Exploring the growing links between digital agriculture, finance capital, and farmland investors and managers in North America

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Abstract

Scholars have recognised digital agricultural technologies and financialization as important vectors of agri-food transformation, yet little research has examined how these trends mutually influence one another. In this paper, we present case studies of four firms that blend together digital agriculture, farmland investment, and finance capital in novel ways. Veripath is an established farmland investment company, with significant holdings in Western and Central Canada. It relies on digital technologies to remotely monitor the performance of its properties and the farming practices of its tenants. Farmers Edge is a digital agriculture platform and service provider founded in Canada in 2005, with operations spanning North America, Brazil, and Australia. The firm has received significant backing from finance capital and is partnering with U.S. farmland management services provider Farmers National Company to facilitate data flow among farmers, landowners, and investors. Finally, we present the cases of AcreTrader and FarmTogether, two recently launched farmland investment platforms promising to 'democratise' farmland investment by offering investors a seamless online experience for buying rural properties. We analyse how these firms represent an evolving nexus between finance capital and digital agriculture, with implications for agri-food restructuring.

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Introduction

Digital agricultural technologies, including sensors, satellite imagery, decision support systems, smart tractors, and other data-collecting farm tools are shaping the ways in which food is produced. Farmers are increasingly adopting these tools to achieve production efficiencies and to assist with farm management decision making (McFadden et al., 2023). At the same time, the agri-food sector is increasingly a space of institutional investment through the assetization of farmland and the financialization of other segments of the food chain. In North America, the most common model of institutional investment in farmland sees investors purchasing farmland and renting it back to farm operators in an own-lease out model (Desmarais et al., 2017; Fairbairn, 2020). Farmland properties may be grouped together in an investment portfolio or purchased by individual investors as a direct investment.

Scholars have recognised digital agricultural technologies and financialization as important vectors of agri-food transformation, yet little research to date has examined how these trends mutually influence one another. However, this topic is starting to attract the attention of social scientists who are interested in exploring how farmland investors and adjacent actors are using digital agricultural technologies in the process of farmland assetization and management (Duncan et al., 2022; Fairbairn, 2020; Ouma, 2020; Magnan & Sunley 2017; Desmarais et al. 2017). This emergent area of research brings together social science scholarship on financialization, digitalization, political economy, and critical data studies. As digital agricultural technologies continue to develop, new arrangements of actors are materializing to capitalise on their affordances (Duncan, 2023). To elaborate, the properties of digital agricultural technologies, namely their ability to collect massive amounts of real-time data, have gained the attention of a variety of actors in the agri-food space who have unique and vested interests in the opportunities provided by this data. In this case, digital agricultural data offers farmland investors the ability to monitor their investments more closely. Therefore, in this research, we focus on two main actors – ag-tech firms and farmland investors – to analyse their role in reshaping on-going trends within the agri-food sector.

To better understand how digitalization and assetization are mutually reinforcing trends in the agri-food sector, we pose two complementary research questions:

- *In what ways are farmland investors/investment firms using digital technologies as part of their business model, in an effort to increase efficiency and drive down costs?*
- *In what ways are ag-tech firms leveraging their digital technologies and platforms in order to service the farmland investment and management sector?*

To address these research questions, we present case studies of four firms that blend together digital technologies, farmland investment/management, and finance capital in novel ways. Veripath is an established farmland investment company, with significant holdings in Western and Central Canada. It has recently deployed digital technologies to remotely monitor the performance of its properties and the farming practices of its tenants. Farmers Edge is a digital agriculture platform and service provider founded in Canada in 2005, with operations spanning North America, Brazil, and Australia. The firm has received significant backing from finance capital and has partnered with U.S. farmland management services provider Farmers National Company (FNC) to facilitate data flow among farmers, landowners, and investors. Finally, we present the cases of AcreTrader and FarmTogether, two recently launched farmland investment platforms, promising to 'democratise' farmland investment by offering investors a seamless online experience for buying rural properties.

The cases illustrate different paths and entry points for digital technologies in the farmland investment and management sector. Investment management firms and farmland owners are deploying new technologies to assess, valorise, and monitor farmland as a financial asset, while also promoting, in certain cases, the adoption of digital agriculture tools on their portfolios. Meanwhile, digital agriculture technology providers are seeking

strategic partnerships with owners and managers of large farmland portfolios as a method of reaching scale in 'enrolled acres'. At the same time, they are promoting their tools as mechanisms of land and labour surveillance and data production for the 'sustainable management' and valorisation of farmland assets. These trends point to the increasingly important role digital technologies play in the business models of large-scale farmland investors and managers, with implications for competition and scalability in the sector. They also raise questions of 'algorithmic governance' (Danaher et al., 2017) and 'surveillance capitalism' (Zuboff, 2019) as they apply to farmland operators and tenants.

The paper is presented as follows: a concise overview of the literatures examining financialization and digitalization, highlighting recent scholarship on the connection to farmland investment; an explanation of the case study methodology; the results in form of the four case studies; and then the discussion and conclusion focusing on the implications of agri-food restructuring.

Context and literature review

There is a well-established scholarly literature examining the financialization (Burch & Lawrence, 2009; Bjorkhaug et al., 2018; Clapp & Isakson, 2018; Fairbairn, 2020) and assetization (Ouma, 2020) of farmland as part of a broader process of global capitalist restructuring dating to the mid-2000s. While financialization captures the macro-trends whereby financial actors and logics exert increasing influence over agriculture, assetization refers more specifically to the meso- and micro-processes by which farmland is made into a financial asset, that is, a knowable and investible object from the perspective of financial actors, with predictable financial returns and income flows (Ouma, 2020; Birch & Ward, 2022).

Social science scholars have likewise recently begun to develop a substantial literature on the digital transformation of the agri-food sector (Klerkx et al., 2019; Duncan et al., 2021a; Barrett & Rose, 2020). With a debt to early studies of the political economy of precision agriculture tools (Wolf & Buttel, 1996; Wolf & Wood, 1997), the recent literature has examined questions of data ownership and control (Fraser, 2018; Wiseman et al., 2019), sustainability (Lioutas & Charatsari, 2020), labour (Rotz et al., 2019a), and the complex politics of digital agriculture (Bronson & Knezevic, 2016; Bronson, 2022; Rotz et al., 2019b; Duncan et al. 2021b). Through critical data studies, political economy, and science and technology studies (STS), critiques of digital agriculture have emerged. Taken together, these critiques have largely centred around how new digital agricultural technologies are reshaping power relations in the agri-food sector. This research contributes to this literature by investigating the formation of new configurations of power between the emerging actors of agri-tech firms and farmland investors.

Recent work has begun to explore how farmland investors and adjacent actors are using digital agricultural technologies in the process of farmland assetization and management (Duncan et al., 2022; Fairbairn, 2020; Ouma, 2020). Investors use the data generated by digital agricultural tools to help make farmland more 'visible' and 'legible'. For instance, certain investor owners require their farmer tenants to follow corporate standards of care, backed up by remote monitoring of practices and/or data transfer (Duncan et al., 2022). In turn, the data collected help to 'valorise' farm properties by providing a digital track record, including data like crop yields, soil fertility, rainfall patterns, and more. Some large institutional farmland owners like Nuveen have deployed satellite and other remote-sensing technology to monitor crop health, land use, and farming practices on their massive portfolios (2.1 million acres under management globally). Firms like CIBO have specialised in farmland valuation, relying on big data sets, and provide analytics and support to farmland investors (Fairbairn, 2020: 91-2). Meanwhile, farmland real estate platforms like Tillable have promoted the adoption of digital agricultural tools and willingness to share data as criteria for selecting reliable and productive tenants (Duncan et al. 2022.; see also Fairbairn 2020: 92). Tillable promotes the use of farmland data as a mechanism for comparing and benchmarking properties for sale or rent. The development of these types of platforms, as well as others that rely on data to make predictive recommendations for farms, is a main

characteristic of digital agriculture. Platform capitalism can be defined by the creation of platforms that are digital spaces (both hardware and software) designed to enable exchange of capital, or else to create a place for other actors to conduct business (Srinek 2017).

These trends raise questions around power, equity, surveillance, data ownership, and sustainability. Fraser (2019) likens the rollout of precision agriculture tools to a 'data grab', where agricultural technology providers appropriate, aggregate, and analyse the data generated on farms by high-tech machinery and other tools, creating new products, platforms, and markets such 'decision support services', which are sold to farmers and others. The 'data grab' amounts to a form of dispossession affecting farmers to various degrees, depending on their ability to control and make sense of the data they themselves generate. Duncan et al. (2022) have critiqued the deployment of digital technologies by farmland investors and farmland real estate platforms as having the potential to undermine farmer autonomy, increase surveillance, and fuel further farmland financialization and consolidation.

Building on the themes of power, autonomy, and decision making, scholarship on algorithmic rationality and governmentality has proven to be central to understanding technological shifts in agriculture. Algorithmic rationality, driven by certain logics of capitalism, refers to "the reorganization of industry and reasoning around rules-based grounds" (Miles, 2019: 5). Algorithms are designed through a rules-based logic that allows for the rationalization of processes and increased control in decision-making. It is through these highly rationalised rules-based processes that algorithms get elevated as an 'authority' in different social contexts. In turn, algorithmic rationality gives way to algorithmic governance when this logic is generalised (Danaher et al., 2017). In agriculture, this concept has been used to understand the nuanced reliance on proprietary algorithms in farmer decision making (Miles, 2019; Gardezi & Stock, 2021). These concepts are particularly relevant for exploring the algorithms relevant to farmland investment – including digital technologies that use algorithms to influence farmer/investor decision making and to select and promote farmland as investable.

The prospect of digital agricultural technologies improving the sustainability of agri-food systems is contested (Clapp & Ruder 2020; Green et al., 2021). Wolf and Wood (1997) argue that, while precision agriculture tools are marketed as 'greening' modern agriculture, they in fact serve to legitimise the chemical-intensive industrial model. While helping to maximise the efficiency of fertiliser and pesticide application, these technologies do not substantially alter the input-intensive nature of industrial farming. Similarly, while Lioutas and Charatsari (2020) recognise the ability of big data in agriculture to improve output and certain environmental metrics, they question the overall contribution of these technologies to sustainability, given the uneven distribution of benefits to different classes of farmers. There is a need to further scrutinise the role of big data and ag-tech in 'green capitalism' discourses, particularly as this relates to increasingly influential players such as institutional and corporate farmland investors.

It is worth exploring parallels between the capitalist restructuring of other forms of real estate and farmland markets. Sadowski (2019) has examined the growing capital convergence between platform capitalism and real estate. Drawing on the work of Fields (2019) and Shaw (2018), he shows how the increasing penetration of platform corporations into real estate is helping overcome traditional market 'frictions' such as the illiquidity and immobility of real estate. Fields (2019) has proposed the concept of the 'automated landlord' to describe how large institutional owners of Single Family Rentals (SFRs) have deployed digital technologies as a means of managing their geographically dispersed and fragmented property portfolios in the residential real estate market. Under this model, "the management of tenants and properties is increasingly not only mediated, but governed, by smartphones, digital platforms, and apps, and the data and analytics these devices and infrastructures gather and enable" (Fields, 2019). She shows how "[n]ew information technologies enabled investors to aggregate ownership of resources, extract income flows, and securely convey these flows to capital markets." In our case studies, we draw upon some of these developments in the commercial and urban real estate markets to make comparisons to the strategies used by farmland investors and managers

in overcoming market 'frictions'.

Case study methodology

The purpose of case studies is to create a more profound understanding of a social phenomenon through in-depth exploration (Tight, 2010; Yin, 2011). Case study approaches may be used to explore bounded systems while using data collection to systematically gather information on the operations and functionality of the system (Chmiliar, 2010). In this study, we explore the bounded systems of distinct corporate actors, either farmland investment firms or ag-tech firms, and their networks to better understand how they are operating within and reshaping the agri-food sector. Case study methodology is particularly useful as these firms might be unique, but are not necessarily singular, in the sense that there are others like them in existence and continuing to develop. Thus, our exploration of these four firms provides a window into a network of actors and relations that continues to evolve.

Our theoretical framework draws on some of the key ideas presented in the literature review, namely assetization, surveillance capitalism, algorithmic rationality, and platform capitalism. For both the selection of the case studies and their analysis, the overlap of these themes presents insights into the connections between digitalization and financialization. The cases are all connected to farmland assetization, present technologies that provide mechanisms for surveillance, rely on algorithms for decision making, and present platforms for data transactions. Bringing these themes together and describing how they are enacted through four case studies helps to shed light on the financialization-digitalization nexus.

Our cases were purposively selected to reflect what we hypothesised to be the mutually constituted relationships between farmland investment and ag-tech firms. Therefore, we selected a private equity farmland investor (Veripath), an ag-tech firm (Farmers Edge), and some emerging actors that are combining these two roles by developing digital platforms specifically for farmland investment (presented together – AcreTrader and FarmTogether). Geographically, we selected cases operating in Canada and/or the United States. Digital agriculture firms and farmland investors appear to be mostly interested in the typical highly capitalised, industrial farms found in Canada and the United States. As case studies are often informed by data collection from multiple sources (Castree, 2005), we collected and systematically documented material found online related to these firms including: annual reports, web pages, blog posts, media articles, and press releases.
The materials were analysed and coded thematically to produce four case studies. We focused on how these actors are deploying digital agriculture and platform technologies to pursue their business goals in the distinct but overlapping farmland investment and ag tech spaces. We began with a deductive coding approach to develop qualitative descriptive characteristics of each firm by gathering details on its business model, financial backings and holdings, and growth trajectory. We then used an inductive coding approach for thematic analysis. Examples of the codes that emerged from this round of analysis include sustainability discourses, targeted investment audiences, key partnerships, and details of digital technologies used by each firm. The qualitative results of each of the case studies are presented below.

Case studies

Veripath

Veripath Farmland Partners (previously AgCapita) is a well-established private equity farmland investor that has developed several open-ended farmland funds since 2007. Today, it has a portfolio of 110,000 acres across 30 locations in Canada, with approximately $CAD275 million under management (Veripath, 2023). Like other firms involved with farmland assetization, it uses a strictly 'own-lease out' strategy in its portfolio, renting all its parcels to tenant farmers and preferring not to assume any of the production-related risks of crop farming.

In recent years, the firm has increasingly turned to digital technology to automate monitoring and surveillance

of its farmland portfolio. Specifically, it uses satellite imaging combined with NDVI (Normalised Difference Vegetation Index) technology to remotely monitor plant health and farming practices, such as tillage and crop rotation. The approach has been described as "a proprietary land management system that leverages an in-house software platform combined with satellite monitoring and AI crop analysis" (Kiernan-Stone, 2022).

Veripath justifies its monitoring practices by means of a sustainability discourse, to ensure that its tenants use sound farming practices. It has developed a Responsible Investment Policy that is aligned with the UN's Principles for Responsible Investment in farmland (Veripath, 2021). Its monitoring processes are governed by a set of 'best practices' agreed to by renters, and which includes annual reporting and an annual visual inspection conducted in-person or by satellite – demonstrating the types of surveillance enabled by digital technologies. As Veripath has a concern about farmers' practices, renters must agree to updated agrology testing. The company promotes Conservation Agriculture (CA) practices, including direct seeding, cover cropping, and crop rotation, to which renters must commit through a statement of best practices. Veripath links CA to positive environmental outcomes, including sustainability (conserving and enhancing natural resources), biodiversity, and carbon capture (Veripath, 2021). It thus promotes a version of 'green capitalism', where highly capitalised farmers partner with the farmland investor to continually improve farming practices in line with corporate sustainability goals.

According to the company, its monitoring systems have been developed to drive down costs by replacing 'boots on the ground' inspection with remote surveillance of tenant farming practices (Cross, 2023). This has been made possible by the decreasing cost of these digital technologies (Bloomberg News, 2021). Presumably, this in turn drives down the costs of managing the portfolio and improves the overall profitability of the investment. The company emphasises the scalability of its systems, which aligns with its ambitious expansion goals. Quoted in a farm press article, Veripath's CEO Stephen Johnston explains:

> *You can see, that as we expect to get to 300,000 or 400,000 acres, and you're making these measurements for every (quarter section), … that it would really be practically beyond the capability of human beings to cost effectively and reliably manage this … (Veripath's) system does all of this. It's all automated. This is a really big competitive advantage because you want to own and not operate. But if you don't operate, your monitoring has to be impeccable. (Cross, 2023)*

As Fairbairn (2020: 91) has pointed out, "advances in data collection, storage, and analytics promise to remove the upward limit on landownership consolidation", which historically was limited by the constraints of monitoring vast territories. A unique feature of Veripath's monitoring system is automation. Specific events detected by satellite imagery will trigger a notification to the farmland owner. As CEO Stephen Johnston explains: "We've never had any farming practice problems, ever, in 16 years, but if the farmer were to say he grew canola and the satellite were to say it was wheat, the system would automatically flag that and ask for an explanation" (as cited in Cross, 2023).

The strategy deployed by Veripath is comparable to the 'automated landlord' model developed by institutional investors in the Single Family Rentals (SFR) sector in the U.S. (Fields, 2019). Investors have assembled and managed large portfolios of SFR units in part by deploying digital technologies (i.e., algorithmic rationality) for property evaluation and acquisition (see below) and by automating several aspects of property management (lease signing and renewal, rent collection, maintenance requests, for instance). As Fields (2019) has argued, digital technologies allow institutional owners of SFRs to efficiently monitor and manage their large, spatially expansive portfolios. Furthermore, the data collected and analysed from each unit helps the firm attract investors:

> *Bespoke technology platforms support such visibility into workflows and make field operations transparent to executives. From an upstream perspective, this visibility and transparency is desirable to credit rating agencies, the banks putting together securitizations, and investors, because it demonstrates an ability to meet reporting requirements and, across different operators, lends the ability to generate a larger body of data about the asset class as a whole (Fields, 2019).*

In a similar way, the monitoring and data collection activities of major farmland investors will help valorise not only their own portfolios but contribute to the ongoing standardization and benchmarking of farmland as an asset class.

Farmers Edge

Farmers Edge is a Canadian firm offering comprehensive digital agriculture 'solutions' to farmers and their partners. It provides both hardware (i.e., sensors, weather stations, telematic devices) and software (its own fully integrated platform called FarmCommand) in a package designed to produce a wide range of data, including: forecasts, historical data, and notifications related to weather; satellite imagery (for determining crop health and pest/disease identification); and equipment tracking (including productivity, working time, fuel consumption, and area covered). These data are used for benchmarking, predictive modelling using artificial intelligence (AI) and machine learning, planning, reporting, and analytics. Additionally, the FarmCommand platform automates crop insurance reporting and claims and is integrated with the company's Smart Carbon programme for monetizing carbon credits. The former CEO of the company described its business model as "decision ag", where the firm not only collects vast quantities of data through its devices but supplies the algorithms and data analytics to provide production advice to users (Bronson, 2022: 115). In line with other forms of platform capitalism (e.g., Google or Facebook), it attempts to provide an all-in-one platform for farm needs.

The company was founded in 2005 and has made numerous acquisitions over the years. It has received substantial financial backing from Fairfax Financial Holdings, a publicly traded Canadian insurance and asset management firm, which initially invested in Farmers Edge in 2015. By 2020, Fairfax had invested $CAD376 million in the digital ag firm. In 2021, Farmers Edge launched an IPO with a share price of $CAD18.80, raising $CAD144 million (Fairfax, 2021). At its peak in 2020, the company had 23 million acres enrolled in its various programmes (Farmers Edge, 2020b).

In 2020, Farmers Edge launched a new partnership with Farmers National Company (FNC), a U.S. landowner services firm with over two million acres under management. According to a press release, "The partnership equips landowners and operators with access to a wealth of digital and agronomic resources designed to support daily operations, improve sustainability, and create a seamless digital connection between stakeholders" (Farmers Edge, 2020a). FNC cited rising land prices and competition as motivation for the partnership. The firms touted the partnership as a mechanism to establish transparency and trust among stakeholders such as renters and landowners. At the same time, the collaboration is intended to generate extensive data about land and farming operations to support the financial value of farm properties.

> *"Leasing land is a high-stakes investment for everyone involved," says Wade Barnes, Farmers Edge CEO and co-founder. "Landowners want to ensure their assets are protected for generations to come, and operators need to be able to demonstrate their commitment to the land while also turning a profit. By working together with FNC, we're equipping their clients with innovative solutions that improve land value while also bringing a new level of connectivity and decision-support for sustainable crop production. Digital agriculture is reshaping the industry, and farm real estate is no exception; I predict we will see a significant shift in the importance it plays in operator selection, conservation requirements, and land prices in years to come" (emphasis added). (Farmers Edge, 2020a)*

The status of the partnership between Farmers Edge and FNC is unclear. For instance, neither company reports how many acres in FNC's portfolio are managed using FarmCommand. It is also unclear if FNC's farm managers and tenants are required to use FarmCommand or whether they access it at preferential rates. In 2022, FNC announced a partnership with a different digital agriculture platform provider, Bayer, owner of Climate FieldView (FNC, 2022). It is not clear if Climate FieldView has replaced or serves to complement FarmCommand as a preferred platform for FNC's farm managers.

Despite the unknowns, this example shows how digital agriculture companies may leverage their platforms

as an attractive product for farmland services companies and asset managers to monitor and valorise their portfolios on behalf of their clients. Deals such as these are appealing to digital agriculture platforms as a way to enrol a large number of acres into their programmes. As a platform-based digital agriculture company, Farmers Edge has built its business model on growing the number of acres enrolled. For the farmland services company, the use of digital agricultural tools provides its clients, farmland owners, with detailed information on the agricultural performance of their assets and potentially valuable information about farmland operators (whether tenant farmers or in-house farmland managers). We can expect further strategic deals between major farmland investors/managers and specific digital agriculture platforms or providers. This case study of a partnership between a digital agriculture company and a farmland service company is a clear example of how the trends of digitalization and financialization are finding synergies.

In recent years, Farmers Edge has faced serious financial struggles, burning through large amounts of cash and seeing a decline in the number of acres[1] enrolled in its programmes (Fontes, 2022). In July 2022, it received a $75 million loan from Fairfax Financial Holdings, its majority shareholder. As of late April 2023, the company's stock price had plummeted to $CAD 0.18, less than 1% of its price at its initial public offering. According to its financial statements, it lost nearly $CAD60 million in 2022 (Fontes, 2023) and Fairfax Financial Holdings, its majority shareholder, reported a $CAD133 million write-down on its balance sheet because of the company's struggles (Fairfax, 2022). Clearly, the financial struggles faced by Farmers Edge put its business model into doubt.

AcreTrader and FarmTogether

AcreTrader and FarmTogether are two relatively new farmland investment companies using an online platform structure to raise capital, facilitate investments, and market their 'product'. Each provides an extensive library of promotional material targeted towards investors, with articles on the agriculture sector in general, farmland economics, investing principles, and digital agriculture. These firms deploy many of the usual tropes and discourses of the farmland investment 'thesis': growing food demand, pressures on the supply of farmland, low correlation to stock markets, inflation hedging, and portfolio diversification. AcreTrader is backed by several venture capital funds, totalling $USD80 million, though it explicitly distances itself from some of the more controversial aspects of start-up business culture: "We have a sound, long-term-focused business model that doesn't fit the Silicon Valley mold of 'growth at all costs'" (Malloy, 2023). However, it has been highly characteristic of Silicon Valley to focus efforts on developing new platforms that circulate novel forms of capital.

These platforms differentiate themselves from other farmland investment firms by offering a seamless online experience for browsing properties, reviewing documents and information packages on specific deals, and investing. In other words, their business model is investing in farmland at the 'click of a button', with an appeal to transparency and ease of use for investors. This is enabled by providing an online portal to execute farmland deals, with functionality that includes supplying documentation for due diligence, electronically signing documents, and transferring money. Investors can then access information about their farmland portfolio – including crop reports, and agronomic and financial performance metrics – through an online dashboard. FarmTogether describes its model as follows:

> *[T]hrough the FarmTogether platform, investors can review each property's risk/return profile, fee, and ownership structure, on-farm sustainability practices, legal documents, and more. Our platform makes it easy for investors to add farmland to their portfolios through low investment minimums and without having to conduct their own on-site due diligence— we take care of this for you.*
>
> *We provide a seamless and secure online experience, where account setup, accreditation document upload, and payment selection can be completed in minutes. Once the investment is confirmed, investors can track their portfolio's performance over time within the FarmTogether portal. (FarmTogether, 2023)*

[1]At the end of the 4th quarter of 2022, enrolled acres were at 9.8 million (down from peak of 23 million): https://farmersedge.ca/investor-relations/reports-and-filings/

These firms tend to target 'retail investors', that is individuals who qualify as accredited investors based on minimum thresholds for annual income and/or net worth[2].

Both firms suggest that they are 'democratizing' farmland investment by making it easier and more accessible to retail investors. In part, the claim is based on their offer of 'fractional ownership' and 'crowdfunding' models that allow investors to own a share of a property with relatively modest investments, as low as $USD15,000 for certain types of deals. This structure differs from that offered by established fund-based farmland investment schemes, where investors buy units in a portfolio of farmland acquired by the asset manager, such as investment firms like Nuveen or Hancock Agricultural Investment Group. FarmTogether offers a variety of options for investors, including individually managed accounts, fractional ownership/crowdfunding, and funds. AcreTrader seems to only offer 'fractional ownership' of individual properties. The company identifies target properties then creates an entity, e.g., a limited liability company (LLC) to conduct due diligence and undertake to purchase the farm. Interested investors are invited to buy shares in the LLC, giving them a financial interest in the farm property, but without holding legal title.

Both firms use AI and other proprietary technologies for evaluating and ranking/scoring potential deals, based on their access to large data sets related to farmland. The use of digital tools is central to the firms' ability to efficiently evaluate and process a large number of potential deals based on factors such as physical/spatial land characteristics, soil analysis, financials, yields, farm infrastructure, and more. In turn, the data is retrieved from/generated by satellite imagery, remote sensing, digital maps, and other technologies. AcreTrader describes its evaluation process thus:

> *We have a thorough process of reviewing land on a state, county, and local level, and only accept a very small percentage of the land parcels we examine. Our review process includes both a comparable approach and income-based approach. We use a myriad of advanced software tools, including our proprietary comprehensive mapping and data science tools, and in-depth valuation techniques to account for all the unique aspects of each piece of property. A member of our team will almost always conduct an on-site visit, or, at the very least, we have a local land manager go out for us. (AcreTrader, 2023).*

For its part, FarmTogether describes its due diligence process as follows:

> *Through both our proprietary sourcing technology and strategic partnerships, we review a mix of on-market and off-market opportunities across the United States. … [W]e conduct a property analysis incorporating over 150 data sets from public, private and proprietary data sources. We then apply our proprietary technology and investment expertise to zero in on the best investment opportunities in our target geographies and crops. Finally, we then look at all the due diligence items relevant to the specific farm. We use a 105-point checklist to evaluate each property, which includes soil, leaf, water, capital improvements, title, local legislation, depth of the supporting farming ecosystem, cost of inputs, farmworker wages, and more. (FarmTogether, 2023)*

These processes are similar to the strategy deployed by institutional owners of large portfolios of SFRs, observed by Fields (2019), who notes that these firms use an 'acquisition engine' or 'acquisition platform', based on their own algorithms, to evaluate and select properties. The strategy allows the firms to optimise the selection and acquisition of new properties based on projected earnings calculated from a myriad of nationally collected data points. Again, this highlights the role of algorithmic governance in decisions around what types of farmland are considered a worthy investment.

FarmTogether specifically touts the deployment of digital agriculture technologies on its properties as a way to build the value of the farms.

> *As investors, knowing that good farmland is a scarce resource, our priority is always to identify and invest in the properties that demonstrate great potential, but also to focus on where we feel we can build value—including by implementing digital innovations on the farm. … our longer-term vision is to put the digital transformation of agriculture to work on the farms we own, making their productive potential and longevity*

[2] To qualify as an accredited investor, an individual must have an annual income of over $US 200,000 or a net worth of over $USD 1 million, not including their primary residence.

> *stronger yet. While we believe the future of farming is regenerative, we also believe it is heavily digital. … Armed with the power of data, we're looking to inject capital into agriculture such that farmers can more capably feed people and care for the planet into the future. (Wensley, 2020)*

Thus, the firm's philosophy combines 'regenerative agriculture' and digital agriculture in a vision of investors putting capital to work for both people and the planet. This framing is consistent with the 'techno-finance fixes' typical of other contemporary agri-food start-ups, where boosters invoke the power of finance combined with digital technologies to solve global problems as a way of motivating investment in the space (Sippel & Dolinga, 2022).

The introduction of these farmland investment platforms parallels developments in the commercial and residential real estate sectors, where there is a growing convergence of digital technology, finance, and traditional market actors. Shaw (2020) defines Platform Real Estate "as particular arrangements of user agencies within interoperable layers of digital technologies that produce and offer certain paths of action to real estate market participants." As with all digital platforms, the firms working in this space create market value by connecting users in new ways and collecting, analysing, and packaging huge quantities of data that can be monetised. In the farmland real estate market, there are signs of novel platforms connecting farmland owners, investors, and market intermediaries through new digital tools and interfaces.

Discussion and Conclusion

The cases we have presented here show novel ways in which digital technologies are being integrated into the farmland investment landscape, and in turn how the financialization of farmland may help drive the digitalization of agriculture.

For farmland investment managers, remote sensing technologies, satellite imagery, and GPS guidance are becoming important techno-fixes to problems of surveillance and monitoring. In effect, these technologies lead to a form of spatial compression allowing farmland investment managers to keep a 'digital eye' much more easily and cheaply on their vast portfolios. These findings are consistent with Duncan et al. (2022), who found that visibility was a key attribute of digital agriculture that appeals to farmland investment firms. As this becomes a competitive advantage in the field, we can expect this approach to spread and the costs of portfolio monitoring and surveillance to decrease, and for increased adoption of these technologies on farms. At present, farmland investors have automated only limited functions (e.g., crop verification), but perhaps others could soon be as well (e.g., lease renewal, setting rental rates).

The introduction of these technologies raises ethical questions for farmer tenants and operators, who may now be subject to remote surveillance. What consequences could there be for farmers when their actions (or other variables) trigger a notification or red flag? Immediate economic consequences might include the cancellation of leases, but tenants could also conceivably face reputational damage based on poor performance or adverse events in the field. What recourse will tenants have if they dispute the events or decisions that may trigger a notification? The deployment of these technologies thus raises questions of algorithmic governance and surveillance capitalism as it applies to farm operators (tenants, contract farm operators, or in-house operators). With the number of rented farmland acres in Canada increasing, there is a need to create transparent data governance mechanisms that clearly state the consequences of entering into a rental agreement with a landlord that uses digital surveillance (Statistics Canada, 2022). Additionally, with the cost of farmland rental rates increasing in some areas (Munch, 2023), farm operators who object to surveillance will likely be displaced. In other words, farm tenants who do not wish to be monitored risk being passed over if another available tenant willingly agrees to using surveillance technologies.

Farmers are increasingly competing for land and are concerned over the concentration of farmland in the hands of institutional investors (Magnan et al. 2022). The balance of power in leasing is often dependent on who the

landlord is. With institutional investors as landlords, they have a keen interest in surveilling their investments and controlling more aspects of production than many 'traditional landlords'. For instance, landlords might previously have been city dwellers who had inherited farmland but did not have the background or interest to manage it, and who therefore rented it out. However, as landlords increasingly become large institutional investment firms that employ digital surveillance tools, the scales are perhaps even less favourable to renters.

Farmland investors today are using digital technologies, including AI, to analyse farmland properties. They are harnessing the power of big data to more efficiently make investment decisions, not only about which properties to buy, but also around investment exit. Again, this is likely to confer competitive advantages on the first adopters of such technologies. In turn, each firm's proprietary evaluation algorithm becomes part of the value proposition for the farmland investment firm. As owners of large farmland portfolios, farmland investors may also be using farm-operator data (collected by farm machinery and on-farm sensors) to inform decisions such as tenant selection and lease renewal.

Farmland investment companies are also digitizing the investment process itself by offering a seamless online experience for investors. Although platforms like AcreTrader and FarmTogether claim to be 'democratizing' farmland, the investment minima and criteria for being an accredited investor put these investments out of the reach of a large majority of households. Nevertheless, these platforms make farmland investment accessible to a larger number of people and seem to specifically target 'retail investors'. The aim is to reduce the 'friction' involved in farmland investment, a process until now considered cumbersome and complicated, with strong parallels to developments in other real estate markets. A unique feature of their approach is the extent to which prospective investors can 'window shop' farmland properties, with extensive information including photos, maps, and financials, being marketed online on the platforms. Like other sectors that have seen 'platformization' (e.g., Amazon, Airbnb, Uber), the farmland investment sector is moving into platform capitalism. Platforms like AcreTrader and FarmTogether embody the essential characteristics of all platforms: 1) they are digital infrastructures that allow groups to interact (in this case investors); 2) they produce and are reliant on network effects – meaning an increase in users creates an increase in value; and 3) they are designed to appeal to varied users (Srnicek, 2017). The latter point is critical because while these platforms might appear as neutral spaces for the exchange of investment capital, they embody a particular form of land politics, namely, land is treated as an easily transferable commodity while its complex (and 'stubborn') materiality is ignored (Li, 2014; Sippel, 2023).

Future research could explore the narratives and discourses used to market these farm properties as investment targets. Our case studies indicate that green capitalism and environmentally responsible farm management is a selling point articulated by investment firms. Sippel (2023) found that investment firms often assuage doubts about the unpredictability of farming with storytelling of the farm as a factory, controllable farming, and connotations of modernity (mechanization, specialization, and efficiency). What other rural, land, and food imaginaries are evoked by these images and information packages?

Drawing on the example of Farmers Edge, we have presented some evidence that ag-tech platform providers are seeking opportunities for strategic relationships with farmland investors and managers. To date, the specifics of such relationships are unclear. But given the growing importance of farmland investment managers as stewards of large land portfolios, this type of relationship has a great deal of potential. What are the possibilities for further strategic deals between digital agriculture providers and farmland managers and investors? What are the prospects of a digital agriculture provider such as Bayer's Climate FieldView acquiring a farmland management firm or its own large portfolio of land as a strategy for vertical integration? Mergers, acquisitions, and consolidation in the agri-food sector is an on-going trend (Clapp, 2018) and shifts in the space of digital agriculture require further analysis (Bronson & Knezevic, 2016).

This exploratory case study research provides evidence that the trends experienced in the residential real

estate market with SFRs are not unique and are very much reflected in the farmland investment market. Predicated on a fixation with algorithmic rationality, the increasingly enmeshed relationship between digital agricultural firms and farmland investment firms creates an efficient monitoring mechanism for farmland assetization and simplifies and smooths out investment processes. The likely result of these two features is the heightened interest of institutional investment in farmland, ultimately leading to restructuring of land ownership and tenancy arrangements.

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