PURDUE CENTER FOR COMMERCIAL AGRICULTURE

ANNUAL REPORT 2018

PURDUE UNIVERSITY | Center for Commercial Agriculture

LETTER FROM THE DIRECTOR

This past year was an exciting one for the Center for Commercial Agriculture. The center delivered a wide variety of programming, both in-person and via the web, during 2018 while also supporting a variety of applied research programs within the department of agricultural economics. Please take a few minutes to review the summaries of the center's major programs and initiatives during 2018.

The Purdue-CME Group *Ag Economy Barometer* completed its third year of operation in 2018 and the barometer's reach keeps expanding. As the only national survey focused on agricultural producer sentiment, its proven to be a valuable way to gauge the production agriculture sector's health and mood. Widely quoted in both the agricultural and business press, the monthly surveys create opportunities to query producers on a variety of timely topics ranging from their perspective on agricultural trade to their interest in investing in new technology. In addition to the monthly reports provided via the barometer's web site, barometer results were also featured in sessions at USDA's Ag Outlook Conference in Washington, D.C. and at the Commodity Classic in Anaheim, CA, both held in February.

During 2018 the center coordinated the Purdue Farm Management Tour along with Purdue Extension Educators in Johnson and Shelby counties. Each year the Tour features in-depth discussions with successful farming operations to help attendees identify management strategies they can implement on their own farms to improve profitability. This year's tour featured stops at four top-notch southern Indiana crop and livestock operations with attendance of nearly 300 farmers and agribusiness staff members.

Webinars and recorded videos continue to be an important component of the Center's programming. During 2018 the Center produced nine webinars, in addition to providing six recorded videos coordinated with the release of the Ag Economy Barometer. Webinar topics ranged from commodity outlook to a focus on crop insurance decisions. The webinars and recorded videos are available via the Center's web site or on the Center's YouTube channel.

The pilot program for the Purdue Farm Business Internship program entered its second year in 2018. The program matches Purdue student interns with progressive commercial operations to provide students with valuable work experience and an opportunity to learn more about farm business operations. Plans to enhance the program in 2019 are underway.

Finally, the Center launched a new tool this past year, the Crop Basis Tool. The Tool provides historical basis data to help Eastern Corn Belt producers forecast corn and soybean basis for their region. More details regarding the Tool are available in this year's report.

Thank you for interest in and support of the Purdue Center for Commercial Agriculture. As always, if you have suggestions for future programs or research, or you just want to chat, we'd love to hear from you.

Sincerely,

James Mintert
Director

CENTER ACTIVITIES

WEBINARS

Webinars are a key information delivery technique for the center. Webinars make it possible to connect with a broad audience on a variety of timely topics. From 2014 through 2018, the center delivered 69 webinars and recorded videos on farm and financial management, agricultural outlook and strategy topics, as well as on the Purdue/CME Group Ag Economy Barometer. Archived webinars are available on the center's YouTube channel for participants unable to watch live.

2019 AG OUTLOOK

December 19, 2018
Purdue ag. economists Chris Hurt, Michael Langemeier and Jim Mintert discussed updated corn and soybean supply/demand information, 2019 corn and soybean planting decisions, and the implications for farmers of the recently passed 2018 Farm Bill.
YouTube views: 224
Registrations: 671

FALL CROP OUTLOOK

September 13, 2018
Updated corn and soybean outlook following the release of USDA's September Crop Production and WASDE reports. Purdue ag. economists Chris Hurt, Michael Langemeier and Jim Mintert discussed the outlook, marketing strategies, and storage opportunities, in addition to an early look at estimated 2019 corn and soybean breakevens.
YouTube views: 650
Registrations: 490

MANAGING YOUR FARM IN CHALLENGING TIMES

August 22, 2018
Purdue ag. economists Chris Hurt, Craig Dobbins, Michael Langemeier and Jim Mintert discussed marketing strategies for 2018 corn and soybean crops, provided updated farmland value and cash rent information from the June 2018 Purdue Land Values Survey, and made projections for 2019 corn and soybean returns.
YouTube views: 237
Registrations: 186

2018 PURDUE CROP OUTLOOK

July 3, 2018
Corn & soybean outlook focused on updated trade tariff information, along with information from USDA's June 30th Acreage & Grain Stocks reports. Purdue ag. economists Chris Hurt, Jim Mintert and Michael Langemeier discussed all this and more.
YouTube views: 337
Registrations: 241

2018 CROP OUTLOOK

March 30, 2018
Purdue ag. economists Chris Hurt, Michael Langemeier and Jim Mintert reviewed the crop outlook following the March 30th release of USDA's Planting Intentions & Grain Stocks reports.
YouTube views: 164
Registrations: 88

MAKING YOUR 2018 CROP INSURANCE DECISIONS

March 1, 2018
Purdue ag. economists Michael Langemeier and Jim Mintert discussed 2018 corn and soybean crop insurance choices and provided insight into decision making for corn and soybean farmers.
YouTube views: 380
Registrations: 25

AG BUSINESS CLIMATE OUTLOOK FOR 2018

January 5, 2018
Purdue ag. economists Chris Hurt, Michael Langemeier and Jim Mintert discussed the ag. economy outlook and management strategies for 2018.
YouTube views: 306
Registrations: 377

PURDUE/CME GROUP AG ECONOMY BAROMETER MONTHLY RECORDED VIDEOS

August 7, September 4, October 2, November 6, December 4, and January 8
The second half of 2018, the Center for Commercial Agriculture, in partnership with the CME Group, switched to monthly recorded videos featuring insights from the *Ag Economy Barometer*. Each video included discussions about producer sentiment toward the agricultural economy and drivers of sentiment.
YouTube views: 235, 268, 149, 169, 126, 80

PURDUE/CME GROUP AG ECONOMY

BAROMETER QUARTERLY WEBINARS

February 8 and May 3

In the first half 2018, the Center for Commercial Agriculture, in partnership with the CME Group, continued quarterly webinars featuring insights from the *Ag Economy Barometer*. Each webinar included discussions about producer sentiment toward the agricultural economy and drivers of sentiment.

YouTube views: 134, 120

Registrations: 405

PROGRAMMING AND PUBLICATIONS

ASSOCIATION OF AGRICULTURAL PRODUCTION EXECUTIVES

The membership of the Association of Agricultural Production Executives (AAPEX), an organization that is now more than two decades old, is composed of many of the nation's leading agricultural producers. AAPEX is devoted to ongoing executive education for its members. The Center for Commercial Agriculture delivered the 2018 AAPEX Annual Meeting in New Orleans, Louisiana, January 31 - February 3rd. Nearly 150 AAPEX members attended the 2018 meeting representing 31 states and three countries. There were several new additions to the program in 2018 but the highlight was the pre-meeting field tour that included a visit to the ZEN-NOH grain facility in Convent, LA and a visit to the Monsanto glyphosate plant in Luling, LA. Working with this group of producers provides the Purdue faculty and staff with insights into the research and educational needs of America's leading farmers and provides opportunities for further collaboration.

CENTER ACTIVITIES

PURDUE TOP FARMER CONFERENCE

The Purdue Top Farmer Conference is one of the most successful and longest running management programs geared specifically for farmers. The 51st conference took place on January 11, with optional half-day pre-conference workshops on January 10. This year's conference featured a session about weather impacts on crop production given by University of Illinois' Eric Snodgrass, who specializes in atmospheric science. Other topics included taking advantage of technology, using technology beyond precision applications, making strategic farm decisions on new trade policies, and surviving rising interest rates with a challenging farm financial situation. Speakers included agricultural economics experts from the Center for Commercial Agriculture, Purdue Extension, Purdue's Department of Agricultural Economics, and Purdue's Department of Agronomy. In addition to educational sessions, the more than 100 conference participants had multiple opportunities to network with their peers from across the country.

PURDUE FARM MANAGEMENT TOUR

The 86th Annual Purdue Farm Management Tour was held June 21-22, 2018, in Johnson and Shelby counties. One of the tour's primary goals is to encourage Hoosier farmers to develop high-level management knowledge and skills. Gill Family Farm, Norton Farms, Douglas Farms, and Fischer Food Grade Inc. hosted and provided tour attendees with insights about innovative ways to approach the challenges facing today's farming operations. These farms have demonstrated highly successful business management practices. In addition to touring four progressive and diverse operations, the 2018 tour also included an agricultural outlook update by Purdue's Chris Hurt.

INTRODUCTION TO THE BUSINESS OF COMMERCIAL AGRICULTURE

This two-credit undergraduate class provides an overview of U.S. commercial agriculture from an insider's perspective. Each class period features a presentation by a farmer or agribusiness executive focused on their firm's position within the industry. Students enrolled in the course gain a better appreciation of the diversity among U.S. farms and agribusinesses in addition to gaining insight into business strategy from professionals in the field. Students also learn more about the wide range of career opportunities available to College of Agriculture graduates and how they can position themselves for future success. In addition to guest speakers, this course includes field trips to an area farm and agribusiness. Although class presentations by farmers and agribusiness executives cover a wide range of topics, there are several common themes covered each year, including an emphasis on the importance of understanding the markets in which the business operates, information gathering, efficiency and technical innovation in competitive advantage, and business relationships. The course also emphasizes the importance of financial management and business culture.

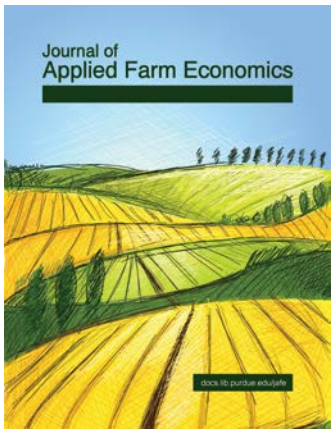
CATCH FIRE AT I2 – IGNITE AND INSPIRE!

The Center for Commercial Agriculture held the second annual Women in Agriculture symposium in September of 2018. The symposium was attended by 35 ambitious women from Purdue University, Michigan State University, Huntington University, and the University of Illinois all pursuing degrees and careers in agriculture. The two-day symposium covered a range of topics designed to assist and inspire the future women of agriculture. Professionals from Ceres Solutions, Nutrien, and AgReliant Genetics provided tips and tricks for rocking resumes, career fairs, and job interviews. Women also learned about the importance of mentors and how to utilize mentors within their careers from Farm Credit

Mid-America, Compeer Financial, and Reynolds Farm Equipment personnel. The symposium also included sessions on key issues and opportunities in ag, working with others and across cultures, and paying it forward. The first day was concluded with humbling words from Vern Hawkins, Syngenta, on character, humility, and success and the final day was concluded with motivating words of wisdom from Purdue University College of Agriculture Dean, Karen Plaut. Our future leaders left the symposium passionate and inspired for their futures and the future of agriculture. Planning is underway for the 2019 Women in Agriculture symposium. We look forward to increasing the number of attendees along with welcoming attendees from additional universities.

FARM BUSINESS INTERNSHIP

The Center for Commercial Agriculture's Farm Business Internship moved into its second year in the summer of 2018. Three Purdue Agriculture students were placed on Indiana farms during summer break where they gained experience working with progressive commercial farming operations. Interns gained valuable experience in farm business operations combined with on-farm work experience. The program will move into its third year in the summer of 2019, looking to increase student and farm participation.



JOURNAL OF APPLIED FARM ECONOMICS

The Journal of Applied Farm Economics (JAFE) entered its second year of publication in 2018. JAFE is an open access online journal published by the Scholarly Publishing Service unit of the Purdue Libraries and the Purdue University Press with financial support from the Center for Commercial Agriculture. During 2018 two editions of JAFE were published comprised of six articles. Topics ranged from the impact of best beef cattle management practices in a drought to annual net returns to cover crops. Beth Yeager, associate professor of agricultural economics at Kansas State University continues to serve as editor with professors Michael Langemeier, James Mintert and Tim Baker of Purdue University and Levi Russell, assistant professor at the University of Georgia, serving as associate editors.

AG ECONOMY BAROMETER

PURDUE-CME GROUP AG ECONOMY BAROMETER

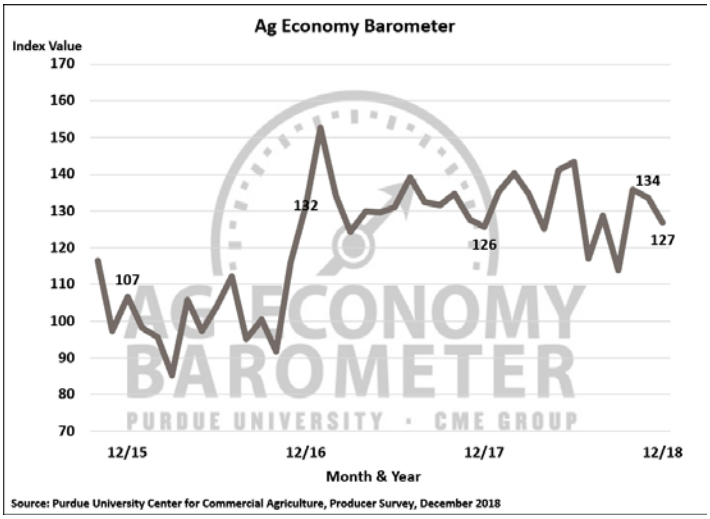
James Mintert & Michael Langemeier

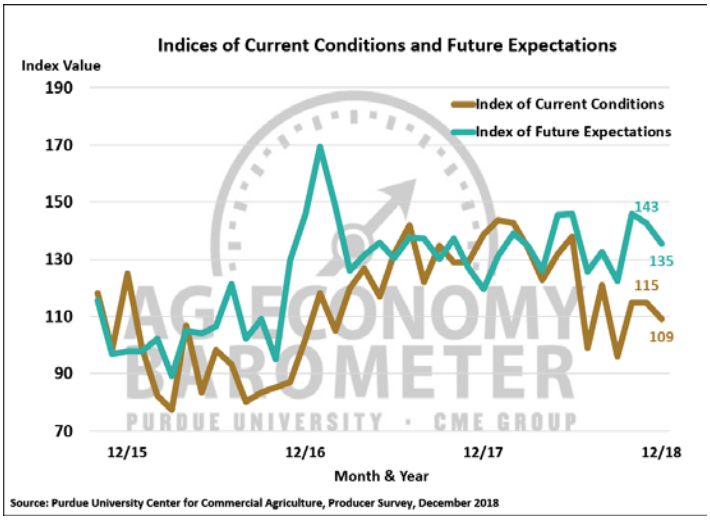
The *Ag Economy Barometer* fluctuated during the course of 2018, but by December 2018 was back near its year ago level of 127. However, the barometer did fluctuate significantly during the course of the year as the impact of trade conflicts with key ag trade partners China, Mexico and Canada and sharp declines in commodity prices dominated the headlines. The barometer reached its low point of the year in September when it fell to 114.

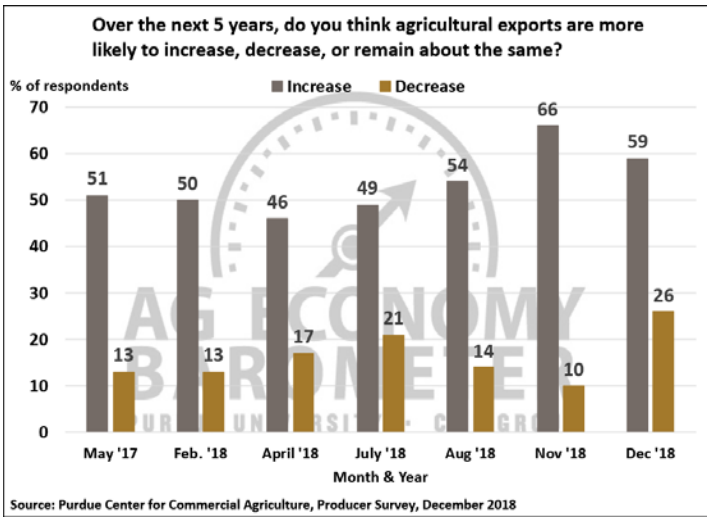
An interesting shift in producer perceptions took place during 2018 regarding both current conditions and future expectations. The December 2018 Index of Current Conditions was substantially below a year earlier, registering a year-to-year decline of 30 points.

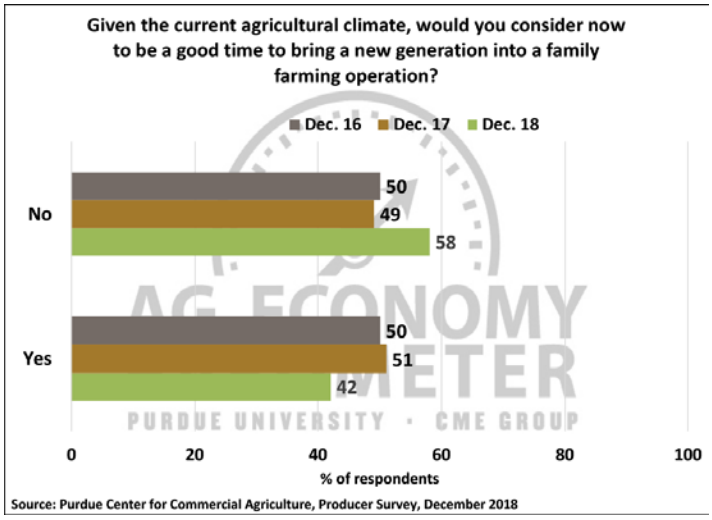
In contrast, the Index of Future Expectations was actually 15 points higher in December 2018 than in December 2017. This divergence in perceptions has been especially notable since spring 2018 as producers continued to exhibit more confidence in future conditions for their farms in the face of weakening perceptions regarding current economic conditions.

To track farmers perceptions about future ag trade, barometer surveys repeatedly asked farmers whether they expect U.S. agricultural exports to increase or decrease in the upcoming five years. Responses to this question became more positive from April through November 2018, but that changed on the December





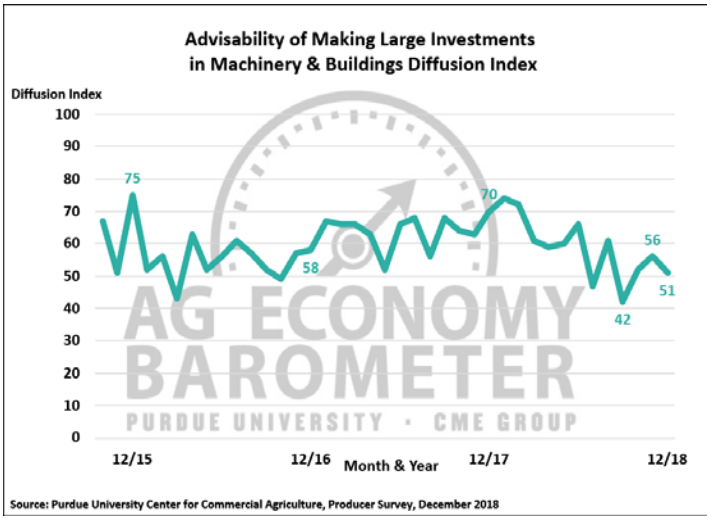


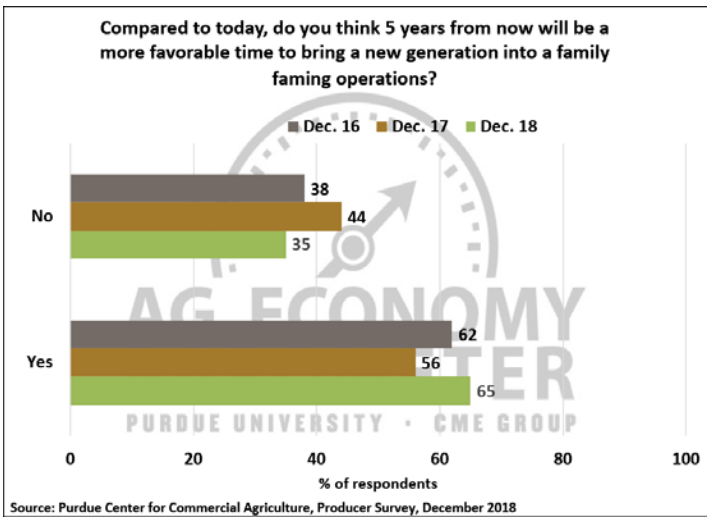


2018 survey as the percentage of producers expecting exports to increase declined from 66 percent in November to 59 percent in December and the percentage expecting exports to decrease increased from 10 percent in November to 26 percent in December.

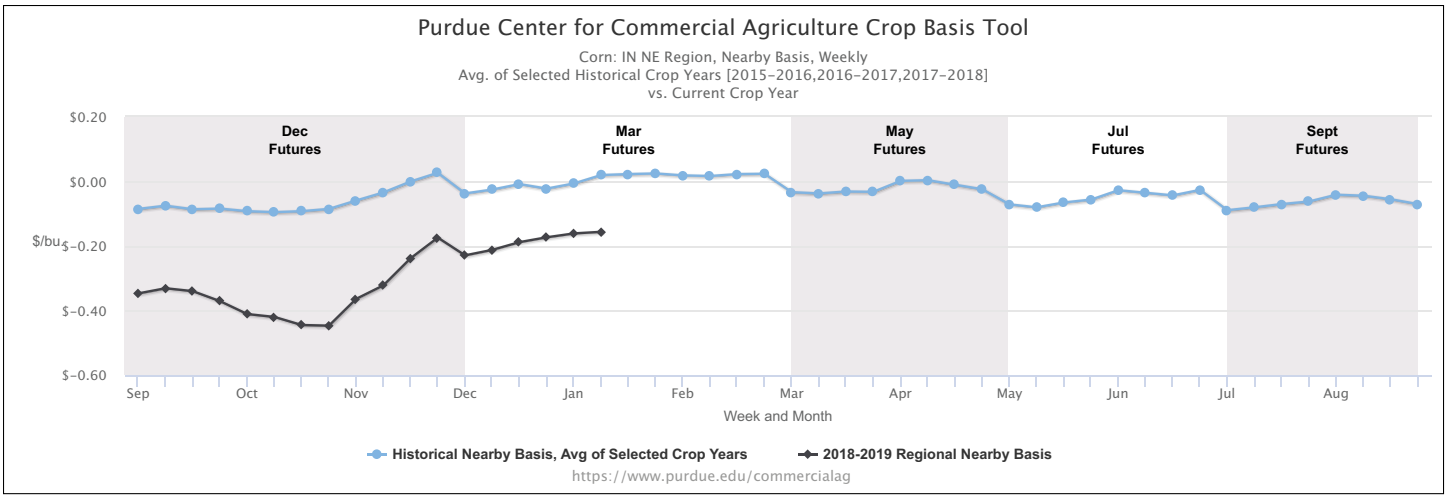
Producers' interest in making large investments in their farm operations was much lower at the end of 2018 than at the beginning of the year. The Large Farm Investment Index fell to a reading of 51 in December 2018, which was 9 points higher than in September, when it reached its lowest reading of the last three years, but well below a year earlier, when it reached a reading of 70. The year-to-year decline in the index suggested that farmers were wary of making substantial farm investments given current financial conditions on their farms.

Another indication of producer unease was their viewpoint on whether or not this is a good time to bring a new generation into a family farming operation. Responses to this question in 2016 and 2017 were essentially split 50-50. But on the December 2018 survey, producers were noticeably more negative with 58 percent of respondents saying now was not a good time, and just 42 percent indicating this is a good time, to join a family farming operation. However, when we asked respondents if they thought that, compared to today, five years from now be a more favorable time to bring a new generation onboard, the change in time frame made a big difference. The percentage of respondents that said yes to this question jumped to 65 percent and the percentage of producers that said no fell to 35 percent. Once again, producers indicated that they are more optimistic about future rather than near-term prospects for U.S. agriculture.





CROP BASIS TOOL



PURDUE CENTER FOR COMMERCIAL AGRICULTURE CROP BASIS TOOL

Nathanael Thompson, James Mintert & Chris Hurt

The Purdue Center for Commercial Agriculture launched a new web-based tool in 2018 that provides access to weekly historical and contemporaneous corn and soybean basis data for local market regions in the Eastern Corn Belt. The tool was developed with financial support from the Center for Commercial Agriculture and USDA's North Central Risk Management Education Center. The tool can be accessed at either the *Purdue Center for Commercial Agriculture* website (purdue.edu/commercialag) or the *Managing Farm Risk* website (purdue.edu/farmrisk).

DATA

Daily cash price data from approximately 2,000 grain elevators and processors in four states (Indiana, Illinois, Michigan, and Ohio) were acquired from DTN. The data bank contains cash and futures price data beginning in 2004 and is updated weekly with new cash and futures price data. Cash price data are averaged within each USDA crop reporting district in each state to generate regional average cash price series. Wednesday afternoon cash and futures settlement prices are then used to compute weekly basis data for each crop and crop reporting district. To facilitate comparisons across crop-marketing years, a crop year is defined as having 48 weeks with four weeks per month. When a month has five Wednesdays, prices from the fourth and fifth Wednesdays are averaged and reported as the fourth week.

HOW THE TOOL WORKS

Once arriving at the site, users select input information for the information they would like to review. Users can select their state (Indiana, Illinois, Michigan, or Ohio), crop, futures contract and USDA crop reporting district by choosing their county. The site will generate a chart of the current crop year's basis vs. any historical average the user chooses. Evaluation of historical basis information indicates that in the Eastern Corn Belt a good starting point for corn basis forecasts is the most recent three-year average basis level for the region and time frame of interest. For soybeans, the most recent two-year average basis level for the region and time frame generally provide the most accurate basis forecasts.

INTERPRETING THE OUTPUT

Once a user has made all the input selections, an updated chart of the data is produced by clicking the site's Submit button. An example chart is provided above. Notice two different lines appear on the chart. The blue line is the historical nearby basis data selected and the black line (which is automatically included on all charts) is the corresponding basis for the current crop year (2018-2019).

APPLICATIONS

The information provided in the crop basis tool can be used to create basis forecasts that are critical to a number of management and marketing decisions. For example, this information can be used for planning purposes to create pre-harvest price expectations. In addition, basis forecasts are a critical component for analyzing a number of marketing opportunities including cash bids, forward contract bids, hedging opportunities, and storage opportunities. During 2019 the Center for Commercial Agriculture will be offering a number of crop marketing workshops focused on helping crop producers improve their crop marketing skills using this new tool.

DOES YOUR FARM NEED TO EXPAND?

Michael Langemeier & Michael Boehlje

There are numerous motivations for farms to expand their businesses. Even in today's environment of tight margins, many farms are exploring expansion options. When exploring these options, it is important to evaluate how farm growth impacts the farm's strategy or strategic direction. This article discusses reasons why farms grow and strategic direction.

Reasons for Farm Growth

There are numerous reasons why a farm may want to grow including the following: reduce costs, improve profit margins, improve asset utilization, bring in new family members, invest retained earnings, and more fully utilize the skills of key managers. The reduction in costs and improvement in profit margins and asset utilization are related to economies of size. As farms become larger, fixed costs per unit of production decline. These fixed cost declines are typically related to machinery and equipment, and labor costs. In addition, as farms expand they are often in a better position to purchase and adopt new technology. These technologies often reduce per-unit machinery and equipment costs and improve labor productivity.

On a related note, Boehlje (2013) suggests that farm growth is a natural phenomenon. The relatively larger operating profit margins per unit of output combined with higher output levels allows larger farms to reinvest more of their earnings into the business. For many small and medium sized farms; salaries, withdrawals, and payouts to the business owners and managers typically account for a relatively high percentage of the farm's annual earnings resulting in fewer funds that can be used to reinvest in the farm business. The larger absolute amount of retained earnings for larger scale farms means that larger scale farms can acquire more resources and increase their output more rapidly than a smaller scale business that may need to use most of its earnings to support withdrawals or payouts to managers.

Besides economies of size, there are many other reasons why farms expand. Many managers are motivated to expand their businesses to provide more opportunities to employ the skill sets of an increasingly capable management team or to bring in another family member or key employee. Growth often allows managers to focus on one or two aspects of the business rather than trying to manage all aspects of the business.

Growth can also allow a farm to capture pecuniary economies of size. These economies of size may relate to input purchases and output sales. Larger farms often can purchase inputs, such as seed, at a relatively lower per-unit cost and sell products at a relatively higher per-unit price. In addition, buyers of products often prefer to do business with fewer firms and so will provide preferred supplier incentives to businesses with larger and growing volumes.

Strategic Direction

Before growing, it is essential for an operation to think about their strategic direction. Is the operation interested in a commodity based strategy or a differentiated product strategy? The chart below depicts situations in which a firm can obtain a competitive advantage. A firm can obtain a competitive advantage by having below average per-unit costs of production and receiving average prices per unit for their products (commodity based or low cost strategy) or having average per-unit costs and receiving an above average per-unit price for their products (differentiated product strategy). Box 3 depicts a situation where a firm has below average per-unit costs of production and receives above average per-unit prices for their products. Though this situation is possible, it is

Relative Cost Per Unit	Relative Price per Unit: Lower	Relative Price per Unit: Average	Relative Price per Unit: Higher
Lower	1 - Indeterminate Position	2 - Competitive Advantage	3 - Competitive Advantage
Average	4 - Competitive Disadvantage	5 - Parity Position	6 - Competitive Advantage
Higher	7 - Competitive Disadvantage	8 - Competitive Disadvantage	9 - Indeterminate Position

not commonly achieved. It is more common for firms to be in box 2 or 6.

The agriculture of the past has been primarily a commodity business, and consequently the key to long-term success in farming has been to be a low-cost producer. As producers increase their efficiency through better management and adoption of technology, cost declines and margins increase. However, over time, the continued adoption of the cost saving technologies by the industry results in increased production and margin pressures. In the long-run, the only way to compete successfully in a farming business dominated by commodity production is to be a low-cost producer.

Despite the fact that many farms still pursue the low cost strategy, the basis and dimensions of competition in agriculture are changing. As agriculture is transformed from a commodity to a differentiated product business, competition becomes multi-dimensional - it is not just being cost competitive that will lead to financial success. Differentiated products typically have a broader spectrum of quality features than commodities, and those quality dimensions or features often improve over time. With most non-food products, consumers' purchase and quality standards improve over time, and thus consumers are expecting food products to exhibit similar continuous quality improvement. It is important to note that product differentiation is not a permanent phenomenon. Differentiating attributes become commoditized over time so the successful farmer must constantly evaluate new opportunities for differentiation and be an early adopter or first mover in these new differentiated products before the premiums or margins are pressured by increased numbers of producers who enter the market. Consequently, in differentiated product markets, producers not only compete with respect to cost; they also compete with respect to quality attributes of their products and with respect to the speed or response time to introduce new products as consumer demand and market conditions change.

Conclusions

Growth enables farm businesses to increase revenue and earnings, take advantage of economies of size, and to more fully utilize the skills of current and future employees. As an operation continues to think about growth, how growth impacts strategic direction needs to be addressed.

KEY DRIVERS INFLUENCING CONSOLIDATION IN PRODUCTION AGRICULTURE

Michael Langemeier & Michael Boehlje

The production agricultural sector has historically been much more fragmented than other stages of the food and agricultural industry, but it has been transitioning for decades from modest size, independent businesses to increasingly larger scale businesses that are more tightly aligned across the value chain. This article examines the key drivers that are likely to influence further consolidation and structural change in the next few years.

Key drivers influencing future consolidation are listed in the table on the next page. This table represents an updated version of a table in Langemeier and Boehlje (2017). Each of the drivers is briefly discussed below. It is important to note that many of the drivers are inter-related.

Capital and Land Market Access

Larger farms have two advantages in terms of access to capital and the land market. First, financial performance tends to be relatively higher for larger farms (Hoppe and MacDonald, 2016; Langemeier and Yeager, 2018). Second, retained earnings are larger due to relatively higher financial performance and lower payout ratios (i.e., lower operator withdrawals as a percentage of profit). Due to their enhanced ability to purchase machinery and equipment, and in many instances hire additional labor, larger farms are often better positioned to rent or buy additional farmland. Larger farms also tend to have multiple operators and multiple generations which creates more of an incentive to expand the operation.

Cost Economies

Larger farms will continue to exploit scale economies due to differences in technology use, relatively lower labor and machinery costs per unit of output, and pecuniary economies associated with higher selling prices and lower purchasing prices. Pecuniary economies will be related to volume of inputs purchased and the enhanced opportunities to participate in specialized production contracts or alliances associated with changes in the value chain. Many large farms are already engaging in at least one specialized crop or livestock enterprise. This makes it easier for them to explore other contract opportunities or strategic alliances.

Farm Profitability and Growth Focus

Economies of scale provide an impetus for farm growth. However, economies of scale is not the sole driver of farm consolidation. In addition to lower per-unit costs, larger farms also have higher output levels and higher profits. The use of these higher profits is as important in understanding the growth of successful farms as economies of scale. Particularly for small and midsize farms, withdrawals to business owners account for a higher percentage of the farm's annual profits compared to larger farms. In other words, larger farms have lower payout ratios and face a lower cash drain on earnings. This creates higher retained earnings, which can be used to reinvest in the business (i.e., faster growth rates). In essence, larger farms have more "natural" growth potential because of their higher levels of retained earnings.

	Small Farms	Midsize Farms	Large Farms
Capital and Labor Market Access	0	0	+
Cost Economies	-	0	++
Farm Profitability and Growth Focus	--	-	+
Government Payments and Limits	0	0	-
Managerial Resources	0	0	+
Off-Farm Employment Opportunities	+	0	0
Risk Mitigation	0	0	+
Technology	0	+	++
Value Chain Alliances	+	+	++

Key:
-- Strong Disadvantage
- Disadvantage
0 Neutral
+ Advantage
++ Strong Advantage

Government Payments and Limits

Government payments pertaining to conservation, crop programs (e.g., ARC-CO program), dairy programs, and crop insurance enhance income and mitigate downside

risk. Depending on the program, the government places limits or restrictions on the amount and the parties that can receive payments. These payment limits typically have a greater impact on larger farms than they do on small and midsize farms. However, there are instances in which a small or midsize farm faces restrictions due to the amount of nonfarm income they earn.

Managerial Resources
As farmers continue to grow, capital needs increase, risk management becomes increasingly important, and technology adoption, particularly technologies that are labor saving, has a greater impact on competitive advantage. Because large farms often have multiple operators and generations, they are more likely to have individuals with the pertinent skills in key areas (e.g., financial management, risk management, technology adoption) and to assign point people to these key areas.

Off-Farm Employment Opportunities
Employment opportunities vary across the country, but in general are available to farms of all sizes. Small and midsize farms tend to garner a large portion of their income from off-farm employment (Hoppe and MacDonald, 2016). These opportunities often make it possible for small and midsize farms to be engaged in production agriculture. However, labor competition between farm and non-farm activities, often make it difficult for these farms to grow their farm business.

Risk Mitigation
Many risk instruments, such as hedging, forward pricing, crop insurance, and contracts, are available to most farms. However, these instruments are more likely to be used by larger farms, which have the ability to assign a point person to assess risk management options. Effective use of risk instruments increases a farm's ability to obtain credit and expand their operation. The increase in the use of contracts to produce specialized products will mitigate risk in the production agricultural sector. However, to the extent that contract use varies among farm size categories, the trend towards more contract use will create important differences in price risk exposure.

Technology
Large farms are well positioned to adopt new technologies. As noted previously, large farms tend to have higher profit margins and retained earnings. This increases their ability to adopt and their speed of adoption of new technologies for which the benefits exceed the costs. Larger farms also have the ability to assign one or more individuals specifically to the adoption of new technology. Robotics and big data are going to require additional managerial expertise. Small and midsize farms, given that they are typically operated by sole proprietors, will find it more difficult to reallocate time towards the adoption of these new technologies.

Value Chain Alliances
Many differentiated products start out requiring small acreages or small animal numbers. However, as the demand for a differentiated product expands, the product tends to become "commoditized". Economies of scale and managerial resources will likely improve the relative position of larger farms when it comes to growing products for reconfigured value chains.

PRECISION AGRICULTURE TECHNOLOGY ADOPTION IN U.S. CROP PRODUCTION

James Mintert, Nathanael Thompson, David Widmar, & Courtney Bir

Introduction

Precision agriculture is based on the premise that through the application of technology farmers can reduce their productions costs, improve their productivity or both by applying the right amount of inputs in the right place at the right times (Robert, Rust and Larson, 1995). Precision agriculture technologies have evolved significantly over the last two decades as both manufacturers and software companies developed new products and improved older products. It was widely assumed that cost reductions and productivity increases expected to accrue from application of these technologies would lead to their widespread adoption by now. Although it is true that adoption rates have increased over time, the literature regarding adoption of precision agriculture technologies still indicates that U.S. farmers' adoption lags that of other successful agricultural technologies such as GMO seed technology (Mintert, 2016). However, even the most recently published adoption rate estimates are several years old, leaving open the possibility that adoption rates have changed markedly in recent years. Moreover, there is evidence that adoption rates vary by farm size as larger farms are more likely to adopt precision agriculture technologies than smaller farms (Schimmelpfennig, 2016). If that is true, industry wide adoption rates likely provide an incomplete picture of precision agriculture technologies usage. This is particularly relevant in the U.S. since larger farms, especially for the major U.S crops of corn, soybeans, wheat, cotton, operate most of the acreage and provide the majority of production.

The purpose of this study is to provide an up-to-date assessment of the adoption of key precision agriculture technologies by the larger scale U.S. crop farms that produce the majority of U.S. corn, soybeans, wheat and cotton. Producers of these crops were selected because these four crops collectively accounted for approximately 70 percent of 2017 U.S. planted crop acreage and thereby provide an opportunity for improved understanding of how widespread usage of key precision agriculture technologies is today on the majority of U.S. crop acreage.

Precision agriculture technology is a broad term encompassing many different technologies, some of which are quite specialized and only applicable in a small range of applications. However, there are several key precision agriculture technologies suitable for use in the four principal crops of corn, soybeans, wheat and cotton dominating U.S. planted acreage that have been widely available for many years. Those technologies are yield monitoring, guidance and autosteer for tractors and harvesters, precision soil sampling and variable rate fertilizer application and variable rate seeding. Additionally some newer precision agriculture technologies that appear to be gaining traction with producers, namely the use of drones or unmanned aerial vehicles (UMAV) and satellite/aerial imagery, were also of interest.

Methods

To learn about producers' adoption of these key precision agriculture technologies, a phone survey of U.S. farmers that produce corn, soybeans, wheat and cotton was conducted from early June to early July 2017. To conduct the survey a list of U.S. commercial crop producers was obtained from Farm Journal Publishing and the surveys were conducted via telephone. Respondents were asked a series of questions regarding their usage of yield monitoring, guidance and autosteer, precision soil sampling, variable rate fertilizer application, variable rate seeding, usage of drones and UMAV's and satellite/aerial imagery. The survey sample was stratified to focus on farm operations that provide the majority of U.S. production of the four crops. As a result, only farms that had total planted crop acreage of 1,000 acres were surveyed.

To ensure that the sample of farms was representative of U.S. agriculture, quotas were imposed when sampling. The first quota focused on operation size. The U.S. Department of Agriculture's (USDA) 2012 Census of Agriculture reported that there were nearly 173,500 farms with more than 1,000 acres in the U.S. (USDA, 2014). Sampling a population of this size with a confidence level of 95 percent and a margin error of 5 percent required a sample size of at least 384 respondents. However, according to USDA, nearly half of the farms that operate 1,000 acres or more operate less than 2,000 acres, which is still not a very large farm in the U.S. today. To ensure that the sample was truly representative of U.S. farms that produce the majority of these four crops, the sample size was doubled and quotas established such that at least 400 responses were obtained from farms operating between 1,000 and 2,000 acres and 400 responses from farms operating 2,000 acres or more. To further ensure that the sample was broadly representative of U.S. crop producers, 25 percent

of the sample was comprised of wheat (20.5%) and cotton (4.5%) farmers with the remainder of the sample comprised of farmers with corn or soybean enterprises. The enterprise quotas were derived from the distribution of corn, soybean, wheat and cotton acres reported by USDA in the 2012 Census of Agriculture (USDA, 2014). Ultimately, the survey yielded 837 usable responses.

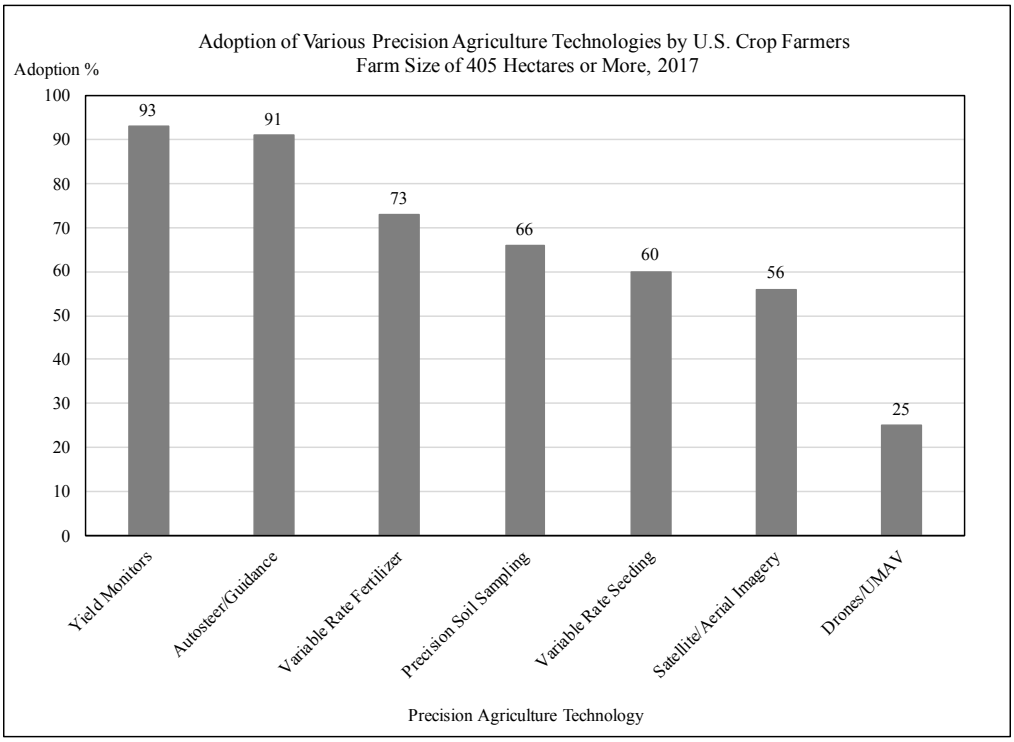
Results

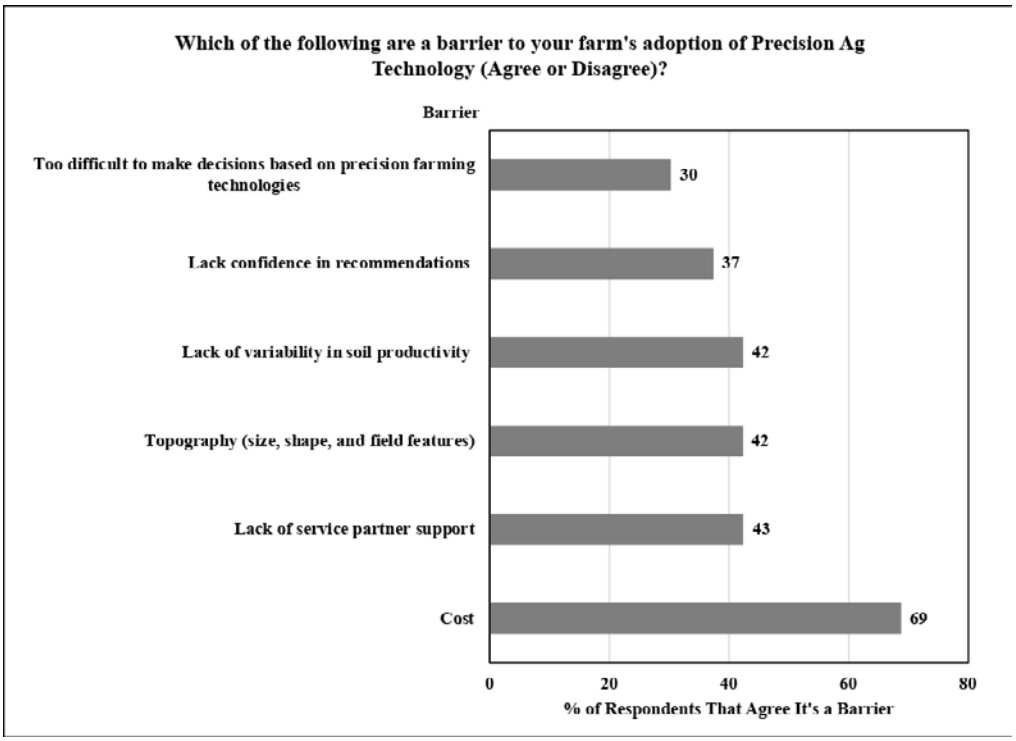
Results from the survey responses were interesting in that they indicated precision agriculture technology was being used on a higher percentage of commercial scale farming operations than reported in previous research. The adjacent chart provides an overview of key results. Nearly all of survey respondents reported using autosteer technology (91%) and yield monitors (93%). The next most popular technology among farmers in the survey was variable rate fertilizer application as 73 percent of respondents reported employing this technology. Sixty-six percent of those surveyed said they use precision soil sampling and 60 percent indicated they use variable rate seeding on their farms. Just over half (56%) of farms in the survey said they make use of satellite or aerial imagery on their farms. Unsurprisingly, one of the newest precision agriculture technologies, use of a drone or UMAV, was the least widely used technology as only 25 percent of respondents reported using this technology on their farm.

To learn more about what might be holding back adoption of precision ag technologies, survey respondents were presented with several potential barriers to adopting precision ag technology and asked whether they agreed or disagreed that the factor was a barrier to their farm's adoption of precision ag technology. The most commonly identified barrier to adoption, by a wide margin, was cost as 69% of respondents agreed it was a barrier. Lack of confidence in recommendations, lack of service partner support, field topography, and lack of variability in soil productivity were all identified by approximately four out of ten (37% to 43%) respondents as barriers to technology adoption. Somewhat fewer producers, just 30% of respondents, felt that difficulty in making decisions based on precision ag technologies was a barrier.

Producers were also queried regarding their plans for the future with respect to investments in precision ag technology. Specifically, we asked producers to look ahead five years and estimate whether their annual investments in precision farming technologies and services would be more than, about the same, or less than in 2016 (the most recent full year when the survey was conducted in summer 2017)? Responses to this question revealed a good degree of optimism about the future of precision ag technology. Just over ninety percent of respondents said they expect to invest the same or even more per year than in 2016. Perhaps more revealing is the fact that nearly half (45%) of respondents said they expect to be investing more in precision technology each year than they invested recently.

As with most technologies, there is a widely held expectation that precision ag technology will improve over time. Broadly speaking, prospective improvements in precision ag technology can come about from 1) better recommendations based upon data collected, which implies better models of crop and livestock production that are reliant on data being collected; or 2) improved data collection. Improved data collection could arise





from engineering improvements that make possible more accurate data collection or, possibly, collection of new data that is not possible with current technology. We asked producers whether they thought most of the improvements would come about from improved data collection or from improved recommendations. Responses from producers were quite interesting. Nearly twice as many producers (64%) expect most of the improvements to come from better recommendations as opposed to improved data collection (32%).

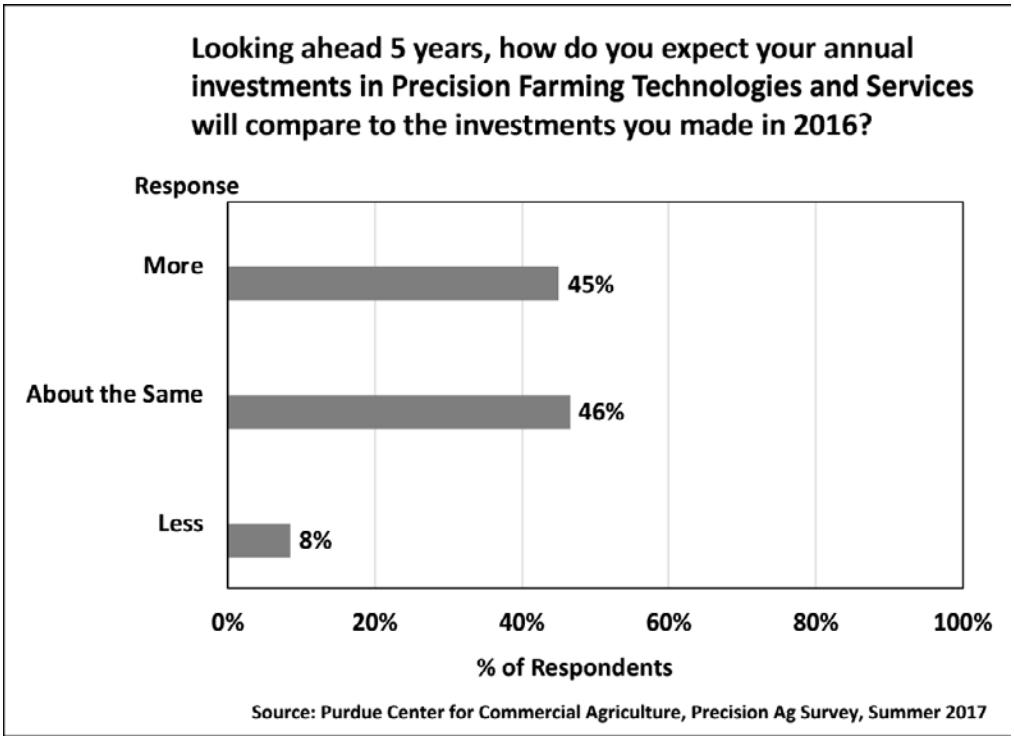
Discussion

Prior to this study, the most recent comprehensive assessment of precision agriculture adoption rates was published by USDA's Economic Research Service (Schimmelpfennig, 2016). Although published in 2016, the data reported by Schimmelpfennig was actually collected long before the publication date. For example, the most recent adoption rate data included for corn and soybean producers were collected in 2010 and 2012, respectively and adoption rate data for cotton and spring wheat producers were even older. In contrast all of the data in this study were collected in mid-2017, meaning data were at least five years newer than in the USDA study. Additionally, the crop producers surveyed in Schimmelpfennig represented a somewhat different enterprise mix than that represented by the producers in this study. Specifically, Schimmelpfennig surveyed corn, soybean, cotton, peanut, rice and spring wheat producers whereas this study reported results obtained from corn, soybean, cotton and wheat producers. With those caveats in mind, it's still interesting to compare some of the results from the USDA study to those presented here.

Schimmelpfennig's results include a breakout for corn farms of their use of GPS soil/yield mapping, guidance systems, and variable rate technology by farm size. Results indicated that, as farm size increased, adoption rates increased. Adoption rates for these technologies on small farms of less than 600 acres were very low, just 12 percent for all of the technologies. Adoption rates for farms ranging in size from 1,000 to 2,200 acres were higher, but still relatively low. For example, use of guidance technology ranged among this group ranged from 33 to 66 percent and use of GPS soil/yield mapping ranged from 39 to 54 percent of farms. The USDA study indicated that it wasn't until the largest size category in the study was examined, farms over 3,800 acres, that reported adoption rates climbed sharply, reaching 80 percent for GPS soil/yield mapping and 84 percent for guidance systems. Still, just 40 percent of these large farms reported that they were using variable rate technology.

There are several reasons that likely account for the higher adoption rates reported in this study, even when adjusted for farm size, compared to those in Schimmelpfennig. First, it appears that over time various precision agriculture technologies are simply being more widely adopted by U.S. producers. The evolving adoption rates could be a function of 1) improvements in the technology over time; 2) reduced cost as the technologies mature; and 3) improved understanding of how to implement the technologies in a crop production system providing higher yields, lower costs per acre or both. The last point is one that is potentially multi-faceted. One possibility is an improvement in crop production models that underlie some of the technologies, especially use of yield mapping

and variable rate technology. But another possibility is the time and effort required on the part of producers to fully realize the benefits these technologies offer. Stated another way, it is possible that it has simply taken time for farm operators to actually learn how to take advantage of precision agriculture technologies. On a related point, the lack of specialization on many smaller farms that might be required to fully capture the benefits of precision agriculture technology could be one reason why precision agriculture technology adoption rates on smaller farms tends to lag behind that of larger farm operations.



Finally, there is an aspect of precision ag technology adoption that our survey was not able to address. Over time, some precision technologies have become standard on new equipment and, as a result, producers might not make an explicit decision to invest in the technology, yet it is still viewed as adopted by the farm since the farm operator has access to it. Although differentiating between precision technologies that come standard vs. technologies requiring an explicit investment decision might not seem important, in some cases there could be a difference between technologies "adopted" because they were standard equipment vs. those purchased to fulfill perceived needs. The difference could lead to a divergence between adoption rate and technology use. Adoption rate might indeed by higher than technology use for some technologies that simply come as standard on new equipment.

Conclusions

Adoption of precision agriculture technologies by U.S. crop producers has been slower than for other key production technologies such as GMO crops. However, results presented here indicate that, by 2017, key precision agriculture technologies were being widely used by U.S. commercial scale producers of corn, soybeans, cotton and wheat as over 90 percent of surveyed producers were using autosteer/guidance technology and yield monitors and nearly three-quarters of producers surveyed were using variable rate fertilizer applications. Usage of precision soil sampling, at 66 percent, and variable rate seeding, at 60 percent of respondents was less popular, suggesting a sizable minority of commercial crop producers were still not convinced that these technologies would improve their farms' profitability. Finally, just one-fourth of the farms in this survey indicated that they had adopted one of the newest precision agriculture technologies, use of drones/UMAV's.

Reviewing the survey results, several points stand out. First, most producers did not seem to view using precision ag technology difficult when making farm level decisions since just 30% of respondents agreed this was a barrier. However, since nearly seven out of ten respondents identified cost as a major barrier to adoption, it indicates a large number of producers still find precision agriculture's value proposition at least somewhat problematic. Nevertheless, producers remain optimistic that precision agriculture's value proposition will improve enough to justify maintaining or actually increasing their investment in the future.

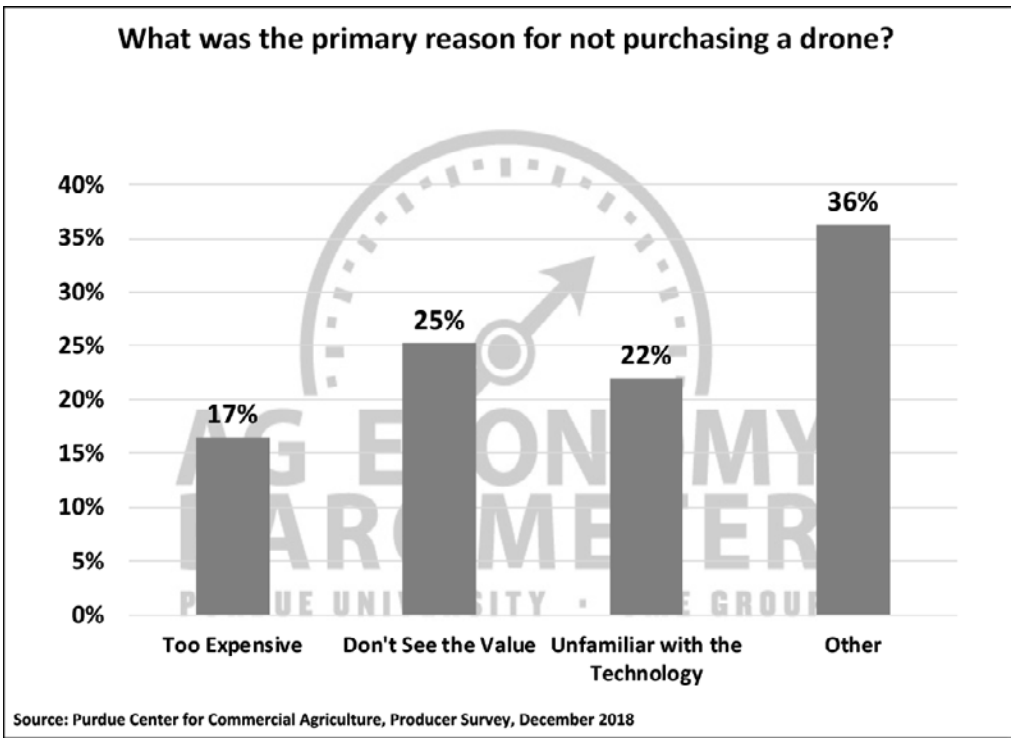
PURDUE/CME BAROMETER DRONE RESPONSE ANALYSIS

Nathan Delay

While much has been written about the potential applications of unmanned aerial vehicles (UAV) or "drones" for commercial agriculture, little objective research is available. To provide a necessary first step, Purdue University and CME Group included questions related to drone usage in their December *Ag Economy Barometer* survey. Respondents were first asked if their farm owns a drone or UAV to which only 13 percent said "yes." The low ownership rate is surprising given the enthusiasm surrounding drone technology.

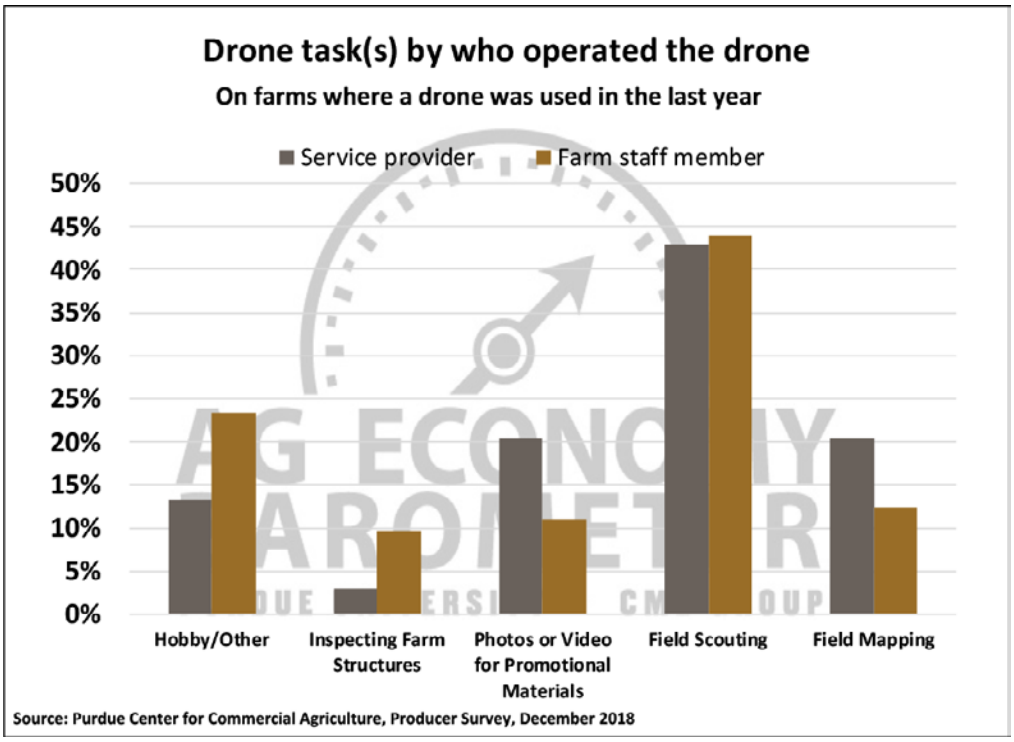
Respondents that answered "no" were asked to identify the main reason for not purchasing a drone. Twenty-five percent indicated that they do not see value in owning a UAV while 22 percent chose not to buy because they are unfamiliar with the technology. The least popular reason for not purchasing a drone was that the technology was "too expensive" (17 percent). The remaining non-adopters (36 percent) selected "other" as the primary reason not purchasing. This suggests that the motives for not purchasing a drone are varied and deserving of further investigation.

Participants were then asked the more general question of whether a drone had been used on their farm in the past year. In contrast to the low rate of ownership, drones were used at least once on over one-third of farms surveyed.



Of farms with positive drone use, 64 percent indicated the drone was operated by an outside service provider while 36 percent reported that a member of the farm staff was the primary operator. Taken together, these responses indicate that agronomists, crop consultants, and other service providers are driving drone use while on-farm ownership and use remains limited.

Farms that used a drone in the past year were asked to identify the tasks the drone was used for. The most common task was "field scouting" at 43 percent of users. Responses were evenly divided between "field mapping," "photos or video for promotional materials," and "hobby/other" at 17 percent of drone users each. The least popular task was for inspection of farm structures at just 6 percent. The breakdown of tasks confirm anecdotal evidence that much of a drone's utility is in its ability to quickly scout a field and identify problem areas, saving both time and energy.



Some differences in tasks performed emerge when looking at operator type. The above chart shows that while field scouting is the most common drone use regardless of the user, service providers are nearly twice as likely to use drones for field mapping and promotional materials. Conversely, drones flown by farm staff members are almost twice as likely to be used for hobby/other and over three times as likely to be used to inspect farm structures. The technical nature of field mapping and creating marketing materials, which may involve additional software and camera equipment, implies that service providers are more specialized in their drone offerings. Comparing the number of tasks performed by operator type confirms this. Service providers performed 1.3 drone tasks on average vs. 1.7 tasks by farm staff members.

When asked if they believed the use of drones on their farm (by either themselves or a service provider) had added value to their operation, the majority (56 percent) responded in the affirmative. Perceptions of value differed slightly according to who operated the drone. For farms that employed a service provider that used a drone, 53 percent indicated a positive value experience vs. 60 percent among farms that operated the drone themselves.

Lastly, surveyed farms that did not own a drone (87 percent of the sample) were asked if they plan to purchase a drone in 2019 to which a mere 6 percent responded "yes."

The December *Ag Economy Barometer* survey shows drone ownership among commercial farms to be low. Despite claims of "out-of-the-box" usability and affordability by drone manufacturers, these results highlight persistent skepticism of drones among producers. Drone usage, however, is moderately high with over one-third of farms using a drone in the past year. Responses suggest that usage is being driven by consultants and service providers who specialize in technical tasks. Drones operated by farm staff members appear to be used for a greater scope of tasks. Drones are most commonly used for field scouting at 43 percent followed by field mapping (17 percent), promotional materials (17 percent), hobby/other (17 percent), and inspecting farm structures (6 percent). Over half of farms reported the technology added value to their operation, indicating moderately high satisfaction among drone users.

CCA INDUSTRY COUNCIL

BECK'S

CORTEVA™ agriscience

GROWMARK

farm CREDIT MID-AMERICA

syngenta

CCA FARMER COUNCIL

- SAM HALCOMB
- BRYAN JOHNSON
- JOHN NIDLINGER
- KIP TOM
- DAVID HARDIN
- LISA KOESTER
- DANITA RODIBAUGH
- DON VILWOCK
- DAVID HOWELL
- KYLE LENNARD
- MIKE SHUTER
- BOB WADE
- LEVI HUFFMAN
- MATT MARTIN

CENTER FACULTY AND STAFF

Tim Baker
Professor

Mike Boehlje
Distinguished Professor Emeritus

Liza Braunlich
Distance Education Specialist

Brady Brewer
Assistant Professor

Nathan Delay
Assistant Professor

Craig Dobbins
Professor

Bruce Erickson
Agronomy Education Distance and Outreach Director

Ken Foster
Professor

Joan Fulton
Professor and Associate Department Head

Brent Gloy
Founding Director, Center for Commercial Agriculture and Visiting Professor

Aissa Good
Managing Director and Business Development Manager

Allan Gray
Professor and Land O'Lakes Chair in Food and Agribusiness

Mike Gunderson
Director, Center for Food and Agricultural Business and Professor

Jason Henderson
Associate Dean and Director of Purdue Extension

Chris Hurt
Professor

Roman Keeney
Associate Professor

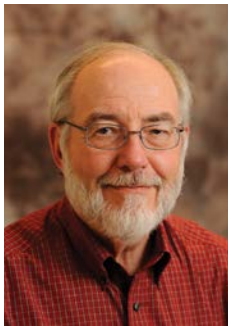
Tammy Kettler
Director of
Corporate Relations

Michael Langemeier
Associate Director,
Center for Commercial
Agriculture and Professor

Danielle Latta
Program Manager

Jayson Lusk
Department Head and
Distinguished Professor

Jim Mintert
Director, Center for Commercial Agriculture and Professor



George Patrick
Professor Emeritus

Nathan Thompson
Assistant Professor

Nicole Widmar
Professor and Grad Chair

Elizabeth Yeager
Associate Professor,
Kansas State University

Sarah Zahn
Administrative Assistant

PURDUE UNIVERSITY | Center for Commercial Agriculture

403 W. State Street West Lafayette, IN 47907-2056
(765) 494-7004 | www.ag.purdue.edu/commercialag