

A hacker plus an agronomist.

As Big Tech meets Big Ag, the job description of “farmer” is changing dramatically.



With the influx of technology, agriculture is not just for farmers, or only about farming, anymore.

Introduction

Once a very traditional, slow-moving and very decentralized industry, farming is experiencing a renewed acceleration and transformation, thanks to the influence of precision agriculture. Precision agriculture helps farmers conserve water. Irrigation scheduling, based on highly accurate weather forecasts and real-time field data, optimizes decision making and consequently reduces resource use. Having access to such forecasts and field data on a mobile platform makes the data relevant for making proactive irrigation-scheduling decisions on the fly.

With retooling and retraining top-of-mind in today's economy, precision agriculture is opening new roles as the farmer evolves away from thinking only as an agronomist. Today, farmers must incorporate broader and more readily available tools and information to make financially savvy decisions that align with their business. Indeed, communications experts, controllers, regulatory specialists, research scientists, biologists, chemists, and software engineers are highly sought after by companies specializing in precision agriculture. It has even created opportunities for industry leaders to hire pilots to fly drones.

This change, of course, has significant talent implications. For many agricultural firms, just buying talent is not sustainable. Plus, there is a growing need to attract senior leadership to manage the evolving industry. Changes in the space are forcing industry giants to hire senior leadership and specialized talent to not only understand the business of farming (including the type and level of production risk), but also to help the farmer with the emerging tools.

Sought-after skill sets in agriculture are changing rapidly. Everyone in agriculture is participating in devising technology solutions and competing for software engineers, data analysts, electro-mechanical engineers, and other cloud experts to pair with agronomists and draw the most out of the new platforms.

"The ideal job description is a 'hacker plus an agronomist,'" says Juan Manuel Vaquer, president and associate general counsel of DuPont Latin America. "Familiarity with analytics, big data, data curation, wireless hardware technology, and agronomy are several of the hot skills in demand."

The most highly sought-out leaders in the industry have strong established affiliations, a proven track record, and credibility in agriculture. These C-suite executives are seasoned veterans in communicating a broader vision to millennials that will attract and retain new talent, who in turn can identify sustainability models, is forthcoming about transparency, and has a keen grasp on dealing with ambiguity.

Technology is giving industry leaders much more credibility and precision with farmers; the industry is able to adjust the recommendations in specific parts of the field rather than on the farm as a whole. Innovation team specialists are agronomists dedicated to working with the large growers who want to work with latest technology.

As technology has evolved during the last decade and new products transform the business, industry leaders have launched professional-development programs to hire current undergraduate students to work as paid interns and subsequently as full-timers after graduation. New high-tech skills are required in the sector, but they do need to be paired with a strong technical background in agronomy.

While technology is the enabler, and it can be great for big farmers who can afford it and have the know-how to use it, it's not yet making a big difference to the hundreds of thousands of small farmers. By generating detailed insights, farmers can make data-based operational decisions that will optimize yield and boost revenue while minimizing expenses and the chances of crop failure.

Precision agriculture and farming's murky business model.

Despite some of the hype around precision agriculture, there still seem to be questions and lack of clarity about the business model. It's important to determine which crop to measure.

"Does the cost of the crop justify the use? It depends on which crop you want to measure. If it's an expensive crop, then yes, but if it's winter wheat, return-on-investment becomes an issue," says Supratik Guha, professor at the University of Chicago, director of the Center for Nanoscale Materials at Argonne National Laboratory, and a former executive and researcher at IBM.

Can precision agriculture really help the American farmer? With the U.S. share of the global grain market less than half what it was in the 1970s, American farmers' incomes will drop 9 percent in 2017, the Agriculture Department estimates, extending the steepest slide since the Great Depression into a fourth year. American farmers' share of the global grain trade has fallen from 65 percent in the mid-1970s to 30 percent today, giving them less sway over prices. More producers and more buyers around the world also mean more potential disruptions from bad weather, famine, or political crisis. Corn prices once varied year-to-year by less than \$1 a bushel. Since 2006 they have shot up and dropped more than \$4 a bushel.

Four years ago, the future seemed to be only in seeds (engineering them to grow better and resist weather and pests) yet nature adapted (new seeds were not as effective as when they were first introduced) and DuPont, farmers, and other companies were forced to seek a more balanced portfolio to include seeds and crop protection.

In order to successfully innovate, market leaders need to cooperate with outsiders. This is a major paradigm change. This means establishing cooperation at laboratory levels. Growers have serious concerns around how the technology integration will ever happen among fierce agribusiness competitors. But they understand that standardization will be key to the success of precision agriculture.

Experts with nutrients, fertilizer, seed tech, and crop protection, along with equipment suppliers and retail networks to the agriculture sector, are communicating and developing these tools, just as Google, Amazon, IBM, and various start-ups are doing.

Everybody is talking to other companies. However, the broader consensus suggests that no one has yet figured out how to make money off precision agriculture, big data, or similar freely available technology.

Deploying smart technology.

Precision agriculture involves the smart usage of technology to enable better decision making and optimized use of resources on farming. Precision agriculture stands to be a key to higher yields and to effectively tackling the rising food demand. Precision farming involves deployment of a web of sensors, drones, and software to gather, process, and analyze data from which to derive actionable insights for on-farm decisions.

Improving yield is an age-old challenge for farms and always will be. However, for the first time in a generation, digital technologies enable farmers to achieve a quantum leap forward in their performance. While improving yield is good for a farm's profitability, it's also increasingly critical to addressing the growing demand for food among an ever-increasing global population.

Today, there are more than 7 billion people on the planet, a figure that's expected to reach 9.7 billion by 2050. By then, the middle class—which typically has more money available for food, leading to greater demand—could reach 5 billion people by 2030. The growing size of megacities and rate of urbanization are further compounding the strain on food systems; by 2050, more than two-thirds of the global population is projected to live in cities. If these numbers hold, overall food production will need to double in a relatively short period of time to meet demand to feed the world's population (United Nations, 2014).

"The biggest question to answer is, how will the growing population be fed? Who will step up and how? How will countries shift policies to secure resources for their own national interests, like China has been doing?" says Hans Jöhr, corporate head of agriculture at Nestlé.

Couple this with achieving a lower environmental impact due to reduced water wastage, chemical run-off, and CO2 emissions, and one can see the critical role that digital technologies play in fostering sustainable farming practices. That's why it's important for all participants in the agriculture ecosystem to embrace new and emerging digital technologies to make their operations more efficient, productive, and profitable. Nitrogen management is an important concern among growers; precision agriculture is helping manage fertilizers' cost and preventing excessive nitrogen application and runoff into streams or lakes.

A grower claimed that drivers for technology adoption rely heavily on cost-benefit and secondarily on environmental benefits (such as the ones derived from *not* overlapping or over-applying inputs: fertilizers).

New digital technologies now make it possible to collect and leverage huge amounts of critical data at minimal costs—thus making a farm's field operations more insight-driven and potentially more productive and efficient.

The agriculture ecosystem is already starting to invest in these digital technologies. The total market size for precision agriculture is expected to reach almost \$8 billion with a compound annual growth rate of 13.5 percent by 2022 (Markets and Markets, 2017).

"How will the growing population be fed? Who will step up and how?"

Hans Jöhr, Corporate Head of Agriculture at Nestlé

Technological change

No single company can drive technological change in the precision-agriculture sector alone. Who will have the right set of skills or capabilities to drive change and adoption of new products and services in the new farm operation by 2025?

Quite likely, it will have to be an agricultural sector outsider to help provide an unbiased and truly integrated solution that adds value to the sector. That outsider—or a neutral party—can help with analytics that monetize data and help farmers and agricultural corporations collaborate. The challenge for the outsider is that it does not have access to producers and has no agronomy background and therefore is not currently a trusted advisor. From a buyer-of-technology perspective, growers want vendors that are agronomists who are also tech-savvy. Working with vendors that speak the same language and understand a grower's agronomical challenges is important. "A win-win would be someone with relationships, trusted advisors, and understanding of disruptive technology," says David Black, chief information officer at CHS, a Fortune 100 global agribusiness company owned by farmers, ranchers, and cooperatives across the United States.

An organization that can establish and navigate an easy-to-use platform (from user-interphase perspective, to data management, to collaborative input organization); can prove technologies produce value-added outcomes; can easily collaborate with other specialist organizations in the market; and can attract and retain the talent necessary to build out these platforms. Each participant in this platform will have to transform its business model and products to help shape data and produce more value, cost reduction, output growth, or other efficiencies.

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Juan Manuel Vaquer, President and Associate General Counsel, DuPont Latin America

Tools and platforms.

Many precision-agriculture solutions are already in use. Growers claim that there currently is significant beta testing of models and programs, and large tech-savvy growers are being asked to pilot them.

Variable-rate spraying, for one, allows farmers to vary spraying rates within a field to optimize crop protection. But its impact until now has been limited due to the granularity and timeliness of the data farmers use and their lack of day-to-day operational decision support. A grower suggested that precision-agriculture models are not yet perfect but have improved significantly since they were first introduced and seem to be getting better every day. These models rely on a lot of data that is collected with equipment on the field as well as some data imputed by growers and farm operators.

John Deere has a long history of technological innovation. Today, Deere is investing heavily in software. Teams are hard at work developing apps that help farmers manage their fields from their mobile devices. One of them, called SeedStar Mobile, lets farmers monitor factors such as the spacing between planted seeds and “singulation” (the term that describes the deployment of a seed from the meter, the machine that regulates seed flow) row by row. There are more than 200,000 Deere machines that can wirelessly transmit agronomic data to remote servers to be organized, analyzed, and tapped for other applications, such as coordinating multiple machines in the same field.

John Deere has also looked outward to jump-start its technological initiatives. In September 2017, the company acquired Blue River Technology, a pioneer in the design and integrated computer vision and machine learning technology that will enable growers to reduce the use of herbicides by spraying only where weeds are present, optimizing the use of inputs in farming.

Corporate partnerships and software integrations can certainly help boost the technological prowess in the short term, but John Deere faces the longer-term challenges of attracting employees with skill sets that match its new businesses, according to Aaron Wetzel, John Deere’s vice president, global crop care platform. “We have long hired workers from the farming community that we serve,” Wetzel says. “How do we leverage that to also attract tech-industry talent?”

By combining digital technologies such as the Internet of Things (IoT) with its big-data analytics, visualization capabilities, and industry knowledge, market leaders have now created several major advancements in the market:

Fieldprint Calculator, a free interactive resource from Field to Market (the Alliance for Sustainable Agriculture)—for corn, cotton, potato, rice, soybean, and white growers—is a tool that focuses on performance related to soil conservation, irrigation metrics, energy consumption, and other agricultural metrics (fieldtomarket.org, 2017).

Maglis, an online decision-support agricultural platform launched by BASF in 2016, is a key partner in helping farmers manage their crops. BASF designed this tool to better understand the farmers' role and their production risk and to work more effectively with them. With the platform, farmers can gather, interpret, and monitor a range of crop-related data that support them in making better decisions on how to grow and market their crops, explains Paul Rea, BASF's senior vice president, crop protection, for North America.

A mobile application on the field agent's handheld device is the hub for connecting the farmer to the agro-input company with a steady stream of information and advice for improving crop yield throughout a season. Farm-based apps can help manage equipment traffic, improve fertilizer efficiency, scout effectively, and teach more about farm soils.

For many farmers, the field of ag-specific mobile apps can feel a bit like the Wild West. The general-use app market seems to be saturated and difficult to navigate, and the market for farming apps is no different. A broad search of "agriculture" in Apple's App Store alone turns up more than 700 results.

Luckily, the market for farming apps has been evolving; separating the wheat from the chaff is a process that has been happening naturally. The most useful apps are apparently being selected for survival based on customer feedback and reviews.

Still, the time a user must spend learning to use each individual app, and the amount of data he or she must input before getting useful output, has many farmers asking: Is it worth it? Growers are also concerned by the perception that software-management tools are looking to deliver add-on product/solutions as another offering. Large companies who own these platforms run the risk of being perceived as biased towards up-selling. Growers are skeptical of suppliers that are telling them exactly what and how to run their operation, and may favor independent companies who are not tied to a larger company, instead of Climate Corp, Encirca, Precision Planting, and others who are now part of larger organizations. Growers, however, also recognize that smaller, newer independent companies may not have significant continuity as their own exit strategy and the ag-technology industry consolidation accelerates.

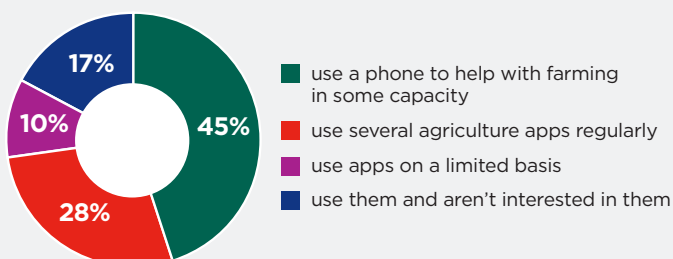
To bring some clarity, *No-Till Farmer* surveyed readers about what mobile apps they use in their operations and what value they provided. We also asked about the frustrations apps created, and which apps farmers had on their wish lists to improve efficiency and productivity in their operations.

According to a *No-Till Farmer* poll in 2015, there are plenty of growers who've jumped on the farming-app bandwagon, but others are still mulling the idea or flatly refusing to do so. But late or no adoption may come at the cost of missed opportunities in farming precision, accuracy, and efficiency. The trend for North America growers shows larger scale adoption by larger farm operations, accompanying economies of scale and large costs-savings opportunities.

Adoption initially was slow as established agriculture-equipment and -input companies had difficulty supporting new technology launches at the retail level. Subsequently, tech support at the retail level has improved significantly. Growers today continue to have concerns over standardization of technology platforms across equipment and systems (i.e., red tractor not communicating effectively with green planter).

Farming from a phone

Source: *No-Till Farmer* survey, 2015



It seems like a no-brainer for farmers if not for the nasty implementation details: new sensors and equipment for granular data measurement, data collection, integration with third-party data sources like weather models and satellite imagery, and number-crunching data analysis to produce recommendations. While not insurmountable hurdles for big corporate farms, the technology requirements and expertise is beyond the reach of smaller farmers, particularly in developing countries. Enter cloud services: the same technology equalizer that allows two-person start-ups to develop software using hundreds of servers can deliver sophisticated agricultural analytics to the family farm.

Together, big data and precision agriculture have a lot in common with burgeoning analytics applications in many other industries. The need for prodigious data collection from many sources, associated storage, and computational horsepower makes it a great fit for cloud services. Not only do shared services broaden the available market for precision agriculture, but the cloud enables agricultural crowdsourcing, by aggregating data from a wide variety of smaller operations to improve prediction models.

Tools, technology, and a changing workforce are driving changes in the agriculture landscape—specifically, big data, artificial intelligence, a sharing/collaborative economy, and the role of women in agriculture.

Big data

With big data, there is a virtual tsunami of information available: ubiquitous sensor systems collect data from a variety of sources—a tractor that is fully connect to the Internet; an air filter with an IP address that can send an email to the manufacturer to order a new one without the needing to worry about it; and devices and sensors in crops to measure sunlight, heat units and pest pressures.

Artificial intelligence

Artificial intelligence is driven by the massive amounts of data collected. This information can be processed and used for critical decisions; some early agricultural

applications might include pest management, scheduling operations, or optimizing animal-health or crop-health treatments and regimens.

Sharing economy

The rapid emergence of the sharing/collaborative economy is another trend influencing the future of agriculture. In fact, agriculture has been a leader in the cooperative-business model. Software platforms to enable and facilitate sharing transactions while maintaining data about trust and relationships can be used to offset the cost of equipment. Following the Airbnb model, similar types of business opportunities with portable or otherwise flexible ag assets will become available, using relationship data to manage software to allow sharing and collaborative transactions for expensive, automated ag machines or even processing equipment and storage facilities.”

Role of women

Major changes and shifts are occurring in the agriculture workforce, specifically the role of women. In the most recent USDA's Census of Agriculture, women as principal farm operators are making up a larger and larger fraction of the industry, accounting for almost \$13 billion in annual sales of ag products.

Several studies point to the fact that women are doing nearly half of the agricultural work globally, yet in many areas lack equal access to capital, machines, and other technologies. With equal access to resources in a developing country in Africa, Central America, or parts of Asia, women will generate up to a 30 percent greater return on investment.

Several business studies in the U.S. point to this same phenomenon. Fortune 500 companies in the upper 25 percent with participation by women on corporate boards of directors generate 42 percent greater return on sales and 53 percent greater return on equity.

Trends in 2017 and beyond.

Interest and investment in precision technology has continued at a fever pitch over the past five years. Every segment of agriculture has set out to explore the efficiency, profitability, and stewardship aspects that precision products and practices have the potential to deliver. And investment from outside agriculture, including leading tech companies in Silicon Valley, continues to ramp up interest and excitement in agricultural technology development and implementation. Overall lack of equipment and software compatibility is the single biggest factor limiting use and adoption of technology in the U.S., an issue that is also getting much attention from inside and outside the industry.

There are other key factors driving the future of precision agriculture. These are six of the most significant factors that are, for better or worse, impacting the speed and depth of technology adoption in agriculture: water quality and use efficiency; technology development staying well ahead of value creation; sustainability initiatives requiring precision-driven data; a chasm growing between the most- and the least-tech-savvy growers; wireless access not consistent or homogeneous; and availability of technical expertise lacking. Agriculture is increasingly a people-relationship business, with a need to learn from each other and to work together to create opportunities.

Untapped potential

Precision agriculture has already turned one of the oldest sectors into one of the most high-tech, thanks to the evolution of big data. Farmers and agribusinesses increasingly are considering how to best take advantage of their treasure troves of data to boost profits and

make agriculture more sustainable. The agriculture giant Monsanto's acquisition several years ago of the Climate Corporation serves as one example. Another low-hanging fruit for big data is research on how to use equipment. For example, it's not clear how fast a tractor should be driven when planting corn: too slow makes for an inefficient process, but too fast results in uneven planting, which hurts yields. After collecting data on the tractor's speed, the eventual yield of the crop, and other factors, however, one could determine the optimal speed for planting.

In order to harness big data's power, companies will probably have to pool information across farms. The problem, at the moment, is that farmers have little incentive to collect quality data. In the United States, some start-ups have tried to pay farmers for data, without much success. Prices and pricing models have been adjusted since their first introduction. Pricing was somewhat tied to commodity prices, and when technologies were first introduced, corn prices were much higher and growers could afford more. Higher levels of competition with new participants into this ag-tech market helped these solutions become more cost-effective. So far, it is the agricultural-input suppliers and agricultural cooperatives that have been able to collect the most data. But even their data sets are relatively small.

The FBN Network was established in 2014 by farmers seeking to develop an independent, unbiased, and objective farmer-driven information source focused on the facts of raw performance. In just two years, FBN has grown to become a network of thousands of America's farmers managing over 8 million acres. As each new farmer joins the FBN Network, every member's seed information, agronomic analytics, and buying power gets stronger.

Some of that big data may come from drones. Small, unmanned aircraft can capture regular images of crops to guide irrigation, pesticide application, and harvesting. And unlike satellites, drones are largely unaffected by cloud cover. Given the operating expense and expertise required, drones will most likely be used commercially at first only for high-value crops, such as wine grapes.

Drone technology will give the agriculture industry a high-tech makeover, with planning and strategy based on real-time data gathering and processing. PwC estimates the market for drone-powered solutions in agriculture at \$32.4 billion. There are six ways aerial and ground-based drones could be used throughout the crop cycle: soil and field analysis, planting, crop spraying, crop monitoring, irrigation, and health assessment.

Beyond the barriers to widespread drone adoption in all industries—safety of drone operations, privacy issues, and insurance-coverage questions—the biggest agricultural concern is the type and quality of data that can be captured. To address this, the industry will push for more sophisticated sensors and cameras, as well as look to develop drones that require minimal training and are highly automated (PWC, 2016).

The tools of precision agriculture will gain widespread use only once they are sold in easy-to-use forms. That's why GPS guidance has become so widespread: Farmers don't need to understand it to use it. Variable-rate technology for fertilizer, to take one example, will take off the day a farmer can trigger it with the mere push of a button. Eventually, precision agriculture could take humans out of the loop entirely. Once that happens, the world won't just see huge gains in productivity. It will see a fundamental shift in the history of agriculture: farming without farmers.

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Acknowledgments

Korn Ferry wishes to thank the following individuals for participating in interviews for this white paper:

Frank DeGennaro, Vice President, Specialty Crops, Perdue Farms

Mike Macrie, Senior Vice President and Chief Information Officer, Land O’Lakes

Fernando Martins, CEO, Agrottools

Supratik Guha, Professor, University of Chicago; and Director, Center for Nanoscale Materials, Argonne National Laboratory

Hans Jöhr, Corporate Head of Agriculture, Nestlé

Pat Pinkston, former Vice President, Technology and Information Solutions, Intelligent Solutions Group, John Deere

Paul Rea, Senior Vice President, Crop Protection, for North America, BASF

Matt Rushing, Vice President, Global Fuse Product Line, AGCO

Juan Manuel Vaquer, President of DuPont Latin America and Associate General Counsel

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