The Age of Digital Agriculture

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INTRODUCTION

Digital agriculture has proven itself as not only one of the most exciting new frontiers in the advance of technology and science, but also as a central element of the solution to one of agriculture’s – and humanity’s – most pressing issues: the need to feed a growing population while minimizing impact on the environment.

The scope of the challenge is daunting, to say the least. Farmers will need to feed a population of nearly 10 billion people by 2050, which will require a 59-98 percent increase in global food production. And they’ll need to do it on less land, using less water and less energy. All in the face of a climate that is in some places becoming warmer, drier, and more erratic.

It’s a herculean task, one that demands the best and brightest minds in technology, science and agriculture. Digital agriculture holds the potential to unlock our next giant leap in farming productivity and efficiency. The combination of advanced data science, sensors and ubiquitous connectivity enables us to deliver real insights to farmers in real time, while in the field. That knowledge gives farmers the power to make more informed decisions, and to effectively manage every inch of their fields for maximum yields.

Digital tools are already making a difference for farmers across the U.S. and other areas around the globe, improving their efficiency in managing fertility, water, and crop health. But we’re only scratching the surface of what’s possible at the intersection of Silicon Valley innovation and a farmer’s ingenuity, historical knowledge and perseverance. As we bring these worlds together, and broaden the reach of digital tools across the globe, we can unlock productivity that will help us to sustainably feed a growing population.

Barriers remain to achieving this goal, however, including key challenges for the technology industry as well as some that fall more to farmers. For those focused on science and tech, we must accelerate the pace of innovation and remove barriers to access for new capabilities. Farmers must be prepared to adapt and embrace additional change and additional transparency to take full advantage of these tools in the years ahead.

In this paper, we will look at where we stand in addressing these challenges, and the potential implications, both for those developing new technologies and those deploying them. Our success in moving past these challenges will largely dictate the extent of digital ag’s ability to help farmers in the years ahead.
DEFINING DIGITAL AG

With news popping up almost daily about new applications, sensors, imaging platforms, even autonomous “robotic” equipment, the ag tech space can be confusing for even the most tech-savvy farmer, whether they’re farming 10,000 acres of corn in Iowa, or 2 hectares of tomatoes and onions in India.

Given all of these new technologies, it is important to clarify terms like “digital ag” and “precision ag.” Digital ag is the use of data and advanced computational techniques to make more informed decisions about managing our crops and agronomic operations. It encompasses all the information in the ag ecosystem, including data about the crop itself, equipment data, environmental data, operational data, and even market and logistics data.

Precision ag is about executing our agricultural plan as precisely as possible and “farming by the seed.” It is often executed by specialized equipment, encompassing how we plant, manage, and harvest that seed, as well as how we manage the soil between plantings with processes like tillage, crop rotation, cover cropping, poly cropping, etc. This specialized equipment can often then provide the data we need in digital ag to do better analysis, such as a “seed firmer” device on a precision planter giving us a high resolution soil map of the field.

Digital and precision ag combined aren’t just about higher yields, but also about being as efficient as possible, producing more with less, and in a sustainable and reliable fashion.

THE ERA OF THE PLATFORM

According to AgFunder research, more than $7.5 billion was invested in “agtech” in 2016 and 2017. But if you ask farmers if they’re seeing billions of dollars worth of innovation on their operations, you’ll probably get a funny look and an emphatic “no.” While we’re seeing technology advances on multiple fronts, it’s often challenging for farmers to realize these advancements. Too often, we’re seeing innovative products from multiple, disparate ventures that have been created in closed environments, requiring farmers to purchase and navigate many different applications to receive a full spectrum of benefits.

Simply put, farmers need technology tools that are built and delivered to intuitively meet their needs in an organized way. If we’re asking them to try to shift between a dozen different apps as they’re planting a field, the digital ag industry is not meeting their needs in a realistic manner.

As an industry, we need to cultivate and support new agricultural technology in open, collaborative ecosystems. We have already seen this approach work in other areas, particularly with consumer technologies. For example, home automation tools consolidate multiple applications and devices from numerous vendors -- music, news, home controls -- into a single, simple, intuitive interface.
For this model to work in digital ag, the industry must acknowledge that no single company will provide a fully comprehensive solution. Companies of all sizes, from established organizations to fledgling startups, are developing innovations, but open collaboration is a proven method that provides increased value. This value gets realized across the ecosystem, from the farmer customer to the other ecosystem partners as well.

As an industry, we’re on the right track, or at least we see the path forward. By opening our product infrastructure, and establishing partnerships with third-party innovators offering complementary products and farm insights, Climate FieldView™ has brought forward the industry’s most broadly connected digital ag platform. The FieldView platform is now able to aggregate data from third parties as tractors pass through fields, drones fly overhead, and equipment pulls soil samples. These insights add to the dozens of unique “data layers” that FieldView provides on its own.

Bringing a platform approach to digital ag tools creates a win-win-win scenario for farmers, Climate, as well as other industry innovators:

- Farmers have at their fingertips more insights from multiple technology providers, and they’re able to access those insights real time, often while using a single app and a single login.
- FieldView’s offering becomes more valuable to farmers because it’s able to leverage innovation from other companies that focus on a niche aspect of farm management, or are particularly strong in certain areas.
- Third-party innovators partnering with The Climate Corporation™ gain new customers and exposure to new markets (more on this below), and their innovation has increased value in the context of the overall farm operation.

The growth of digital agriculture and connected equipment is starting to show up in large commercial farming operations (drones, sensors, farm robots) as well as in smallholder farming operations in developing nations. To maximize its potential, we need to deliver applications with a farmer and industry-friendly platform approach.
There is huge inefficiency today in both the analog nature of much of the farming industry as well as the newer digital ag sector. As new digital tools replace those old analogs, and the platform approach optimizes the digital sector, we will see a compounding effect on the pace of innovation, making it faster than we’ve ever seen before.

At the industry level, we see consolidation across the largest players. Dow/DuPont, ChemChina/Syngenta, and Bayer/Monsanto have all merged, or are in the process of merging. One of the main drivers behind this consolidation is for better efficiency in research and development. Today these companies invest many of the same dollars in their R&D infrastructure, and the pace of innovation is slow as companies often have to wait until products are commercially available before beginning development of complementary innovations. The opportunity created with these mergers is that even with maintaining existing R&D investment levels but eliminating the redundancy, combined with simultaneous development across R&D lines, will bring more innovations to market more cost effectively and at a much faster pace.

In the ag startup sector, there is currently a large amount of investment being lost due to the difficulty small companies have in getting from innovation to market. Today there is a lot of investment redundancy by these companies: creating account systems, cloud storage, IoT infrastructure, field support, dealer/retailer adoption, accessing farmers, expanding across geographies, etc. All of those things have to be done today by every single company. With the advent of a common digital ag platform, a lot of those things become standardized, which allows small companies to focus their investment solely on their innovation. The platform era will thus accelerate the pace and reduce the cost of startup innovations reaching the market.
“The decision to partner with Climate has allowed Conservis to not only provide growers with a richer, more complete experience, but helped strengthen our awareness on-farm.”

- GREG THOMPSON, VP CHANNEL, CONSERVIS

The last “sector” I’ll call out is the startup/industry leader hybrid. Sometimes we see that disruption (and value and change) happen dramatically when an established industry veteran acquires a startup and is then able to accelerate that startup’s efforts using its industry position and resources. A great example of this is the success of Android™ after being acquired by Google. The telecom industry could trust in Google’s established position and backing to invest in long-term product development around Android. Today, Android accounts for more than 80% of all shipping smartphones. The Climate Corporation, and its acquisition by Monsanto, is an example of this type of hybrid in agriculture. DowDupont has acquired Granular® in a similar fashion. As the industry consolidates, we may see more of these types of hybrids, which could additionally accelerate the pace of innovation and change across the space.

When you combine the R&D investments of consolidated industry veterans, the efficiency of the common digital platform, and the potentially dramatic effect of startup/industry hybrids, we anticipate the coming of one of the most innovative eras within agriculture to date.

THE VALUE AND OWNERSHIP OF DATA

One of the questions I get asked frequently by both journalists and farmers alike is “what is ag data worth?” Today we have an abundance of ag data, distributed across a multitude of different members of the ecosystem. Dealers typically have soil test results and prescriptions, farmers have planting and harvest data, and as-applied data is often either non-existent or scattered among the two. Then there is data from weather stations, soil moisture probes, grain silos, weigh wagons, elevators, satellites, product manufacturers... the list goes on.

Before we can talk about its value, we should talk about the ownership of ag data. This may seem simple on the surface, but the uses of ag data are increasing quickly, and the policies of all the various members of the industry have not kept pace. For example, The Climate Corporation has proudly set the precedent from very early on that the farmer owns the data generated on their farm by their equipment and our policy is very clear about how that data will be used.

However, who owns the data that comes off a retailer’s applicator rig? Obviously the retailer owns and operates the equipment that generates the data file. The farmer is paying the retailer to provide the service, but I don’t know of many retailers today who have a data policy specified in their service contracts about the grower also getting the data file. Pragmatically, we know both the retailer and the farmer need a copy of the data. The retailer can use the data as a rollup of the work done across different customers as well as for application compliance. The farmer can incorporate the data into their crop’s performance analysis and use it as proof the service was performed by the retailer as contracted.
“It’s all about creating more value to the farmer. Instead of disparate services focused on either agronomic OR economic outcomes, together we provide an improved user experience giving economic insight around agronomic decisions.”

-GREG THOMPSON, VP CHANNEL, CONSERVIS

What about landowners who lease their land to be farmed by someone else? What is in the lease agreement about data rights and ownership? Many lease agreements today are still done with a handshake, but wouldn’t it be best for the landowner to have a digital record of everything that was done to their land? This is especially useful in the event they change lessees. Potential new lessees can see past performance of the fields (weighing the rental costs against production and commodity prices), and the landowner can prove that the soil’s quality has been preserved through proper management.

It should be noted that not everyone agrees with Climate’s position on the farmer ownership of data. Some industry members think they own the data that comes off their equipment. What about soil test labs? Do they own their test results? Can they offer additional services to third parties to access all of their sample data across their test footprint? How would their customers feel about that? Do they have data-use policies in place that clearly state all of this? We’ve made some good progress around data ownership in agriculture, but this is an area that needs further maturity to clarify some of these details.

Once we establish ownership and get the appropriate data use policies in place across the industry, we can start to talk about the value. There are a number of issues we face with the value of ag data today. First, we see a wide variance in the quality. Data from various equipment types can be “dirty” and require an extensive amount of post processing to be useful. Harvest data, for example, can vary widely based on how well the combine was calibrated. Different equipment may have different GPS resolution. Grower-entered data is often a non-standard mix of pseudo-language and shorthand used to identify the hybrid, seed treatment, starter fertility, etc. We often don’t have great “depth” of data, meaning we may have plant and harvest, but may not know what was done for fertility, or seed treatment, or crop protection. Having this much disparity in ag data today makes it very difficult to define the value of an individual grower’s data.

The digital ag industry is still very young. Data is being used today to make better prescriptions, optimize fertility, spot pest and disease pressure earlier, manage logistics, etc. Thus, for now the value of ag data is defined by the improvements our customers recognize directly through increased productivity.
A NEW LEVEL OF TRANSPARENCY

Last year I hosted a group of leading ag industry CIOs at our headquarters in San Francisco. One of their questions to me was what they should be doing to prepare for this new digital age of agriculture. I told them to think about and prepare for a whole new era of transparency in their business. The great thing about data is it allows us to quantify nearly everything, make adjustments, and measure the results. However, if your business is not ready for it, this can be quite disruptive.

So what will this new era of transparency bring? One of the most obvious benefits will be understanding the performance of different products and practices. As our datasets grow, we’ll be able to quantify and understand the performance of each of our decisions in a way we’ve never been able to do before. This will change the way our customers select their products, as well as the practices they employ to use those products.

That means our industry must also change the way it sells those products. This doesn’t mean that the “best product wins” either, because there is no unilateral definition for “best product” in agriculture. For some customers, the “best product” may be the highest-yielding. For others, it may be the best ROI for a given investment level, or shaped by a particular risk profile. It may be limited by available equipment, number of acres, product availability in a region, weather, disease and pest pressure, the list goes on.

Another new area of transparency will be what happens on the farm, which will carry through the entire chain from producer to consumer. Some farmers are ready for this and some are not, but it will happen. Partly because we need the transparency to fully quantify performance, but also because consumers and governments are starting to demand it. Consumers want to know about the products they are purchasing. Governments (and landowners) want to know that farmers are acting responsibly and sustainably.

Everything a farmer does soon will be tracked and recorded digitally - from the genetics of the seed they plant, to the equipment they plant it with, all of the management practices and products in between, to the conditions under which they produce it. This type of on-farm transparency will also help us with sustainability and environmental responsibility. This is the goal of digital and precision agriculture: to do precisely and properly what is needed and nothing more or less.

Lastly, there will be new transparency around our industry service providers. The performance of the products and services they provide, like recommendation, application, scouting and detection, testing, etc. will be digitally recorded and included in the “digital lifecycle” of every crop produced. Farmers will have insight into the services they’re paying for and the value they are getting in return in a way they’ve never had before.

We’ve seen some early signs of this in the data layers we’re analyzing now, including missed applications from satellite imagery, incomplete application from equipment maps, higher-resolution scouting from drones and aircraft, better soil sampling from equipment-mounted sensors, etc. This new transparency and efficiency should ultimately lead to higher-quality services at better prices for farmers. It will also be a new way for service providers to differentiate and compete.
DISRUPTION AND VALUE

These new digital capabilities are bound to bring about some disruption, and nearly all disruption is about value creation. That value is either created through new products or services, or through new efficiencies in the existing market. We’ve witnessed disruption several times in the technology sector. The advent of the Linux® operating system on inexpensive Intel® hardware killed the large server market. Apple and Google redefined the smartphone market with the iPhone® and Android respectively. Now we’re seeing Tesla disrupt the auto industry with their electric cars, and Amazon working to potentially disrupt the supermarket industry with their purchase of Whole Foods. In all of these examples, firmly established industry players were forced to either redefine their business and their value proposition, or see their business marginalized by new innovation.

The value created by disruption is almost always due to the established players not addressing a market need, either by choice or by ability. If we look at agriculture today, the amount of R&D spent is incredibly low compared to many other industries, such as consumer technology, automotive and consumer products. That may be an indication that the industry as a whole is not innovating aggressively enough for the market need, which of course means available opportunity. As mentioned previously, the consolidation of the industry leaders in the space is certainly in part to improve this R&D investment issue.
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“We see a number of startups entering the space now tackling things like data analysis, system integration, price transparency, input procurement, sensors and hardware, imagery, resource management, profitability, etc. These entrants include a multitude of startups from around the world as well as successful companies in other sectors like Microsoft and Google. Existing industry players will need to adapt to this disruption (or even lead it), or risk the consequences to their established businesses.

WITH VALUE COMES CHANGE

If disruption creates value, then value creates change. Digital ag has the potential to bring new value to every member of the ecosystem, so what changes might we expect in this new digital ag landscape?

On the farm, we can expect every action to be recorded as a data layer. This means data agreements, connected equipment, sensors, mobile applications, and a new level of tech savviness by the farmer (and the farm employees). The easier we can make these new technologies, the faster we’ll see their adoption.

Farmers will for the first time be able to quantify all of their decisions on their operation. Want to know how a new seed performed? Check the data. Want to understand the effects of your fertility program? Check the data. Want to know precisely where you have disease pressure and apply a prophylactic treatment? Check the data. Today these tools are just getting started, but soon we’ll have machine learning and data analytics applied to be very prescriptive about ways the farmer can improve their operation. That is real value, and that will drive change in how farmers run their farms. It won’t just involve the farmer either, but the general manager and farm hands as well.

The agronomist will also change. Today the need to get out and scout fields manually makes it difficult to cover all customer fields with the rate and fidelity necessary. Identifying disease often happens at a stage when a lot of damage is already done. Recommending seed or other products can often be on a limited, experiential basis. These new digital tools will empower the agronomist to scout “remotely”, more thoroughly (multiple image bands like thermal, chlorophyll, etc.), more quickly (disease recognition via satellite, drone, robot, etc.), and offer recommendations quantified by access to broad-acre data sets and trials. Note that nowhere did I say we replace the agronomist with a digital tool. Agronomists are a key member of the farmer’s operation, and they will get even better and more valuable with these new tools.

“My grandfather and my father both said ‘you know whatever you get, leave it better than how you found it.’ Now that we have more tools we’re able to figure out ways to improve.”

-JOHN O., THIRD-GENERATION NEBRASKA FARMER
Change will also come to dealers and retailers. Imagine the ability to digitally track the status and health of all farmer customers in real time, and then tie that into operations and work order systems. The fleet of applicator rigs will produce digital maps for every service rendered, delivered seamlessly into the grower’s account. Soil tests and fall applications can run in real time as combines roll, all coordinated via a digital “control center.” The performance of products for that season can be analyzed almost immediately, making decisions and locking in seed orders for the following year.

Another big optimization for dealers is optimizing their internal investment. Rather than build infrastructure, dealers and retailers will be able to focus more on their customers. What new services can they provide in this digital era?

How can they better invest in their core service business to differentiate? As dealers and retailers see value in these new tools for themselves, they will accelerate getting their customers up and running as well.

Change will also come to other members of the ecosystem. Insurance agents will have high-resolution aerial imagery within 24 hours of a weather event. Grain elevators will have advance forecast and scheduling to manage demand and storage needs. Marketers will have far better insight into expected season-end yields. Profitability and planning tools will have less manual data entry as customers will have seamless data flow across all of their systems. Nearly every part of the industry will be touched by this new digital era of agriculture.
“Out of the 4,000 acres we farm, 120 acres are owned, the rest are cash-rented. Margins are pretty darn tight ... In this day and age you've gotta stay at the leading edge of technology to stay ahead of the game. I think this is where it's at.”

- JASON O., SECOND-GENERATION IOWA FARMER

**THE GLOBAL EFFECT**

While we often focus our conversation around the cutting-edge technology being adopted by commercial farms, we’d be remiss if we didn’t recognize the nearly one third of the earth’s population that either owns or works in the smallholder farm segment. These farms are typically defined as two hectares (about 5 acres) or less.

Probably the biggest hurdle in getting any kind of technology to this segment is the sheer scale of the market. Using field staff and human resources to support these growers the way we do in the commercial farm space is really not an option. We must use technology to handle the scale.

The exciting change happening across this space is the adoption of Android smartphones. Android devices are now available for as little as $25, and as regions like India and Africa push mobile payments, the adoption of these devices has rapidly accelerated. We’re seeing broad penetration of 40 percent or more in regions like India, with near-universal penetration among the more technically savvy smallholders.

This rapidly growing smartphone capability is ushering in a new wave of ag service providers, as digital is the ideal way to cost-effectively handle the scale.

An entirely new range of capabilities are being enabled through the smartphone, including procurement, market pricing, weather, irrigation control, agronomic advice, direct-to-retail sale and distribution, and a host of other services.

Interestingly, the ecosystem of these new digital service providers in the smallholder space is experiencing many of the same issues we see in the commercial farming sector. While they are all creating unique innovation, they too are facing the same barriers of building account systems, cloud storage, IoT infrastructure, accessing farmers, etc. The services and the value propositions are different, but the fundamentals are the same as the commercial farming sector. The Climate Corporation is currently piloting a project in this space as well, as our mission is to help all the world’s farmers with digital tools.

While we talk a lot about the promise digital ag holds for commercial farming, it’s even more exciting to think about the transformation it may hold for the smallholder space. More than two billion people could have their livelihoods improved through digital technology, and we can only speculate on the potential impact of these changes on the global food supply and reducing the impact of hunger around the world.
“When the farm was transitioned over to me, it was like ‘holy cow there’s a lot of pressure on me to make this thing succeed,’ and there still is. Being able to collect data and have it all in one place - and then being able to sit there and analyze it, on my own ... we’ve learned more about what we’re doing and what we can be doing to make better decisions.”

-JOHN O., NEBRASKA FARMER

CONCLUSION

There’s no question that digital ag will continue to expand in the years to come, providing farmers with increasingly powerful tools to improve harvests and profitability while reducing food security concerns and enabling more sustainable agricultural practices around the globe. But, at the same time, there are significant questions that remain as to how quickly digital tools can develop, and how quickly the digital ag industry, farmers and the entire agriculture ecosystem can adapt to make the most of them.

As we work together to address challenges, answer questions, alleviate fears and advance change, we can expedite the transformation of agriculture into a data insights-driven enterprise. At every step along the way, we are helping to address one of society’s most pressing challenges in feeding a growing population.
Mark Young leads the development of a unified technical vision, architecture, and roadmap to help The Climate Corporation deliver an industry-leading digital agriculture platform. Mark has more than 20 years of experience in Silicon Valley, and growing up on a New Jersey farm has nurtured a unique perspective on digital ag. Mark previously served as a Director of Mobile Product Excellence at Yahoo, the Chief Technology Officer of Mobile Technology at Zynga, and the Founder and Chief Technology Officer at HipLogic.

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