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Technology in Agriculture: Data-Driven Farming

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Executive Summary

Today's technology affords farmers the ability to instantaneously collect data about almost every facet of their cropping (and increasingly, their livestock operations) year-round. As a result, there has been unprecedented growth in the amount of data collected at the farm level. This farm-level "Small Data" increasingly provides management insights to agricultural producers allowing them to manage more risk factors than ever before. At the same time, this profusion of Small Data can now be aggregated by many means to create agricultural "Big Data." Analysis of Big Data in agriculture holds many potential advantages for producers and creates the opportunity for better macroeconomic analysis of farm policy tools, food programs, and management of agricultural risk at a national scale.

The current technological, economic, and legal environments raise issues about how the value of agricultural data will be captured among the agricultural producers generating the data and the agricultural technology providers (ATPs) aggregating it. Producers receiving what they deem to be sufficient value for their data contributions is critical as a potential gateway issue for making those contributions; without large, robust participation in agricultural data systems, such systems will fail to reach their full potential.

Thus, addressing the concerns of agricultural producers with respect to their rights in data, the value it creates, and their privacy if they choose to share their information is vital to see that the agricultural industry collectively maximizes the value of these data technologies. Farmers often express these concerns collectively as a concern about who "owns" their data, and there are no clear answers in the current intellectual property framework. However, the question of agricultural data ownership may not be as important as ensuring farmers always have access to their data can receive value from its use, and can feel comfortable with the level of privacy – or lack thereof – that can be afforded to those participating in Big Data platforms.

Significant steps are already underway to facilitate consensus among industry stakeholders regarding these issues. This Committee and Congress as a whole may best be able to facilitate the realization of Big Data's potential advantages to U.S. agriculture through support of this consensus effort, support of educational efforts to help agricultural producers make informed decisions about how to engage with Big Data systems, continued development of more robust protections for agricultural data shared with the government, and continued support of improved broadband access in rural areas.

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Perhaps the greatest contribution to this testimony and my understanding of agricultural data systems, though, was made by Dr. Marvin Stone. Dr. Stone was a giant in the agricultural data field, contributing tremendously to the development of the Green Seeker technology that significantly advanced machine-sensing of plant health. He was also instrumental in the development of the SAE J1939 standard that forms the foundation for many of the machine data technologies at the heart of this discussion. Beyond being a giant in the field we examine here today, Dr. Stone was a mentor to myself and hundreds of other students at Oklahoma State University. He and his wife were both killed in the tragic Oklahoma State University homecoming parade accident of October 24, 2015. I hope this testimony honors his memory, the contributions he made to this field, to the U.S. agriculture industry, and to all his students.

Issue Analysis

1. Introduction

I would like to thank Subcommittee Chairman Moran, Ranking Member Blumenthal, and the Members of the Committee for the opportunity to present my observations on the collection and utilization of data in agriculture and the legal issues surrounding the concept of Big Data and its application to U.S. farmers and ranchers. This new frontier in agriculture presents a fascinating and sometimes paradoxical mix of cutting edge technology, recent legal changes, and centuries-old doctrines of common law. In my testimony today, I will discuss how both "Small Data" and "Big Data" in agriculture are being utilized by agricultural producers and what lies just over the horizon for those technologies. I will also discuss some of the opportunities and challenges posed by the advancements in agricultural data technology. Then, I lay a framework for discussing the legal issues surrounding Big Data in agriculture, discuss how the current U.S. legal environment addresses ownership and privacy rights in agricultural data, and suggest some potential avenues for policy responses that may facilitate the economic advantages to be gained from the application of Big Data principles to agricultural data while dealing with the concerns associated with such applications.

2. The growth of Small Data and Big Data in production agriculture

The concept of Big Data has exploded in a relatively short period of time. However, there would be no Big Data in agriculture were it not for Small Data. Since these definitions and the issues surrounding data use in agriculture continue to evolve, my testimony today will provide some framing for both.

2.1 Defining core terms in the Data-Driven Farming discussion

Three terms immediately rise to the top in an examination of the agricultural data discussion: agricultural data, Small Data, and Big Data. Taken together, the use of Small Data and Big Data in agriculture is increasingly referred to as "**digital agriculture**."

The concept of **agricultural data** is almost too broad to define, but looking at research in the field and conversations surrounding agricultural data indicates the term centers around two more specific concepts: "telematics" or "machine" data and "agronomic" data. **Telematics data** (sometimes called "**machine data**") refers to the information an agricultural implement (such as a planter) or self-propelled vehicle (such as a tractor or combine) collects about itself. Almost by definition, telematics data comes from agricultural equipment owned, operated, or hired under contract by the agricultural producer. **Agronomic data** refers to information about a crop or its environment, such as "as-planted" information from a seed planter, "as-applied" information from a fertilizer sprayer, yield data from a grain combine, and so on. While agronomic data resembles telematics data in that much of it is gleaned directly from agricultural implements, agronomic data can also be obtained from many other sources such as hand-held sensors, aerial platforms such as manned survey flights or flights by unmanned aerial systems (UAS, commonly called "drones"), and even satellite imagery.

Another piece of the agricultural data puzzle is so-called "metadata," which includes management information such as seeding depth, seed placement, cultivar, machinery diagnostics, time and motion, dates of tillage, planting, scouting, spraying, and input application. In addition to data on the products and how those products are applied, information on external environmental circumstances such as weather including precipitation events, evapotranspiration, and heat unit accumulation help to round out the complete agricultural data package.[1]

Beyond these data sources, numerous other data sources continue to emerge in the agricultural data space. Work continues to build data collection technology in the livestock industries, ranging from GPS-enabled cattle ear tags to "bolus" sensors that can be swallowed by animals to provide health data. Some would argue that vendor-generated data about producers might also fit into this category; such data could include everything from payment history data to customer relationship management (CRM) information (does the producer try to negotiate input prices, have preferences for some products over others, typically buy inputs from one salesperson versus others, etc.).

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[1] T. Griffin, et al., "Big Data Considerations for Rural Property Professionals." JOURNAL OF THE AMERICAN SOCIETY OF FARM MANAGERS AND RURAL APPRAISERS, 2016:167, 168.

Agricultural data is the foundation for Small Data systems. In simplest terms, farms use "**Small Data**" when data are isolated to the fields where the data originated. Farmers who use information technology to conduct their own on-farm experiments, document yield penalties from poor drainage, or negotiate crop share agreements are using data that is considered "small."

Perhaps ironically, the evolution and revolution in agricultural Big Data comes from the expansion of "Small Data" in agriculture.[2] There has been remarkable growth in producers' ability to collect data pertaining only to their own operation through the growth of techniques and technologies such as grid soil sampling, telematics systems for farm equipment, Global Positioning Systems (GPS) / Global Navigation Satellite Systems (GNSS), farm aerial imagery acquired via small unmanned aerial systems (sUAS) and the like. Producer adoption of these information technologies has increased dramatically in recent years,[3] giving rise to a profusion of agricultural data heretofore unseen.[4]

The new abundance of field-level information provided by these technologies could improve the ability of producers to make profit-maximizing decisions benefitting the producer operating the field, *i.e.* Small Data.[5] However, pooling the datasets of hundreds or thousands of fields could hold a much greater potential value both to individual producers and the agricultural industry as a whole. Agricultural Big Data – farm data that has been combined into an aggregate form – has the potential to reveal undiscovered insights. Currently, only limited quantitative evidence exists regarding the value of assembling data from precision agriculture technology into a community; however, indirect evidence suggests farm data has economic value.

While the term **Big Data** is relatively new, it refers to a concept that is not. There are many definitions for the term, but a straight-forward one might be "a collection of data from traditional and digital sources inside and outside your company that represents a source for ongoing discovery and analysis."[6] While this definition sounds much like traditional data analysis (and it is), recent advances in both data collection and transmission increase the analytical power of data analysis procedures by orders of magnitude. The "big" in Big Data comes from the fact data sets continue to grow exponentially both in breadth (with more and more firms collecting data) and depth (with data from more and more sources long the food supply chain being aggregated by more firms). Conceptually, Big Data is defined as

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[2] K. Coble, T. Griffin, A. Misrha, and S. Ferrell, "Big Data in Agriculture: A Challenge for the Future," forthcoming in APPLIED ECONOMICS AND POLICY PERSPECTIVES (accepted for publication October 20, 2017).

[3] T. Griffin, Miller, N.J., Bergtold, J., Shanoyan, A., Sharda, A., and Ciampitti, I.A. 2017. Farm's Sequence of Adoption of Information-Intensive Precision Agricultural Technology. APPLIED ENGINEERING IN AGRICULTURE 33(4):521-527 DOI: 10.13031/AEA.12228.

[4] B. Erickson, and D. Widmar. 2015. *Precision Agricultural Services Dealership Survey Results.* West Lafayette, Indiana, Purdue University, August. Accessed June 21, 2016: http://agribusiness.purdue.edu/files/resources/2015-crop-life-purdue-precision-dealer-survey.pdf

[5] Griffin, *supra* note 3.

[6] L. Arthur. 2013. What is big data? FORBES, CMO Network blog entry. Available at http://www.forbes.com/sites/lisaarthur/2013/08/15/what-is-big-data/, last accessed November 15, 2014.

the analysis of datasets requiring advanced tools to manage the data due to four factors: volume, velocity, variety, and veracity.

Table 1: Big Data defining factors

Factor	Definition
Volume	The sheer amount of data precludes its storage on a single computer system; analytic software must aggregate the data from multiple systems
Velocity	New data enters the analysis continuously at high rates of transmission.
Variety	Data is aggregated from a variety of sources, many of which may use different data formats.
Veracity	Accuracy of the data is vital to correct analysis, while the data source may apply varying (or no) methods of data validation. Thus the Big Data system may have to independently validate the data or make assumptions about its accuracy.

Agricultural data has arguably already crossed over into the realm of Big Data as measured by these factors.

Existing technologies can already generate over 10 MB of data per acre, and when extrapolated over the 90 million acres of corn ground in the U.S., this means 900 terabytes (TB, 1 TB being equal to 1,000,000 MB) of data could be generated on corn acres alone.[7] A student at Ohio State University recently completed the "Terra Byte" project to determine how much data could be garnered from one corn plant, with a resulting 18.4 gigabytes) of data; over a 100 acre corn field, this would be the equivalent of 60 petabytes (PB, 1 PB being equal to 1,000,000,000 MB).[8] Already, the commodity dataset has grown too large to be transported via broadband connections, or even physically via external hard drives, meaning analytical software must go to the data[9] Thus, the volume requirement for Big Data is satisfied.

Looking only at as-planted data collected from planters via telematics, 5.5 MB of data on location, speed, cultivar, and other geo-spatial and meta-data are collected for each acre planted. During planting seasons, the size of the aggregated farm data community becomes much larger every day. Although agricultural operations are seasonal, it should be recognized that even for commodity crops like corn, cotton, soybean, rice, and wheat that peak planting times differ for each such that as-planted data are collected during several

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[7] T. Griffin, "Can Agricultural or Farm Data Be Considered Big Data?" Kansas State University, https://www.agmanager.info/machinery/precision-agriculture/precision-ag-farm-data-blog/can%C2%A0agricultural%C2%A0or%C2%A0farm%C2%A0data%C2%A0be (last visited November 8, 2017).

[8] M. Brookhart and M. Reese. "World Record for Data Collection Set by OSU Precision Ag Team." Ohio Country Journal, October 11, 2017, http://ocj.com/2017/10/world-record-for-data-collection-set-by-osu-precision-ag-team/#.Wd45GMwR0Qo.twitter (last visited November 8, 2017).

[9] Grifin, *supra* note 7

months of the year rather than all at once. In addition to planting, other field operations such as tillage, spray applications, and harvest occur at other times during the season; each operation adding to the community of data. Thus, Griffin observes, planting data alone would satisfy the "velocity" component of Big Data.[10] By the same token, each of these data points are being collected by different brands of equipment using different file formats and supplemented using manually-collected data such as soil samples, all of which may be reported in non-standard formats, satisfying the "variety component."[11]

That leaves the "veracity" component and agricultural data can certainly pose veracity challenges. Such challenges arise from the problems inherent in trying to measure biological processes by mechanical means. Data quality has been a contentious topic in precision agriculture for decades; especially regarding raw yield monitor data and other farm data collected by on-the-go sensors. A part of the debate on the veracity of yield data involves whether the farmer or combine operator properly calibrates the yield monitor. Therefore, both sensors and human error influence farm data quality. Given this, agricultural data appears to more than satisfy the Big Data test.[12]

Although not as prominent to the discussion as Big Data and agricultural data, another important term to define is service provider. **Service provider** (sometimes called an "**Agricultural Technology Provider**" or "**ATP**") is the term frequently used to describe a party external to the farm providing some service regarding either crop production or management of the crop enterprise. Crop production services could include fertilizer or chemical applicators, custom operators, or harvest contractors whose equipment generate agricultural data regarding the farm. Management services include traditional services such as crop consulting and scouting, but increasingly include services targeted specifically at data collection and analysis.

2.2 Opportunities and Challenges arising from Small and Big Data use in Agriculture

It is important to note this discussion would not occur were it not for the tremendous potential the nascent farm data revolution promises. Existing technologies such as real-time kinematics (RTK) and "auto-steer" (sometimes referred to as "GNSS-enabled navigation technology) have already provided substantial economic returns to farmers.[13] Improved sensing of soil conditions, crop health, and yields has led to significantly improved management information for agricultural producers. As mentioned above, this represents Small Data, with data generated – and decisions made – at the farm level.

To date, much of the gains from improved sensing technologies and their sharing with service providers have come from eliminating inefficiencies in the utilization of agronomic

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10 *Id.*
11 *Id.*
12 *Id.*
13 *See, e.g.* M. Darr, "Big Data and Big Opportunities," paper presented at PrecisionAg Big Data Conference, August 21, 2014 (Ames, Iowa).

and machinery inputs. Put another way, we have seen significant increases in the use of Small Data.

Small Data sees a variety of farm-level uses. Data kept isolated to the originating farm has value, but the value of that data is limited to just that farm or potentially to farms in relative proximity. The primary uses of farm data are those for which the data were initially generated such as documenting within-field site-specific yields with a yield monitor.[14] Typically, primary uses of data are restricted to the field that the data originated; consider the analogy of using a computer when that computer is not connected to the Internet. Primary data uses are "local" to the field or operation from which they originate and are not connected to data from other areas.

Considerable effort has been made by farmers, researchers, and others from within and external to the agricultural industry to profitably utilize data generated from precision agricultural technologies. The majority of these efforts have historically focused on one-field-at-a-time or maybe even at the whole farm level but for only that one farm. The value of farm data when isolated to a specific farm has been limited and only of value to that particular farm (or some value for the next farmer of the land). At the very least, the value of that data decays very quickly with distance from the field.

Indeed, it is possible that the site-specific value of farm data might actually play a role in farmland values themselves. Griffin and Taylor[15] explored how big data could impact farmland values and rental rates, stating "It remains unclear whether the 'data premium' [for farmland conveyed with a significant farm-specific dataset] will be a true premium (an amount added to the market price of land) or a penalty (an amount deducted from the market price of land). In the short-run, early movers who choose to provide data to land buyers may see a premium. However, as the transfer of data with a land sale becomes more common, a penalty to land parcels without data may become more common." They also describe how biophysical data, such as historical yield, soil test results, and other production data have been included in farmland sales and/or rental agreements, but they suggest these data have not substantially influenced farmland values nor are sufficient to be considered "big." These historical data could be annual whole-field yield written on paper or site-specific geospatial data including GPS yield monitor data or grid soil samples in either electronic form or printed maps. Although the above mentioned data may provide evidence of historical productivity and soil amendment utilization, they do not impact farmland values directly. Farmland values and rental rates will likely be a function of both quantity and quality of geospatial metadata once the big data sector of the agriculture industry matures.

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[14] Note that secondary uses of data will be discussed later in this testimony.

[15] T. Griffin., and Taylor, M.R. (2015). Precision Agriculture Data Impact on Farmland Values: Big Data in Ag. K-State Department of Agricultural Economics AgManagerInfo AM-TWG-PRAG-4.2015 Online: http://www.agmanager.info/crops/prodecon/precision/PrecisionAgData_FarmlandValues.pdf., last visited November 8, 2017.

Farmers have made use of precision agriculture technology and farm data in a variety of ways, and oftentimes in ways that the manufacturers had not anticipated. An early report on how farmers used yield monitors indicated the primary uses of yield data include but not limited to: 1) conduct on-farm experiments, 2) tile drainage decisions, and 3) split crop share rents.[16] To estimate the value of farm data for each of these examples, the alternative decision making process must be evaluated. However, back of the napkin extreme examples make the point that the value of the above scenarios are finite and limited to a single farm.

Perhaps the most dramatic gains lie ahead, though, as agriculture puts the "Big" in Big Data by compiling datasets of sufficient size to enable much more robust statistical analyses of multiple factors influencing commodity production. Examples of how the aggregation of farm data across large datasets can significantly increase value to farmers are illustrated in Table 2 below.[17]

Table 2: Comparison of Primary and Secondary Agricultural Data Uses

Data	Primary Use "Small Data"	Secondary Use "Big Data"
Yield monitor data	Documenting yields; on-farm seed trials	Genetic, environmental, management effect (G x E x M) analyses
Soil sample data	Fertilizer decisions	Regional environmental compliance
Scouting	Spray decisions	Regional analytics of pest patterns

As an example of initial or primary use of farm data, yield monitor data on one farm can help document the farm's productivity on a field-by-field basis and can illustrate how a seed hybrid performed on that farm in one year, given the environment of that farm for that year and the management practices employed during that year. Interesting opportunities arise when that data is "re-used" in Big Data aggregation with similar data across hundreds or even thousands of farms, and this aggregation creates the bridge linking Small and Big Data.

Such aggregation allows for the evaluation of that cultivar across tens of thousands of permutations of factors such as management practices, soil type, and climate. This enables both seed companies and agricultural producers to learn via observational data in one or two years what would take decades of collections by use of traditional seed trials via experimentation. Soil sample data coupled with yield data can inform an agricultural producer about the nutrient uptake of the crop on his or her farm, but Big Data could allow all the agricultural producers in a region to effectively tackle nutrient loading to impaired water bodies through voluntary management of non-point pollution. Crop scouting can help an individual agricultural producer make decisions about the application of a specific

[16] T. Griffin, "Farmers' Use of Yield Monitors," University of Arkansas Fact Sheet FSA36, available at https://www.uaex.edu/publications/pdf/FSA-36.pdf (last visited November 8, 2017).
[17] Table and scenarios taken from Terry Griffin, "Big Data Considerations for Agricultural Attorneys," paper presented at American Agricultural Law Association Annual Symposium, October 23, 2015 (Charleston, South Carolina).

pesticide, but Big Data could allow a crop industry to spot trends in plant pathogens that could be used to head off the spread of potentially devastating plant health threats. The true maturity of Big Data in agriculture may come when the value of secondary uses realize greater aggregate economic value than the primary uses of the data.[18]

The integration of Small Data and Big Data at the farm level could hold important implications for farms competitiveness.[19] Early adopters of big data in other industries (such as healthcare, transportation, and retail) are shown to have gained a competitive advantage within their industries and have realized significant increases in operating margins.[20] There is an emerging discussion in the agribusiness industry and its literature about the potential of big data and its capacity to change the basis of competition in agriculture.[21] This belief is based on the previous trends in the history of innovations powering productivity and enhancing competitiveness in the agri-food supply chain, enabled by information and communication technology (ICT). Among such examples is precision agriculture powered by GPS, remote sensing, and variable rate technology (VRT) technologies in crop farming. While the adopters of ICT-based applications in agricultural production were primarily motivated by the efficiency gains, they also have laid the foundation for the big data infrastructure within agriculture. As a result, modern farms are generating, or have a capacity to generate, a substantial amount of agricultural production data. This data becomes an important intangible resource alongside the physical and human resources, which if managed effectively, can produce substantial value for the farming operation. The important question to ask is under which circumstances the data, as an intangible resource, can become a source of competitive advantage?

Beyond the benefits of Big Data to production agriculture, it also presents the agricultural economics community with numerous opportunities to enhance and expand the analysis of numerous microeconomic, macroeconomic, and agricultural policy issues.[22] For example, microeconomic farm management issues could now be analyzed by aggregating data across thousands of farms using management decisions as variables instead of using a farm-by-farm case study approach. Food program evaluations, regulatory impact analysis, and demand estimation could be accomplished by rapid aggregation and analysis of grocery store UPC scanner data. Geospatial analysis of crop yields could lead to improved precision in the pricing of crop insurance products. Broad environmental sensor networks

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[18] V. Mayer-Schönberger, and K. Cukier, *Big Data: A Revolution That Will Transform How We Live, Work, and Think*, Kindle Edition. Houghton Mifflin Harcourt Publishing Company, New York, NY. 257 pp. 2014.

[19] This discussion of agricultural data and competitive issues is taken from Griffin, *et al.* , *supra* note 1.

[20] J. Manyika, Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., & Byers, A. H. (2011). "Big data: The next frontier for innovation, competition, and productivity." McKinsey Global Group report, available at https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/big-data-the-next-frontier-for-innovation, last visited November 8, 2017).

[21] S. Sonka. (2014). Big Data and the Ag Sector: More than Lots of Numbers. International Food and Agribusiness Management Review, 17(1), 1-20. Available online at http://www.ifama.org/files/IFAMR/Vol%2017/Issue%201/(1)%2020130114.pdf, last visited November 8, 2017.

[22] The following examples are taken from K. Coble, T. Griffin, A. Misrha, and S. Ferrell, "Big Data in Agriculture: A Challenge for the Future," forthcoming in APPLIED ECONOMICS AND POLICY PERSPECTIVES (accepted for publication October 20, 2017).

coupled with farm data could significantly enhance the ability to manage crop fertilizer applications to minimize nutrient runoff impacts.

To understand the potential policy implications of Big Data's growth in agriculture, one must recall that one of the defining characteristics of agricultural Big Data is combining data from multiple farms into a community. A leading reason for this is that each farmer becomes a variable (rather than a constant) once a critical mass of farms is in the community. When farm data were isolated to a single farm, then there was no opportunity to evaluate the management practices specific to that farmer, *i.e.* the management was held constant.

Farm data must be aggregated to perform community analysis. A leading example of community analysis is evaluating how a product (G for "genetics," from classic varietal or hybrid tests) in a given location (E for "environment," including soils, weather, and other uncontrolled factors) under the farm's production practices (M for "management," including controlled factors such as planting dates, seeding rates, timing of operations, tillage practices and many others). When farm data are not aggregated across numerous farms, then the data remain 'small' and the value is limited since the M in analysis known as GxExM, is not a viable variable (only the traditional GxE). When data are aggregated such that M is a variable to the analysis GxExM, insights can be discovered for a majority of participants. Examples of previously unknown discoveries may include which products or bundle of products (seed, fungicides, planting dates) maximize profitability for a given region under specific farm production practices.

Each player (and each group of players) benefit differently with respect to the big data system. One must consider how these different players benefit to comprehend how the value of Big Data systems may be captured relative to the data contributors (farmers) and aggregators (ATPs). The economics of networks are important to fully understand the value gained from the big data community. The value of the data community depends not only on the quality of the data but on how many others participate in the system. Data from numerous farms aggregated into a community are more valuable than data from any one individual farm. In the long run, the aggregator controlling the flow of data enjoys the majority of the value. Other groups, such as those offering analytic services of the aggregated data, enjoy their value capture especially in the short run. Once a critical mass of farms are in the data community, *i.e.* the long run, farmers' bargaining power with the data aggregator likelywill be greatly reduced.

In the long-run the majority of the value will be enjoyed by the one controlling the data community, *i.e.* the data service provider. Other players such as input manufacturers, retailers, and advisors may enjoy their own levels of varying value capture. The important part to be cognizant is that 1) the farmer is not the only player at the big data table and 2) the farmer is not likely to receive the vast majority of the value from participating in the big data system. However, that is not to say that farmers will not still see potentially important benefits from the analyses provided by Big Data systems. Such systems pose the opportunity of providing potentially unprecedented insights to inform farm management decisions, decreasing production risk, and potentially reducing financial and market risks as well.

While there are countless potentially positive uses of Big Data tools, any tool can also be misused. Farmers, ranchers, and other participants in the agricultural industry have expressed concerns about several potential misuses of agricultural data beyond the mere disclosure of confidential information (discussed below). Some producers worry that the ability of equipment manufacturers to access a significant amount of data about their operations, giving the manufacturers the ability to interpolate the farmer's financial condition and use such information to an unfair advantage in transactions with the farmer or to alter the balance of negotiating power in the manufacturer's favor for any number of transactions. Others worry about government agencies taking advantage of aggregated datasets to acquire information that the producer could not be compelled to produce without a formal legal process. Yet another concern is that falsified data could be introduced into individual or aggregated agricultural datasets to skew environmental assessments of farm performance.

One additional Big Data challenge worries both producers and economists. As stated in Coble, *et. al:*[23]

> The Holy Grail for market participants is to get perfect information as soon as it is knowable, and preferably before it is knowable to others. While Big Data has a long, long way to go before achieving this, bigger steps toward that goal are being taken faster than ever before. Thus, a significant concern with aggregating agricultural data is whether – either legitimately or not – a small number of market participants (or a single actor) could get access to information sufficient to move (or even manipulate) markets faster than, or to the exclusion of, other market participants. While there are numerous rules in place to deal with a broad range of market-manipulating activities, none of these current rules contemplate the type of actions that could take place with a sufficiently large aggregated dataset. Currently, there are various rules restricting insider trading (see 17 C.F.R. §1.59(a), 17 C.F.R. § 1.3(ee)), and government employees are prohibited from using data for financial gain that has not been disseminated to the public (7 U.S.C. §6c(a)(3)). However, there are no rules governing "very good market information" such as that which could be obtained through completely legal means by aggregating sufficient telematics data (as an example). As a result, research on the potential market effects of growing market asymmetries that could be triggered by growing Big Data aggregations and the implications of policies restricting the use of aggregated data in commodity market transactions could do much to inform the development of law in the arena.

Only time and experience will tell whether these concerns are well-founded, but the fact they exist may well impact producers' willingness to participate in Big Data systems, and

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[23] *Supra*, note 22.

thus impact the future of the industry. Most industry observers believe the benefits to individual producers and the agricultural industry as a whole far outweigh the potential risks. However, bringing about the full economic benefits of Big Data in agriculture requires a robust system by which large numbers of agricultural producers can share their data since the predictive power of statistical analysis increases with the number of observations available for each variable examined[24]. The agricultural data industry is working tirelessly to create those systems. The issue is one of trust – farmers must feel they can trust Big Data systems before they will participate. Thus, the issue of most concern to this hearing may not be whether we will have systems that *can* accept and analyze that data; it is perhaps how Congress can facilitate the development of an environment in which farmers *will* share their data. Metcalfe's Law states that the value of a network is proportionate to the number of its members. Put another way, Facebook has little value if you are its only member, but it has tremendous value when populated by millions of members. Thus, agricultural producers can only harness the value of Big Data if we can foster an environment in which they are comfortable sharing their data. However, that participation might be inevitable given the increasing prevalence of data-collection technologies. As Griffin and Shanoyan observe, going "off the grid" with respect to agricultural data may be possible in the near term, but eventually will require farmers to use then-antiquated technology, placing them at further competitive disadvantage.[25]

Given this potential inevitability of data sharing, one must turn to questions of what rights farmers can retain in their shared data. Do they retain ownership of their information? Is there any hope of retaining their privacy in that information once it is shared?

2.3 Framing the legal issues surrounding data in agriculture

The issues involved in the discussion of data in agriculture are almost innumerable, but many can be brought under the umbrella of two over-arching concepts: agricultural data ownership, and protections against its unauthorized disclosure. Although each of these issues is discussed in greater detail later in this testimony, a brief framing of each issue is provided here.

2.3.1. Ownership of agricultural data

As agricultural producers began to realize the information they were generating (and, in some cases, sharing with service providers) had potential economic value, questions began to arise regarding who had the superior "ownership" right to that information, given that multiple parties had a hand in its creation. Further, the realization of agricultural data's value changed the relative negotiation power between parties. This is an important concept; if their data is shared by someone other than them with a third party, that sharing may cause the farmer to lose negotiation power with vendors, landlords, and the like as a

[24] *See generally* GEORGE G. JUDGE, ET AL, INTRODUCTION TO THE THEORY AND PRACTICE OF ECONOMETRICS (2nd ed, 1988), 96.

[25] T. Griffin and A. Shanoyan, "Is Going Off the Grid Possible in the Age of Farm Data?" Kansas State University, https://www.agmanager.info/machinery/precision-agriculture/precision-ag-farm-data-blog/going-grid-possible-age-farm-data (last visited November 7, 2017).

result. Thus, farmers may wish to assert "ownership" of data so as to exercise one of the rights of property ownership, namely, to exclude others from its use. Thus, this issue might be framed as "*Who owns data generated about an agricultural producer's operation?*"

2.3.2. Privacy rights for agricultural data

As discussed in more detail below, it is possible – and even likely –the greatest economic value of agricultural data to the farm owner comes not from his or her own analysis of the data but from its aggregation with data from hundreds or even thousands of other farms (in a true Big Data model) to provide management information and trend identification that could not be derived from any smaller dataset. For example, one of the most common analyses provided by ATPs to farmers are "comparative analytics" (for example, benchmarking performance relative to similarly-situated operations). While that might have some economic value for the producer, much greater benefits await via advanced analysis. The balance of negotiating power between the farmer and the aggregator will eventually determine what proportion of the analyses conducted benefit each party. While aggregation may in some ways reduce the disclosure or discovery of information about any one farm (through the anonymization of individual farm data by aggregation with many other farms), it naturally also raises fears about the release of that information (whether the result of intentional activity such as database hacking or an accidental disclosure). This leads to the second question: "*What protections prevent the disclosure of agricultural data to outside parties?*"

3. Current Legal Framework for Ownership of Agricultural Data

The United States has one of the most robust systems of property rights in the world, empowered by a legal system making it easy (relatively speaking) to enforce those rights. Thus, the first place many look for a means of protecting one's data from misappropriation and/or misuse is the property right system. This requires one to examine who "owns" agricultural data. The answer to the question is not simple, though, as traditional notions of property ownership find challenge in their application to pure information.

The notion of property ownership typically involves some form of six interests, including the right to possess (occupy or hold), use (interact with, alter, or manipulate), enjoy (in this context, profit from), exclude others from, transfer, and consume or destroy. Some of these interests do not fit, or at least do not fit well, with data ownership. Excluding others from data, for example, is difficult, particularly when it is possible for many people to "possess" the property without diminishing its value to the others, just as the value of a book to one person may not be diminished by the fact other people own the same book.[26] Thus, the better question may be "*What are the rights and responsibilities of the parties in a data disclosure relationship with respect to that data*?"[27]

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[26] L. Smith. 2006. "RFID and other embedded technologies: who owns the data?" SANTA CLARA COMPUTER AND HIGH TECHNOLOGY LAW JOURNAL

[27] R. Peterson. 2013. "Can data governance address the conundrum of who owns data?" Educause blog, http://www.educause.edu/blogs/rodney/can-data-governance-address-conundrum-who-owns-data, last accessed November 8, 2017.

Data is difficult to define as a form of property, but it most closely resembles intellectual property. As a result, the intellectual property framework serves as a useful starting point to define what rights a farmer might have to their agricultural data. Intellectual property can be divided into four categories: (1) trademark, (2) patent, (3) copyright, and (4) trade secret. The first three areas compose the realm of federal intellectual property law as they are defined by the Constitution as areas in which Congress has legislative authority.[28] Since trademark is not relevant to a discussion about data,[29] the analysis will focus on patent, copyright, and trade secret.

3.1 Application of patent law to agricultural data

The U.S. Patent Act states "whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor" (35 U.S.C. § 101). Generally, for an invention to be patentable, it must be useful (capable of performing its intended purpose), novel (different from existing knowledge in the field), and non-obvious (somewhat difficult to define, but as set forth in the Patent Act, "a patent may not be obtained… if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains").[30] Patent serves as a poor fit for a model of agricultural data ownership since it protects "inventions." Raw data, such as agricultural data, would not satisfy the definition of invention.

It should be noted patentable inventions could be derived from the analysis of agricultural data. While this does not mean the data itself is patentable, it does suggest that any agreement governing the disclosure of agricultural data by the agricultural producer should address who holds the rights to inventions so derived.

3.2 Application of copyright law to agricultural data

The federal Copyright Act states the following:

Copyright protection subsists, in accordance with this title, in original works of authorship fixed in any tangible medium of expression, now known or later developed, from which they can be perceived, reproduced, or otherwise communicated, either directly or with the aid of a machine or device. Works of authorship include the following categories:

literary works;
musical works, including any accompanying words;
dramatic works, including any accompanying music;

[28] U.S. Constitution, Article I, § 8, clause 8.
[29] The Federal Trademark Act (sometimes called the Lanham Act) defines trademark as "any word, name, symbol, or device, or any combination thereof...to identify and distinguish his or her goods, including a unique product, from those manufactured or sold by others and to indicate the source of the goods, even if that source is unknown." 15 U.S.C. § 1127.
[30] 35 U.S.C. §§ 102, 103.

pantomimes and choreographic works;
pictorial, graphic, and sculptural works;
motion pictures and other audiovisual works;
sound recordings; and
architectural works. [31]

More so than trademark and patent, the copyright model at least resembles a model applicable to agricultural data. At the same time, however, the model also has numerous problems in addressing agricultural data. First, the list of "works of authorship" provided in the statute strongly suggests a creative component is important to the copyrightable material. Second, the term "original works of authorship" also has been interpreted to require some element of creative input by the author of the copyrighted material. This requirement was highlighted in the case of *Fiest Publications Inc. v. Rural Telephone Service Company*,[32] where the U.S. Supreme Court held the Copyright Act does not protect individual facts. In *Fiest*, the question was whether a pure telephone directory (consisting solely of a list of telephone numbers, organized alphabetically by the holder's last name) was copyrightable. Since the directory consisted solely of pure data and was organized in the only practical way to organize such data, the Supreme Court held the work did not satisfy the creative requirements of the Copyright Act.[33] This ruling affirmed the principle that raw facts and data, in and of themselves, are not copyrightable. Put another way, the fact that ABC Plumbing's telephone number is 555-1234 is not copyrightable. However, an author can add creative components to facts and data such as illustrations, commentary, or alternative organization systems and can copyright the creative components even if they cannot copyright the underlying facts and data. Continuing the analogy, ABC's phone number alone is not copyrightable, but a Yellow Pages® ad with ABC Plumbing's number accompanied by a logo and a description of the company's services *would* be copyrightable.

Agricultural data in and of itself may not be copyrightable, but it can lead to copyrightable works. For example, agricultural data may not be copyrightable, but a report summarizing the data and adding recommendations for action might be. Again, then, it is incumbent upon those disclosing agricultural data to include language in their agreements with the receiving party to define the rights to such works derived from the data.

A separate issue regarding copyrights deriving from agricultural data also continues to emerge. Increasingly, the original agricultural data is never even disclosed to the agricultural producer; rather, the data has been processed into a report or a new form through use of a computer algorithm. Quite simply, agricultural producers may often receive a completely computer-generated report with no human author. This requires moving into the realm of copyrights in computer generated works – an area that is far from settled.[34] The evolution of understanding who holds the rights to computer-generated works with regard to agricultural data played out recently in the discussions surrounding

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[31] 17 U.S.C. § 102(a).
[32] 499 U.S. 340 (1991).
[33] *See id.*
[34] *See generally* M. Leaffer, UNDERSTANDING COPYRIGHT LAW, 109-110 (5th ed. 2011).

comments by Deere & Company on proposed exemptions to the Digital Millennium Copyright Act[35] regarding copyright protection systems in vehicle software.[36]

3.3 Application of trade secret law to agricultural data

While trademark, patent, and copyright do not appear to fit as models for farm data ownership, trade secret has the potential to serve the agriculture industry's concerns regarding rights in data shared with Big Data service providers. Importantly, trade secret is a function of state law (unlike trademark, patent, and copyright, which are all creatures of federal law). At the time of this testimony, all but three states have adopted the Uniform Trade Secrets Act, providing a degree of consistency in trade secret law across most states.

Under the Uniform Trade Secrets Act ("UTSA"), a "trade secret" is defined as:

> … information, including a formula, pattern, compilation, program, device, method, technique, or process, that:
> (i) derives independent economic value, actual or potential, from not being generally known to, and not being readily ascertainable by proper means by, other persons who can obtain economic value from its disclosure or use, and
> (ii) is the subject of efforts that are reasonable under the circumstances to maintain its secrecy.

Importantly, this definition makes clear "information… pattern[s], [and] compilation[s]" can be protected as trade secret. This, at last, affords hope of a protective model for farm data. This is not to say that trade secret is a perfect model for protecting farm data, however. Note the two additional requirements of trade secret: first, the information has actual or potential economic value from not being known to other parties, and second, it is the subject of reasonable efforts to maintain the secret.

The first provision requires that to be protected as a trade secret, farm data such as planting rates, harvest yields, or outlines of fields and machinery paths must have economic value because such information is not generally known. While a farmer may (or may not) have a privacy interest in this information, the question remains as to whether the economic value of that information derives, at least in part, from being a secret. The counterargument to that point is the economic value of the information comes from the farmer's analysis of that information and the application of that analysis to his or her own operation – a value completely independent of what anyone else does with the information – and that the information for that farm, standing alone, has no economic value to anyone else since that

[35] 17 U.S.C. §§ 512, 1201–1205, 1301–1332; 28 U.S.C. § 4001

[36] *See* Deere & Company, "Long Comment Regarding a Proposed Exemption Under 17 U.S.C. 1201" (2015). Available at http://copyright.gov/1201/2015/comments-032715/class%2022/John_Deere_Class22_1201_2014.pdf (last visited November 8, 2017). *Compare* K. Weins, WIRED (Business Blog Section, online edition) (editorial) "We Can't Let John Deere Destroy the Very Idea of Ownership," April 21, 2015. http://www.wired.com/2015/04/dmca-ownership-john-deere/ (last visited November 8, 2017).

information is useless to anyone not farming that particular farm.[37] One can see this first element poses problems for the trade secret model. It should be noted here there is a clear economic benefit to the collection of farm data; otherwise companies would not be investing billions of dollars to position themselves in the agricultural data industry.[38] This represents a question yet to be answered clearly by the body of trade secret law: whether one can have trade secret protection in information that standing alone has no economic value to other parties, but does have such value when aggregated with similar data from other parties.

The second provision – the data be subject to reasonable efforts to maintain its secrecy – also finds problems in an environment where the data is continuously uploaded to another party without the intervention of the disclosing party. The fact that data are disclosed to another party does not mean it cannot be protected as a trade secret; if that were the case, there would be little need for much of trade secret law. Rather, the question is how and to whom the information is disclosed. As noted in the Restatement (Third) of Unfair Competition's comments on the Uniform Trade Secret Act, "…the owner is not required to go to extraordinary lengths to maintain secrecy; all that is needed is that he or she takes reasonable steps to ensure that the information does not become generally known."[39]

The question becomes what constitutes "reasonable steps" to keep continuously uploaded data protected, or data that is voluntarily shared with a Big Data ATP. Almost certainly this means there must be some form of agreement in place between the disclosing party and the receiving party regarding how the receiving party must treat the received information, including to whom (if anyone) the receiving party may disclose that information. Such agreements are discussed in greater detail below. However, there is some question as to whether any agreement could protect the trade secret claim for data that was disclosed to an ATP. When one discusses farm data privacy, one often consider the concept of remaining anonymous. However, in the Big Data world anonymity is no longer achievable, at least in the same manner as it once was. Mayer-Schönberger and Cukier describe how even sanitized data can reveal the identity of individuals by combining additional layers of (probably publicly available) data. Given the prevalence of public geospatial data, data from USDA, and plat maps, it is possible in many circumstances to use those data layers with a sanitized community of farm data to reveal all the data that were intended to remain anonymous. As a result, one could argue sharing data with an aggregator essentially renders it ineligible as a trade secret (regardless of a non-disclosure agreement with the aggregator) since the receiver cannot make a reasonable guarantee that the data can be kept secret.[40] This concept has implications not only for the potential

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[37] An agricultural producer could, hypothetically, use such data to bid rented agricultural land away from another tenant if they could somehow demonstrate they could provide the landowner with evidence they could increase the landowner's returns. However, this seems a tenuous argument for the economic value element of the UTSA test and has no application at all in a scenario with owned agricultural land.

[38] *See* B. Upbin, FORBES (Tech business blog), "Monsanto Buys Climate Corp for $930 Million," October 2, 2013. http://www.forbes.com/sites/bruceupbin/2013/10/02/monsanto-buys-climate-corp-for-930-million/.

[39] Smith, *supra* note 26, *citing* Restatement of Unfair Competition (Third) §757 (1995).

[40] Griffin and Shanoyan, *supra* note 25.

application of trade secret principles to agricultural data, but to broader privacy policy concerns as well.

Assuming for the moment that trade secret protection can be obtained for agricultural data, one should consider the use of a "non-disclosure agreement" when sharing data with an ATP. While an explicit written "non-disclosure agreement" (or "NDA") is not necessary to claim trade secret protection, such an agreement is almost certainly a good idea if an agricultural producer wishes to retain a protectable ownership interest in their data if such an interest exists. Not only can such an agreement clarify a number of issues unique to the relationship between the disclosing and receiving parties, but also can address numerous novel issues in the current information environment that trade secret law have not yet reached.

The concept of NDAs as separate agreements may be practicable for one-on-one relationships, such as those between agricultural producers and smaller consulting firms, negotiating separate agreements with multiple entities poses significant transaction costs. This problem is particularly magnified when one considers larger corporate service providers who would face the issue of negotiating tens of thousands of NDAs. Unsurprisingly, such entities choose to create standard agreements in their form contracts. While certainly understandable, this in turn creates the "opt-out problem" wherein a farmer who believes the form contract does not adequately protect his or her interests is forced to either agree to the form or do without the product or service – which may be the only product or service compatible with a significant portion of the very expensive equipment he or she already owns or uses. This then provokes the discussion of whether such contracts are enforceable or are, instead, adhesion contracts. There is yet to be found consistency among federal courts as to the enforceability of such software use agreements.[41]

To conclude the trade secret analysis, colorable arguments exist both for and against the proposition farm data poses an "ownable" and protectable trade secret. That said, this option provides the best doctrinal fit among the traditional intellectual property forms, and farmers wishing to preserve whatever rights they do indeed have in that data seem best advised to use the trade secret model to inform the their protective measures. Even so, use of trade secret doctrine as a protective measure for agricultural data has drawbacks in the lack of consistency among states in trade secret law (although the UTSA has done much to add consistency to the field) and the fact it is often a "backward looking" and costly solution since trade secret must frequently be used to seek damages (which are often difficult to both prove and quantify) through litigation after a disclosure has already been made.

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[41] The asymmetry of EULA's has led to allegations they represent "adhesion contracts" and should not be enforceable as a matter of policy. However, some courts have found insufficient evidence of adhesion and held such agreements enforceable. *Compare* cases finding EULAs enforceable: *Ariz. Cartridge Remanufacturers Ass'n v. Lexmark Int'l, Inc.,* 421 F.3d 981 (9th Cir., 2005); *ProCD, Inc. v. Zeidenberg,* 86 F.3d 1447 (7th Cir. 1996); *Microsoft v. Harmony Computers,* 846 F. Supp 208 (E.D.N.Y. 1994); *Novell v. Network Trade Center,* 25 F. Supp. 2d. 1218 (D. Utah, 1997) *with* cases finding EULAs unenforceable: *Step-Saver Data Systems Inc. v. Wyse Technology,* 939 F.2d 91 (3rd Cir. 1991); *Vault Corp. v. Quaid Software Ltd.* 847 F.2d 255 (5th Cir. 1988); *Klocek v. Gateway, Inc.,* 104 F. Supp. 2d 1332 (D. Kan. 2000).

4. Current Legal Framework for Privacy Rights in Agricultural Data

Those concerned about the disclosure of personal data can certainly cite a number of damaging data breach examples. Recent history suggests many of the real threats in data transfers come from insufficient controls to prevent the disclosure of personally identifiable information ("PII") to outside parties and inadequate agreements on the uses of data by parties to whom it is disclosed.

To the extent producers regard agricultural data as proprietary, their concerns about its disclosure naturally invite a review of the release or theft of proprietary information in other sectors. One need not look far into the past to find numerous examples of the disclosure of PII, whether merely inadvertent or the result of targeted hacks. Attacks on companies' payment systems have resulted in the credit card information of hundreds of millions of customers from Adobe Systems (150 million customers), Heartland Payment Systems (130 million customers), TJX (parent company of TJ Maxx and Marshalls, 94 million customers), TRW Information Systems (credit reporting company, 90 million customers), Sony (70 million customers) each of which dwarf breaches attracting more media attention such as Home Depot (56 million customers) and Target (40 million customers).[42] Perhaps the most troubling data breach in recent history, though, was the 2017 Equifax data breach, which exposed a large array of personal and financial data for over 143 million.[43] The Equifax breach is especially troubling for many consumers, as Equifax was entrusted with the most sensitive personal information consumers could provide, and was supposed to serve as a secure repository for that information. It is reasonable to surmise that particular breach was a significant setback for the trust of agricultural producers in systems that could collect their financial data.

To some extent, there may be a very limited reasonable "expectation of privacy" in agricultural data since a significant segment of such data is available from public sources or sources obtainable from public vantage points (such as aerial or satellite imagery). Nevertheless, there remains an also-significant segment of data for which an argument could be made that a privacy interest exists. The challenge may be figuring out who has the best ability to protect that data from disclosure.

The greatest risk of data breaches for agricultural producers may be attacks against aggregators, since attacks against individual farm systems pose very high barriers relative to the amount of data such an attack could obtain. Theoretically, a hacker could tap into the tractor/implement network (also called the tractor/implement bus) using a number of commercially-available technologies allow farmers to plug into the network and access Controller Area Network ("CAN") messages directly; for example, one could purchase a CAN message reader ("CAN sniffer") to read machine diagnostic codes for repairs.[44]

[42] J. Pepitone, "5 of the Biggest-ever Credit Card Hacks," (2013) CNN Money, a*vailable at* http://money.cnn.com/gallery/technology/security/2013/12/19/biggest-credit-card-hacks/ (last visited November 8, 2017).

[43] Federal Trade Commission, "The Equifax Data Breach: What to Do." https://www.consumer.ftc.gov/blog/2017/09/equifax-data-breach-what-do (last visited November 8, 2017).

[44] Interview with Dr. John Fulton, Ohio State University Department of Food, Agricultural, and Biological Engineering, July 6, 2015.

Someone wishing to "steal" data would likely not want to be present to retrieve the data from the device, though, and would likely prefer to use a CAN data logger coupled with a device to wirelessly transmit the data. Many data loggers are available to the public as well; for example, the "Snapshot®" device used by Progressive Insurance for some insurance programs is simply a CAN data logger plugged into a vehicle's On-Board Diagnostic (OBD-II) port.[45] Alternatively, of course, if one wanted to steal large amounts of agricultural data at once, one could attempt to hack a cellular network provider used by an equipment manufacturer to carry their data signals. Further, it should be noted the equipment manufacturer likely has no ability to specify or enforce the security protocols used to safeguard such cellular transmissions.

While such an approach would work for standard messages transmitted over the bus, it would not work for proprietary messages. To decode such messages, the prospective hacker would have to develop a system for decoding the information being provided from the task controller for the implement, and that task would take almost as much work (if not more) than the work in developing the task controller system in the first place.[46] Note, that several companies now provide means for reverse-engineering proprietary CAN messages (such as those related to crop yield) so farmers can automatically transfer yield data to the cloud. Such technology could also be used to decode other proprietary information.[47] Perhaps ironically, the growth of proprietary data network protocols that lead to complaints about the lack of interoperability of farm equipment systems could also provide greater protection against data breaches.

Additionally, the Global Positioning System "GPS" receiver in most systems connects directly to the implement's task controller. As a result, a "bug" might receive information about the commands sent to the implement but without the associated location data, rendering it meaningless. The bug would require its own GPS receiver along with implement data (the configuration and dimensions of the implement), which today could be done for a modest equipment cost.[48] Obtaining agronomic data via a physical connection to an implement poses a task manageable for someone knowledgeable in SAE J1939 and ISO 11783[49] technology.[50] However, building and deploying such a device

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[45] *See* Progressive Corporation, "Snapshot® Terms and Conditions," https://www.progressive.com/auto/snapshot-terms-conditions/ (last visited November 8, 2017).

[46] *See* interview with Dr. Marvin Stone (June 10, 2015).

[47] Interview with Dr. John Fulton, Ohio State University Department of Food, Agricultural, and Biological Engineering, July 6, 2015.

[48] A relatively quick search of Google will yield many GPS receiver units for less than $50.

[49] SAE International, "The SAE J1939 Communications Network: An Overview of the J 1939 Family of Standards and How they are Used," 5 (white paper), *available at* http://www.sae.org/misc/pdfs/J1939.pdf (last visited November 8, 2017). *See also* INTERNATIONAL ORGANIZATION FOR STANDARDIZATION, ISO DRAFT INTERNATIONAL STANDARD ISO/DIS 11783: TRACTORS AND MACHINERY FOR AGRICULTURE AND FORESTRY – SERIAL CONTROL AND COMMUNICATIONS DATA NETWORK (2012). The ISO 11783 standard is often referred to as the "ISOBUS standard" and defines how the on-board computer networks on most agricultural equipment works and how their individual components work together. Combined, SAE J1939 and ISO 11783 govern much of how the data-collection network on any agricultural equipment works.

[50] M. Miettien, "Implementation of ISO 11783 Compatible Task Controller," XVI CIGR (International Commission of Agricultural and Biosystems Engineering) World Congress, Bonn, Germany (2006), available at http://users.aalto.fi/~ttoksane/pub/2006_CIGR20062.pdf (last visited November 8, 2017).

poses a significant amount of effort (to say nothing of the potentially-criminal trespass involved in deploying it) in relation to the prospect of collecting data on only one farm.

As illustrated from this discussion, a number of factors in the configuration and operation of farm data networks limit the opportunities for hackers to take agricultural data directly from the agricultural producer. Admittedly, most producers put little thought into their systems being physically hacked but worry instead about their data being accessed through an intercepted cellular signal. They might also worry about a bad actor hacking the system to implant false data. First, virtually all cellular signals are encrypted when transmitted and decrypted at the cellular tower;[51] without the decryption key, interpreting any data transmitted would be difficult (although not impossible for a sophisticated hacker; recent news has highlighted the ability of some groups to do so[52]). The use of data encryption through a secure sockets layer ("SSL") protocol by the farmer and his or her service provider in data transfers adds another difficult-to-break security barrier to interception of the data.[53]

Most agricultural data disclosed to a service provider is likely in the form of telematics data, raw data regarding crop production, GIS information about the farm, and other similar types. Conversely, hackers frequently go after large concentrations of data with easily-converted financial value, such as credit card information. Thus, it may be difficult for hackers to make a "quick buck" from agricultural data making it a less-appealing target of attack. Nevertheless, an adage in computer security is "where there is value, there will be a hacker."[54] As a result, systems storing agricultural data are less likely to be directly attacked, but farmers are understandably concerned that PII may be stolen if, for example, their vendor account information is somehow linked to their agricultural data or if their account information is stored with a third party that is a more appealing target. Depending on the type of computer at issue and its common use, the federal Computer Fraud and Abuse Act ("CFAA")[55] may provide a means of prosecuting unauthorized access of the computer in the event agricultural data linked to PII is compromised. Discussed below, the federal Electronic Communications Privacy Act (ECPA)[56] could also be used as a potential prosecutorial tool for those attempting to intercept agricultural data during the data transmission process.

The theft of PII by criminals is one threat posed by data transfers, but so too is the inadvertent, or perhaps intentional but misinformed, disclosure of data by the party

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[51] For a primer on the process of encoding and decoding cellular signals, *see* How Stuff Works, "How Cell Phones Work," http://electronics.howstuffworks.com/cell-phone.htm (last visited November 8, 2017).
[52] *See* C. Timberg & A. Soltani, *By Cracking Cellphone Code, NSA Has Ability to Decode Private Conversations*, THE WASHINGTON POST, December 13, 2013. Online edition, *available at* http://www.washingtonpost.com/business/technology/by-cracking-cellphone-code-nsa-has-capacity-for-decoding-private-conversations/2013/12/13/e119b598-612f-11e3-bf45-61f69f54fc5f_story.html (last visited November 8, 2017).
[53] *See* C. Heinrich, *Secure Socket Layer (SSL)*, in ENCYLOPEDIA OF CRYPTOGRAPHY AND SECURITY 1135 (Henck C.A. van Tilborg, Sushil Jajodia, eds., 2011)
[54] S. Sammataro, "Cybersecurity for Small or Regional Law Firms," paper presented at American Agricultural Law Association Annual Symposium, Charleston, South Carolina (October 23, 2015).
[55] 18 U.S.C. §§ 1030 *et seq.*
[56] 18 U.S.C. §§ 2510 *et seq.*

receiving that data. Take, for example, the disclosure of thousands of farmers' and ranchers' names, home addresses, GPS coordinates and personal contact information" by EPA in response to a Freedom of Information Act (FOIA) request regarding concentrated animal feeding operations (CAFOs) which prompted a lawsuit from the American Farm Bureau Federation and National Pork Producers Council alleging the agency overstepped its authority in doing so.[57] While this event represents the disclosure of information by an enforcement agency, many farmers fear the converse – that an enforcement agency could compel a data-receiving party to disclose information even if such disclosure were not legally required. Another concern is whether an adverse party in litigation (or even a party contemplating litigation) could persuade a party holding a farmer's data to disclose the data as an aid to their case, again even if such disclosure was not legally required.

Much work remains to be done on defining governmental safeguards against disclosures, and even more work remains to be done in defining how the government can obtain electronic data. Although laws such as the ECPA (heavily modified by the USA Patriot Act) govern the acquisition of information through intercepted communications, there is little law to prevent a government agency from simply requesting data from a service provider. Anecdotal evidence suggests service providers and their legal counsel continue to struggle in defining parameters for how to respond to non-subpoenaed requests for data by government agencies.

All these issues surround restrictions on the taking of information by some unauthorized (or at least questionable) means. While there are at least some laws potentially applicable in these circumstances, there are no laws defining an inherent privacy right in agricultural data.[58] For example, the federal Health Insurance Portability and Accountability Act ("HIPAA")[59] provides privacy rights and restrictions against disclosure of health information; the Gramm-Leach Bliley Act (also known as the Financial Modernization Act of 1999)[60] and Fair Credit Reporting Act[61] protect financial information from disclosure; the Privacy Act of 1974[62] restricts disclosures of personal information by held by the federal government. As of now, though, there are large categories of agricultural data that may fall between the cracks of these laws with no federal (and in most cases, no state) protections against its disclosure.

5. Potential Policy Responses to Address Agricultural Data Issues

Having reviewed the current legal environment surrounding the ownership rights and privacy protections relevant to agricultural data, what can this Committee and Congress do

[57] S. Wyant, "Farm Groups File Lawsuit to Stop EPA Release of Farmers' Personal Data." Agri-Pulse (2013), *available at* http://www.agri-pulse.com/Farm-groups-file-lawsuit-to-stop-EPA-release-of-farmers-personal-data-07082013.asp (last visited November 8, 2017).

[58] T. Janzen, "Legal Issues Surrounding Farm Data Ownership, Transfer, and Control," paper presented at American Agricultural Law Association Annual Symposium, Charleston, South Carolina (October 23, 2015).

[59] 42 US.C. §300gg, 29 U.S.C. §§ 1181 *et seq.* and 42 U.S.C. §§ 1320d *et seq.*

[60] 15 U.S.C § 6803.

[61] 15 U.S.C. §§ 1681 *et seq.*

[62] 5 U.S.C. § 552a.

to enable U.S. farmers and ranchers to take maximum economic advantage of Big Data tools? As referenced above, Big Data cannot be Big Data without "buy-in" to the system from large numbers of agricultural producers. In these beginning years of agricultural data systems, there are many ATPs vying for farmers and their acreages to enroll in their systems. As the system matures, this relationship will likely shift, and there will be few (or perhaps only one) ATP and the vast majority of farms may be participating. Nevertheless, for the maturation process to begin, agricultural producers must "buy in" to the system. At a fundamental level, that buy-in requires trust in the system from those producers. That trust, in turn, likely requires answers to the questions of ownership and privacy in agricultural data.

None of the federal intellectual property laws directly address who holds a protectable intellectual property right in agricultural data. Arguably, the most appropriate fit may be found in state law under the UTSA, although the applicability of that law is questionable as well. The UTSA may provide a useful map to any Congressional efforts to help define ownership rights in agricultural data. Passage of statutory law defining ownership of "agricultural data" may be a daunting task given the complexity of the current federal and state intellectual property framework (which also draws from centuries of common law). Thus, it may be advisable instead to use a consensus-driven approach among agricultural producers and service providers to define agricultural data rights. The coalition led by the American Farm Bureau Federation and its "Privacy and Security Principles for Farm Data"[63] represents a tremendous step forward on this issue. Other groups, such as the Open Ag Data Alliance, continue to build coalitions on the technical side of the Big Data issue to develop systems and standards embodying the principles of interoperability, security and privacy.[64] The next step is to see continued cooperation among groups such as these in integrating their principles in legally-binding service agreements.

Another collaborative effort to help agricultural producers evaluate the data policies and protections of data service providers has been the Ag Data Transparency Evaluator, coordinated by the American Farm Bureau Federation, which requires service providers to undergo a ten-factor review (based in part on the Privacy and Security Principles, with the review self-reported by the service provider) with a satisfactory review resulting in the "Ag Data Transparent" seal.[65] Congressional support of this and other efforts to equip farmers and ranchers in evaluating the data tools available can help foster trust, encourage Big Data participation, and drive many of the potential advantages Big Data services have to offer.

Modern agricultural producers are expected to be proficient in a broad array of the disciplines of science and business, but few have a background in intellectual property law. Support of educational programs to help these producers understand the legal issues at play in Big Data service agreements could do much to help increase trust, advance the consensus

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[63] American Farm Bureau Federation, "Privacy and Security Principles for Farm Data," November 13, 2014 (revised April 1, 2016). Available at https://www.fb.org/issues/technology/data-privacy/privacy-and-security-principles-for-farm-data (last visited November 8, 2017).
[64] Open Ag Data Alliance, "Principals and Use Cases," http://openag.io/about-us/principals-use-cases/ (last visited November 8, 2017).
[65] *See* www.agdatatransparent.com (last visited November 8, 2017).

process, and empower producers to make informed decisions about the cost-benefit analysis of sharing their data under those service agreements. The consensus process may also provide a vehicle for developing an understanding among all stakeholders as to the privacy protections necessary and appropriate to protect agricultural data, which occupies a unique space between purely personal and business information. Such information does not readily fit into the existing framework of federal privacy laws, and as business information, may not belong in such a framework.

One matter in which Congressional action may be directly applied is the development of clearer guidelines regarding the production of agricultural data held by private data aggregators, more robust safeguards against inadvertent disclosure or intentional hacking by outside parties, and clear guidance on when disclosure of government-held data is, and is not, required under the Freedom of Information Act[66] or other circumstances.

Finally, although outside the direct scope of a discussion of legal issues in agricultural use of agricultural data tools, rural access to wireless broadband services is crucial to fully utilizing the potential of agricultural data systems. Before the rapid adoption and usage of agricultural data technologies will occur, the lack of this enabling technology must be addressed. The expansion of connectivity across the US has been a priority, but access has grown slowly. This is especially true in the major crop producing regions. The majority of data transfer occurs over cellular systems, but there are worldwide initiatives to provide wireless connectivity via satellite, balloons, and other platforms. Regardless of platform, the agricultural industry relies upon wireless connectivity to support big data systems.

Telematics allows data to be wirelessly uploaded and downloaded between farm machinery and online servers. However, limited connectivity is a barrier to adoption leading to potential economic losses.[67] Whitacre *et al*. addressed the current connectedness of agricultural production areas.[68] It was these areas that were impacted by the United States Federal Communications Commission (FCC) updated definition of connectivity that could be considered broadband in January 2015. The definition changed from 4 Megabits per second (Mbps) download and 1 Mbps upload to 25 Mbps download and 3 Mbps upload. Although broadband speeds did not instantly change, the level of connectivity that service providers could advertise as 'broadband' changed. The faster speeds required to be considered broadband brought light to connectivity barriers, especially with respect to connectivity gaps in rural areas where agricultural production occurs. Specifically, the 25 Mbps download speed requirement negates the majority of United States wireless connections from being classified as broadband.

However, the vast majority of data being passed between farm equipment and online servers is uploaded rather than downloaded; and upload speeds are typically only a fraction of download speeds. For some types of data such as machine diagnostics and prescriptions,

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[66] 5 U.S.C. § 552.
[67] Griffin, T.W., and Mark, T.B. (2014). "Value of Connectivity in Rural Areas: Case of Precision Agriculture Data." International Conference on Precision Agriculture. July 20-23, 2014. Sacramento, CA.
[68] Whitacre, B.E., Mark, T.B., and Griffin, T.W. (2014). How Connected are Our Farms? Choices. Online: http://www.choicesmagazine.org/choices-magazine/submitted-articles/how-connected-are-our-farms.

current speeds may be adequate. However, yield data and specifically imagery data may require connectivity speeds in excess of what is currently available. In summary, a concerted national policy effort must be made to expand broadband access in rural areas for a number of important rural development purposes, not the least of which is to facilitate the potential economic advantages to be gained by integration of agricultural data technologies on farms and ranches.

Concluding Remarks

The application of Big Data to agricultural production holds the potential to improve the profitability of U.S. agriculture and to better prepare its farmers and ranchers to handle the inherent risks of the industry. Additionally, Big Data could play a vital role in the further development of tools and techniques necessary to feed an ever-growing, hungry world. I commend this Subcommittee for its foresight in addressing these issues, and sincerely thank the Subcommittee, Chairman Moran, and Ranking Member Blumenthal for the opportunity to address you today.