	**70%**	142
No, I don't have Section Control	**27%**	55
Total Respondents: 202		

Q18 Did you use Prescription Maps and/or Variable-Rate Technology (VRT) to apply variable rates or unique rates to your fields in 2016 for any of the following?

Answer Choices	Responses	
No	**49%**	99
Yes, for Fertilizer	**48%**	98
Yes, for Seeding	**24%**	48
Yes, for Spraying	**11%**	22
Yes, for Irrigation	**5%**	10
Other (please specify)	**3%**	6
Total Respondents: 203		

Q19 Do you have Digital Field Borders or electronic Field Boundaries of your farm fields?

Answer Choices	Responses	
Yes, in Software / App / Website access	**37%**	76
Yes, in Equipment displays/controllers	**59%**	120
No	**27%**	56
Total Respondents: 204		

Q20 In 2016, did you look at Imagery or Maps of your farm fields? (Check all that apply)

Answer Choices	Responses	
Yes, historic aerial photos	**35%**	72
Yes, Google Earth	**59%**	120
Yes, NIR or NDVI	**30%**	61
Yes, Soil EC Maps	**19%**	38
Yes, Topo or Drainage	**32%**	65
Yes, Combine Yield Maps	**50%**	102
No	**17%**	35
Total Respondents: 205		

Q21 In 2016, did you look at In-Season Crop Imagery or Remote Sensing of your crops and fields? (Check all that apply)

Answer Choices	Responses	
Yes, captured by Satellite	**28%**	56
Yes, captured by Airplane	**2%**	5
Yes, captured by UAV/Drone	**19%**	39
Yes, captured by Equipment device	**6%**	12
Yes, captured by hand-held device	**4%**	9
No	**59%**	119
Total Respondents: 203		

Q22 In 2016, the combine(s) that harvested your fields... (Check all that apply)

Answer Choices	Responses	
Basic Yield Monitor	**37%**	75
NO Yield Monitor	**16%**	32
Grain cart load cells	**38%**	77
Yield Monitor with GPS	**60%**	121
Yield Data Logged & Stored	**50%**	102
Yield Maps Created from Data	**48%**	96
Total Respondents: 202		

Q23 How did you transfer your yield data or equipment data from the farm equipment to a computer?

Answer Choices	Responses	
Data not transferred yet, still in Equipment	**20%**	40
Manual transfer using USB stick/CF memory card	**44%**	90
Wireless transfer with cellular modem	**11%**	23
Wireless transfer with WI-FI connection	**2%**	5
I don't have Equipment data	**23%**	46
Total		**204**

Q24 Does your farm have Temperature and/or Moisture sensors to monitor the stored grain in bins?

Answer Choices	Responses	
Yes, on 100% of my stored grain	**13%**	27
Yes, on 75% of my stored grain	**22%**	44
Yes, on 50% of my stored grain	**17%**	34
Yes, on 25% of my stored grain	**17%**	34
No	**32%**	65
Total		**204**

Q25 What is your primary method to record weather information for the farm?

Answer Choices	Responses	
Traditional rain gauge & thermometer	**32%**	66
Electronic weather station	**28%**	58
Free weather info government networks	**21%**	43
Free weather info private networks	**8%**	17
Paid Weather info service provider	**10%**	20
Total		**204**

Q26 Which of these tools do you use for farm business management? (Check all that apply)

Answer Choices	Responses	
Desktop computer	**59%**	120
Laptop computer	**73%**	148
Tablet	**62%**	127
Smartphone	**89%**	182
None	**2%**	4

Total Respondents: 204	

Q27 Do you use farm management software on your computer?

Answer Choices	Responses	
Yes	**70%**	142
No	**30%**	62
Total		**204**

Q28 How do you connect to the Internet for your farm business?

Answer Choices	Responses	
Dial-up Connection	**0%**	1
DSL (digital subscriber line)	**8%**	17
Cable Modem	**8%**	17
Fixed Wireless	**46%**	95
Mobile Wireless	**44%**	91
Satellite Service	**19%**	39
Fiber Optic	**5%**	11
Free WiFi (coffee shop)	**1%**	3
I don't know	**1%**	2
I don't Internet	**1%**	3

Total Respondents: 205	

Q29 How satisfied are you with the internet service & internet speed on your farm?

Answer Choices	Responses	
Very satisfied	**11%**	22
Somewhat satisfied	**25%**	51
Neutral	**11%**	22
Somewhat unsatisfied	**25%**	51
Very unsatisfied	**27%**	55
I don't have Internet	**2%**	4
Total		**205**

Q30 Do you use farm management Apps or Websites on your Smartphone or Tablet?

Answer Choices	Responses	
Yes	**72%**	145
No	**28%**	57
Total		**202**

Q31 How many Smartphone/ Tablet Apps or Programs do you use in your farm operations and management?

Answer Choices	Responses	
None	**18%**	37
My Farm uses 1 to 3 Apps in crop year	**41%**	83
My Farm uses 4 to 8 Apps in crop year	**31%**	63
My Farm uses >9 Apps in crop year	**9%**	19
Total		**202**

Q32 How satisfied are you with the cellular coverage & cellular data coverage on your farm?

Answer Choices	Responses	
Very satisfied	**13%**	27
Somewhat satisfied	**29%**	59
Neutral	**13%**	27
Somewhat unsatisfied	**22%**	44
Very unsatisfied	**23%**	47
Total		**204**

Q33 Who manages your farm data? Farm data can include Field records, Field borders, Laboratory results, As-applied data, Prescription Maps, Yield data and Accounting information. (Check all that apply)

Answer Choices	Responses	
My Farm	**81%**	166
Equipment Dealer	**4%**	9
Crop Input Dealer	**6%**	13
Farm/Crop Consultant	**31%**	64
Accountant	**5%**	11
Nobody manages my farm data	**5%**	10
Other	**2%**	5
Total Respondents: 205		

Q34 Who do you feel comfortable sharing your farm precision ag data with? (Check all that apply)

Answer Choices	Responses	
Relatives	31%	62
Farmers or Neighbours	28%	56
Equipment dealers	19%	39
Equipment manufacturers	8%	17
Crop Input suppliers	28%	56
Crop Input manufacturers	8%	16
Local cooperatives	9%	19
Grower associations	13%	27
University researchers	29%	58
Government	15%	31
Nobody outside my Farm	39%	79
Total Respondents: 201		

Q35 Where is your farm located?

Answer Choices	Responses	
Alberta - North	7%	13
Alberta - Central	20%	40
Alberta - South	19%	38
Saskatchewan - North	6%	12
Saskatchewan - Central	14%	28
Saskatchewan - South	12%	24
Manitoba - Winnipeg North	9%	17
Manitoba - Winnipeg South	13%	25
Total		**197**

Q36 What does your farm grow?

Answer Choices	Responses	
Wheat	**94%**	185
Canola	**91%**	179
Barley	**61%**	120
Peas	**55%**	108
Lentil	**23%**	46
Soy	**30%**	60
Corn	**17%**	34
Oats	**30%**	59
Forage	**35%**	68
Cattle	**28%**	55
Hogs	**4%**	7
Other	**29%**	58
Total Respondents: 197		

Q37 What farming practices did you use in 2016 on your farm? (Check all that apply)

Answer Choices	Responses	
Tillage	**27%**	54
Reduced Tillage	**42%**	82
Conserve / No-Tillage	**62%**	123
Fallow	**4%**	8
Row Crops	**15%**	29
Irrigation	**18%**	35
Total Respondents: 197		

Q38 Do you farm?

Answer Choices	Responses	
Full Time	**72%**	145
Part Time	**19%**	38
No, but I work with Farmers	**9%**	19
Total		**202**

Q39 How old are you?

Answer Choices	Responses	
< 25	**4%**	8
25 - 34	**22%**	44
35 - 44	**27%**	55
45 - 54	**24%**	48
55 - 64	**16%**	33
> 65	**7%**	15
Total		**203**

Q40 What is the cropland acreage of your farm operation?

Answer Choices	Responses	
< 640 Acre	**8%**	15
641 to 1,000 Acre	**10%**	19
1,001 to 2,200 Acre	**19%**	37
2,201 to 3,800 Acre	**21%**	40
3,801 to 5,800 Acre	**18%**	35
5,801 to 9,999 Acre	**14%**	27
> 10,000 Acre	**11%**	22
Total		**195**

Q41 What is the annual sales revenue of your farm?

Answer Choices	Responses	
$10,000 to $49,999	**2%**	4
$50,000 to $99,999	**2%**	4
$100,000 to $249,999	**8%**	16
$250,000 to $499,999	**10%**	20
$500,000 to $999,999	**17%**	34
$1 M to $2 million	**21%**	40
> $2 million	**22%**	43
Prefer not to answer	**17%**	34
Total		**195**

Q42 What is your farm business structure?

Answer Choices	Responses	
Sole proprietorship	**20%**	40
Partnership	**20%**	39
Joint Venture	**5%**	9
Communal ownership	**3%**	5
Incorporated company	**53%**	103
Total		**196**