MINE THE DATA NOT THE SOIL: BIG DATA CONSIDERATIONS FOR SOIL FERTILITY

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ABSTRACT

Farm data has become a current topic in agriculture as well as other industries and is known as 'big data'. Debate regarding the ownership of the data and who should receive value from the use of that data are hotly debated. This paper dispels many of the myths of big data in agriculture and offers insights into best management practices with respect to using data isolated to a given farm as well as within a larger community. A substantial portion of this paper was adapted from Griffin et al. (2016).

INTRODUCTION

Big data has gained considerable attention by the agricultural industry even though the potential value has not been well defined. The valuation of agricultural data has been elusive whether from a single field or data aggregated in near real time across many farms. Data from a given farm has finite value to that specific farm, but data aggregated into a community has much greater value.

Big data includes geospatial data and the associated meta-data on production, machinery, and environmental factors including seeding depth, seed placement, cultivar, machinery diagnostics, time and motion, tillage dates, planting, scouting, spraying, and input application. In addition to data on the products and how those products are applied, information on precipitation events, evapotranspiration, and heat unit accumulation supplement the data.

It is intuitive that value exists in agricultural data. Raw data in its original form often has no value at least until it has been converted to information suitable for making decisions. The control of data is deemed valuable, however data valuation is elusive and determining that value is not straightforward. Agricultural value is usually expressed as land values or production such as grain and animal products, but agriculturalists must think differently about the storage, analysis and value of this intangible resource.

METHODS

Data Are Intangible Goods

Data is not like grain or other physical goods. For instance, a farmer can retain ownership of grain even when that grain is stored in an elevator comingled with other producers' grain. Since data are electronic as opposed to physical, copies of raw data are indistinguishable from the original and may be considered identical. Essentially, once a copy of the data has been made available to another party then the originator of the data has minimal control of the data such that multiple entities may have access to viable copies of data (Ellixson and Griffin, 2016).

Furthermore, data is considered a "non-rival" good because the consumption or usage of data by one person does not alter another person's ability to consume or use the same data. A classic example is motion pictures; multiple people can watch the same movie without loss of value to any one viewer by an additional person watching that movie. Agricultural examples of non-rival data includes accessing weather reports or USDA crop production. In these examples, the value to a given farmer is not affected by another farmer acquiring the information. The same is true of data; a farmer and multiple other entities can consume the farmers' data without reducing the value initially enjoyed by the farmer.

Data may be considered "excludable" or "non-excludable" depending upon access rights to the data. Ownership of "excludable" goods carries a right to exclude others from having access. Thus, most privately held goods typically are excludable. Using the non-rival example from above, weather data may be privately held and only available to subscribers such that the data are excludable. If the weather data were reported by a government entity such as USDA, then that data would be non-excludable. Privately held agricultural data can be excludable only while it is controlled by the party that generated it; however, once it has been shared with other parties or aggregated, that excludability is likely significantly reduced or eliminated.

Another characteristic of data is that it is an irreplaceable good. Similar to family heirlooms, specific farm-level data may not be able to be recovered if lost during data transfer or equipment malfunction. The manual transfer of data is one common way data is lost if memory cards are destroyed before being transferred to another storage device. Data transfer over cellular communication is becoming an increasingly available feature in precision agriculture to avoid memory card loss, but this feature is still limited by the quality of the cellular data connection. As with any other digital data it is recommended that data be backed up frequently in multiple locations. The loss of data could diminish the value of the total dataset especially if multiple years of data or certain data layers are lost.

Farm data may be more valuable when shared within a community. For example, analyzing data pooled across many farms may reveal patterns impossible to determine while examining individual farm data; such analyses could suggest management decisions that could increase the profits and efficiency of all the farms. Further, the information that can be derived from this sort of community analysis frequently increases with the number of parties sharing data. This "network externality" effect means that the value of participating in a network, such as a data community, increases with the number of participants. Consider technologies such as the telephone, fax machine, computer modems and the Internet itself; the value of each of these is a function of how many *other* people utilize compatible technology.

Excluding others from benefiting from one's own data usually means avoiding the community and therefore forfeiting any potential benefits. The general population has at least some reluctance in sharing data regarding themselves; and farmers are even more so. To explain farmers' behavior, data can be thought of as a resource. When a farmer gives up control of their intangible resource, they usually perceived that they also give up 1) competitive advantage, 2) bargaining power, or 3) control over something that may be used against their favor (Griffin and Shanoyan).

Separable from farmland

Data may be separable from the land, much like how mineral rights and surface rights can be sold separately in the United States (Griffin and Taylor, 2015). However, minerals are physical rather than digital or electronic. Just like landowners sometimes retain the mineral rights when they sell the surface rights of farmland, the access rights of data may be retained and/or sold in a different transaction. This scenario most likely applies to land purchased by a farmer who then would have to negotiate separately the purchase of the data. For agricultural attorneys this would create a whole new level of property rights that would have to be negotiated in land sales and leases.

Big data impact on farmland values, rents, and leases

Data may also impact farmland values and rental rates. In the short-run, early movers who choose to provide data to land buyers may see a premium. However, data-absent land may have a penalty once the agricultural big data system is mature.

Biophysical data such as historical yield, soil test results, and other production data have been included in farmland sales and/or rental agreements; but these data have not substantially influenced farmland values. 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. This historical data may prove productivity and soil amendment utilization but not directly impact farmland values. Farmland values and rental rates are expected to be a function of quantity and quality of geospatial meta-data once the big data sector of the agricultural industry matures.

Data availability of fields within the potential community influences the farmer's optimum decisions; therefore the presence or absence of data from a specific field may impact their whole farm system. In certain scenarios, a farmer without any fields that have historical data sufficient to participate in a 'big data' system may pay a premium to secure an additional field that includes an adequate quantity and quality of data.

Data Security: Protection and Safety Considerations

Given that data may be valuable, it stands to reason that the data should be collected and stored in a secured procedure such that data loss is avoided. The majority of existing farm data resides in "data tombs" where it lies unused and at risk of being destroyed (even hard drives have known failure rates). Negative implications exist in the case of data loss. Physical loss can be the result of a yield monitor being destroyed during a combine harvester fire or the theft of the farm office computer. Computer hardware and software failures can also result in data loss. Without a secure backup, data loss could result. Since data valuation has been elusive, agricultural attorneys and expert witnesses along with the court system may be instrumental in answering the question of data valuation.

Due to data, wireless internet connectivity impacts farmland values and rents

One of the primary barriers to the adoption and usage of big data is wireless internet connectivity. Telematics, along with the enabling technology of wireless internet, allows data to be uploaded and downloaded between farm machinery and online servers. However, limited connectivity is a common barrier to adoption (Whitacre et al., 2014). In January 2015, the United States Federal Communications Commission (FCC) modified the definition of broadband connectivity. The definition changed from 4 Megabits per second (Mbps) download and 1 Mbps upload to 25 Mbps download and 3 Mbps upload. The 25 megabit per sec (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 have typically only been a fraction of download speeds. For some types of data such as machine diagnostics and prescriptions, current speeds may be adequate. However, yield data and specifically imagery data may require connectivity speeds in excess of what is currently available.

Even with the limited broadband connectivity, the advent of telematics and big data encouraged unprecedented use of the internet by farmers and service providers. It should be noted that not all farmers are cognizant that field equipment wirelessly transmits data to the manufacturer. Erickson and Widmar (2015) report that 7%, 15%, and 20% of agricultural service providers utilize telematics during 2011, 2013, and 2015, respectively. In part, wireless connectivity in crop producing areas has limited the perceived benefits of the technology.

The implication is that farmers who expect to utilize telematics may not be willing to pay rental rates for farmland tracts without adequate wireless connectivity comparable to internet endowed tracts. Knowledge of anticipated wireless connectivity speed of a farmland tract may impact the land value and rental rate similar to yield history, fertility levels, and irrigation potential.

RESULTS AND DISCUSSION

Although agricultural big data is not as mature as some other industries, services surrounding agricultural data are catching up quickly. Agriculturalists should think of data as an intangible good rather than physical goods such as grain, livestock, machinery, farmland or even subsurface minerals. Agricultural data are digital and non-rivalrous. Data valuation continues to be an area of research by economists; and some debate exists regarding listing data on a balance sheet. Although the gaps in wireless connectivity are likely to decline with technological improvements, it is expected that farmland values may be affected by connectivity lags until that time.

An overview of big data implications that agricultural attorneys and their clientele should be cognizant has been provided. Although estimates on the value of farm data has not been provided, studies are underway to quantitatively address how the open market and society will value data.

SUMMARY

The agricultural industry is being impacted by the advent of big data although in its infancy. Considerable progress has been made although barriers still exist that limit the growth of big data and thus the efficiencies afforded by associated technologies. Barriers are likely to continue impeding adoption of both big data and precision agriculture. These barriers include lack of sufficient wireless broadband connectivity. Other barriers include perceptions of potential misappropriation of farm data by community aggregators or hackers; however, perceived loss of competitive advantage from sharing intangible resources are a real barrier at the farm level.

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