INTERNET POLICY REVIEW

Volume 15 **Issue** 4

RESEARCH ARTICLE

OPEN ACCESS

PEER REVIEWED

Platformisation without disruption? Smart farming and platform power in German agriculture

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DOI: https://doi.org/10.14763/2026.4.2130

Published: 3 November 2026
Received: 27 April 2025 **Accepted:** 16 December 2025

Funding: The author did not receive any funding for this research.
Competing Interests: The author has declared that no competing interests exist that have influenced the text.
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Citation: Meyer, J. (2026). Platformisation without disruption? Smart farming and platform power in German agriculture. *Internet Policy Review*, *15*(4). https://doi.org/10.14763/2026.4.2130

Keywords: Platformisation, Platform economy, Digital agriculture, Economic disruption, Smart farming

Abstract: Digital platforms have transformed many economic sectors by enabling new forms of coordination, data aggregation, and value capture. Research on these dynamics has focused largely on information-good sectors, where platform-based business models have often produced disruptive market effects. It remains less clear how platformisation unfolds in sectors where value creation is closely tied to material production processes. This exploratory study examines platformisation in German agriculture, a sector that is increasingly data-driven but has not experienced platform-led disruption. Based on 16 semi-structured expert interviews with stakeholders from the German agricultural platform ecosystem, the analysis focuses on the development of data infrastructures and the reorganisation of economic relations around platforms. The findings show that fragmented data standards, limited interoperability, and a small, highly heterogeneous user base constrain the emergence of scalable, multi-sided platforms. Instead, platformisation primarily proceeds through incumbent-owned farm management systems that centralise machine- and sensor-generated data. These systems support coordination and customer retention and tend to reinforce existing market structures rather than enable disruptive entry. By analysing platformisation in a non-information good sector, the study contributes to platform research by identifying sector-specific limits to scalability and by illustrating how platform power can expand incrementally through incumbent-driven digital infrastructures.

Introduction

Platform-based business models have disrupted many sectors, particularly industries dominated by information goods that are characterised by high fixed production costs, near-zero marginal reproduction costs, and strong returns to scale, such as media and software products (Shapiro & Varian, 1999). In contrast, agriculture, as a non-information sector where value creation is primarily tied to material and biologically embedded production processes rather than scalable information goods, faces structural barriers to platformisation that challenge dominant analytical assumptions of platform studies. While no disruptive, sector-wide digital platform comparable to Airbnb or Uber has emerged in German agriculture, forms of platformisation are nonetheless taking shape. In particular, incumbent-led platforms such as John Deere Operations Center, FendtOne, CLAAS 365FarmNet, BASF's xarvio Field Manager, or Bayer's Climate FieldView illustrate how platform development in agriculture has primarily occurred through firm-specific, proprietary solutions rather than open, cross-sector intermediaries (Hackfort, 2023; Sauvagerd et al., 2024). These platforms typically either focus on machine data aggregation, farm management, or decision support rather than on creating multi-sided markets that reorganise sector-wide economic relations (Birner et al., 2021). Many of these platforms take the form of Farm Management Information Systems (FMIS), that is, farm-level software systems designed to aggregate machine- and sensor-generated data, support operational decision-making, and integrate complementary digital services. As such, FMIS constitute a central empirical focus of this study.

Focusing on digital agriculture in Germany, the study contributes to platform studies by examining a digitally evolving sector in which platformisation has not resulted in disruptive outcomes. Existing research addresses digitalisation-induced shifts in political economy and power asymmetries between farmers and agricultural companies (Bronson, 2022; Hackfort, 2021; Kenney et al., 2020; Klerkx et al., 2019), yet a platformisation perspective offers additional analytical leverage by foregrounding questions of scalability, coordination, and market power. While extensively studied in information sectors (Nieborg et al., 2024; Nieborg & Helmond, 2019; Poell et al., 2019; van Dijck et al., 2018) empirical insights into non-information sectors like agriculture remain limited (Butollo, 2023; Kenney & Zysman, 2020). This raises questions about whether platformisation dynamics are sector-specific or whether they reveal broader limits to prevailing platform models. Accordingly, this paper addresses two related questions: (RQ1) Why have digital platforms in German agriculture not developed scalable and disruptive business mod-

els comparable to those in other platform-intensive sectors? And (RQ2) What do these dynamics reveal about the limits of scalability and disruption as core assumptions in platform studies?

This paper addresses this research gap through an exploratory case study based on expert interviews with stakeholders in the German agricultural platform economy. Using platformisation as a framework (Poell et al., 2019), particularly its institutional dimensions of data infrastructures and the reorganisation of economic relations around multi-sided markets, the analysis identifies two empirically grounded findings. First, the interview data show that underdeveloped data infrastructures, especially fragmented standards, limited interoperability, and restricted data flows, constitute a central barrier to the emergence of scalable platform business models in German agriculture. In addition, respondents emphasise that a comparatively small, sceptical user base and highly heterogeneous farming practices further constrain economic scaling. Second, the interviews reveal that FMIS are emerging as centralised data platforms for farm data collection and analytics. These proprietary farm-level software systems centralise machine- and sensor-generated data. In doing so, they strengthen customer lock-in and reinforce incumbents' (e.g., machinery, input, and agrochemical companies) market dominance.

Taken together, these findings contribute to ongoing debates on agricultural platformisation by showing how platform development in a non-information sector proceeds without disruptive reorganisation of market structures. Instead, platformisation in German agriculture appears to advance incrementally and in ways that reinforce incumbent power rather than challenge it (Christensen & Raynor, 2013; Porter, 2004; Sauvagerd et al., 2024). More broadly, the study contributes to platform research by highlighting the limits of scalability and disruption commonly assumed in platform studies when applied to material, biologically embedded production sectors.

Platformisation, data infrastructure and multi-sided markets

Conceptual clarification and terminology

Many of the most valuable global companies are operating pervasive and powerful digital platforms that have transformed a variety of economic sectors like retail, communication and the cultural industry by unearthing new business models and capitalising on the combination and analysis of data (Kenney & Zysman, 2020). These transformations and their disruptive effects have spurred discourse about

the nature and dynamics of the platform economy and its regulation (Boyer, 2022), employing terms like *platform capitalism* (Srnicek, 2017), *surveillance capitalism* (Zuboff, 2019) and *digital capitalism* (Staab, 2019) to highlight different aspects and interpretations of the new way of value creation and capture.

In this paper, a platform refers to a digital intermediary that facilitates interactions between two or more distinct user groups, governs access through technical and contractual rules, and enables value creation and capture through the aggregation, coordination, and control of interactions and data (De Reuver et al., 2018; Gawer, 2014; Rochet & Tirole, 2003). The term platform ecosystem denotes the interconnected set of users, complementors, data sources, software components, and governance arrangements that evolve around a platform and shape its economic and strategic dynamics (Jacobides et al., 2018; van Dijck et al., 2018). In the remainder of the paper, the term "platform ecosystem" is used consistently to refer to this constellation.

In line with business model theory, a business model describes how a firm creates value for users and captures value in the form of revenue by configuring activities, resources, and governance arrangements (Teece, 2010). Business models thus specify the underlying logic of value creation and appropriation rather than individual technologies or products. A platform business model is understood as a specific form of business model in which value creation and capture rely on mediating interactions between multiple user groups, leveraging direct and indirect network effects, and monetising access, transactions, or data generated through platform use (Cusumano et al., 2019; Evans & Schmalensee, 2016).

In addition, data infrastructures are understood as the technical standards, protocols, interfaces, and interoperability arrangements that enable the generation, exchange, aggregation, and analysis of data across organisational and technological boundaries (Kitchin, 2014; Poell et al., 2019). For reasons of clarity, the paper uses the terms "platform", "platform ecosystem", and "platform business model" consistently throughout. Alternative formulations are avoided unless analytically required.

Platformisation and platform power

The effects of platform-based business models have been disruptive in many sectors and industries, reshaping them to cater to the affordances of the platforms themselves (Kenney & Zysman, 2020; van Dijck et al., 2018). Companies and their platforms such as Amazon, Uber, and Airbnb have become central to retail, trans-

portation, and accommodation, respectively, by leveraging technology to connect the supply and demand of a good or service directly, often bypassing traditional intermediaries. This puts platforms in a position to aggregate ever more users and data and optimise services, user experiences and prediction, strengthening their position even more and enabling them to expand into adjacent sectors (Kenney & Zysman, 2020). These platforms, while evoking the image of a level playing field, are highly hierarchical (infra)structures with built-in dependencies that centralise power into the hands of the platform owner (van Dijck et al., 2019). Following Poell et al., platformisation will be understood as *"[t]he penetration of the infrastructures, economic processes, and governmental frameworks of platforms in different economic sectors and spheres of life*" (Poell et al., 2019, p. 5-6). On a larger scale, this puts forward the notion of *"[a] platform society in which social and economic traffic is increasingly channelled by a (corporate) global online platform ecosystem that is driven by algorithms and fuelled by data"* (van Dijck et al., 2018, p. 7).

Building on this cultural studies informed conceptualisation of platformisation, Poell and colleagues propose three institutional dimensions along which it unfolds, of which two will serve as a vehicle of operationalising platformisation in agriculture (Poell et al., 2019).[1]

Platforms, business models and multi-sided markets

The first dimension is concerned with data infrastructures and the notion of datafication, which refers to the way in which digital platforms transform practices and processes into data that have previously escaped quantification. Ranging from voluntary survey data to behavioural meta-data, the expanding platform ecosystems of apps, trackers and the Internet of Things (IoT) allow for the capture, aggregation, and analysis of human behaviour with the goal of its prediction and monetisation (Kitchin, 2014; Mejias & Couldry, 2019; Poell et al., 2019). Platformisation in this dimension centres on the emerging affordances of platforms and the opportunities they create for users. The second and economics-informed dimension is concerned with the reorganisation of economic relations around multi-sided markets and centralisation and consolidation of power through platformisation. In their seminal work on the platform economy, Cusumano et al. differentiate between transaction and innovation platforms, not in terms of value capture versus value creation but with regard to the primary mechanisms through which value is generated (Cusumano et al., 2019; Mazzucato, 2018). Transaction platforms, like the on-

1. While the author acknowledges the importance of the dimension of Governance of Interactions, it is not included, as the focus is on the structural dynamics of platformisation at the meso- and macro-levels, rather than the micro-level of user interactions.

line marketplace eBay, facilitate the connection of supply and demand while remaining in control of user interaction and extract value via transaction fees (Cusumano et al., 2019). They are the exemplary "Matchmakers" and creators of multi-sided markets (Evans & Schmalensee, 2016; Rochet & Tirole, 2003). Innovation platforms, like the Android OS or the PlayStation console, are a foundation for third-party complementors to build upon and by doing so increasing the appeal of the platform. Both types of platforms engage in value creation and value capture, albeit through different organisational and strategic logics. Monetisation across both platform types can take multiple forms, including transaction fees, subscriptions, advertising, data-driven services, and various forms of cross-subsidisation, rather than relying on a single revenue stream (Cusumano et al., 2019; Täuscher & Laudien, 2018; Teece, 2010). Growth for both types of digital platforms is driven by direct and indirect network effects. In the former case, the platform's value increases among homogeneous users with each additional participant, whereas in the latter case value arises from interactions between distinct user groups. A telephone book, for example, gains value with more entries which benefits both potential callers and advertisers seeking ad space. This creates powerful economies of scale and ultimately multi-sided markets with potential winner-takes-all effects. This can lead to the rapid expansion of platforms and the dominance of a few major players in certain sectors (Cusumano et al., 2019; Kenney & Zysman, 2020).

Platformisation beyond information-good sectors

Platformisation has been researched in various sectors, particularly those dominated by information goods like the cultural industry (Poell et al., 2022; Prey, 2020), social media (Nieborg & Helmond, 2019) or retail (Culpepper & Thelen, 2020). Information goods are either digital from the start or they and their distribution are easily digitised, for which traditional news media and its digital transformation serve as a prime example. Information goods usually need to be experienced and deliver returns to scale, meaning the high initial fixed costs for production of the first unit are contrasted by almost zero costs for the second (Shapiro & Varian, 1999). However, research is scarce in sectors not dominated or defined by information goods, or sectors where platforms are not easily observable (Butollo, 2023; Nieborg et al., 2024). Following Butollo, it must be emphasised that the field of platform studies primarily investigates the leading companies of the digital economy and less so how digitalisation and the platform economy are transforming existing sectors like agriculture or heavy industry (Butollo, 2023). Additionally, agriculture is a highly regulated sector with strong incumbents, posing a different challenge for platform-based business models than entertainment or retail (Ozalp et al., 2022).

Taken together, these distinctions allow platformisation to be specified more precisely than its broad usage often permits. In this paper, platformisation is understood as a set of analytically distinct, though empirically entangled, dynamics that operate at different levels. As a process, it unfolds along the two institutional dimensions introduced above, namely the datafication of practices that previously escaped quantification through expanding data infrastructures, and the reorganisation of economic relations around multi-sided markets. These processes are sustained by a particular mechanism, lock-in, through which ecosystem integration, switching costs, and direct and indirect network effects tie users to a given platform ecosystem. Whether these dynamics issue in disruptive reorganisation or in the consolidation of existing market structures, however, is not given in advance but depends on the structure of the sector in which they unfold, a question the present study takes up empirically in the case of German agriculture.

The explorative case: Platform economy in German agriculture

Like other sectors, agriculture has advanced through stages of digital transformation, now termed Agriculture 4.0, Precision Farming, or Smart Farming (Kenney et al., 2020). Digital farming generates vast data volumes – expected to exceed 4 million daily data points per farm by 2050 – enabling optimisation of production, forecasting, and machinery maintenance (Rotz et al., 2019; Wolfert et al., 2017). This data-driven model supports decision-making, promising higher yields, resource efficiency, and proactive repairs, ultimately improving farm profitability. At a broader level, digital farming is framed as a more sustainable means of food production, addressing climate change and global food security (Basso & Antle, 2020). Compared to platform-intensive sectors such as media, mobility, or tourism, digital agriculture exhibits some familiar platform dynamics, including data aggregation, user coordination, and attempts to leverage network effects. However, unlike platforms in information-good-dominated sectors, agricultural platforms operate in a context where value creation remains tightly coupled to material production processes, biotic environments, and asset-intensive infrastructures. While platforms in sectors such as ride-hailing or accommodation can scale rapidly by standardising transactions across relatively homogeneous users, agricultural production is characterised by highly heterogeneous practices, environmental conditions, and regulatory constraints. These sectoral differences limit the transferability of platform templates developed in information-good sectors and shape how platformisation unfolds in agriculture. In contrast to platform start-ups in sectors such as mobility or hospitality, where rapid user aggregation can compensate for early

losses, agricultural start-ups face higher marginal costs of onboarding users and weaker network effects (Butollo, 2023; Kenney et al., 2020; Rotz et al., 2019).

Germany's agricultural platform economy is comparatively diverse, comprising machinery manufacturers, input companies, and numerous small to midsize companies offering specialised products and services. German farmers often use equipment from multiple manufacturers, allowing flexibility and customisation for their operations. However, proprietary data formats and limited interoperability stand in stark contrast to the seamless data integration offered within individual manufacturers' platform ecosystems, thereby incentivising farmers to remain within a single vendor's ecosystem and reinforcing vendor lock-in (Hackfort, 2023; Sauvagerd et al., 2024). The platform landscape is primarily shaped by FMIS operated by incumbent agribusinesses, which address a wide range of farming needs. In addition, there are a few digital transaction platforms that facilitate the exchange of goods, services, and agricultural information (Tummers et al., 2019).

For established agricultural companies that already have farmers using their hardware and services, digitalisation presents an opportunity to add data management and advisory services to their portfolio. Companies like the machine manufacturer John Deere or the chemical conglomerate of Bayer-Monsanto aim at funnelling the data generated by their machinery and sensors to their platforms to further their dominant position and avoid third-parties intermediating the relationship between them and the farmers (Birner et al., 2021; Kenney et al., 2020).

Furthermore, global digital companies like Google, Microsoft, IBM and Amazon are developing interests in agriculture. Their resources and abilities in cloud space, data aggregation, computing and prediction position them especially well as potential disruptors of the sector but they lack the direct relationship with the end-users and supply chain. However, their strategies do not seem to include the development of proprietary platforms but the cooperation with the incumbents and start-ups in regard to delivering infrastructural services like server capacity and cloud computing (Birner et al., 2021; Kenney et al., 2020; Sauvagerd et al., 2024).

Lastly, new entrants in the agricultural sector, mostly venture-capital backed start-ups pursuing rapid scaling, try to establish new business models by using digital technology to disrupt the sector. Following Kenney et al., these start-ups either try to trade farmer's data for recommendation services, replace local farm suppliers by becoming a more efficient marketplace or to intermediate downstream-relationships between farmers and consumers, food processors or distributors (Kenney et al., 2020). Nevertheless, as of now there is not a dominant platform-based busi-

ness model emerging in digital agriculture and start-ups are facing difficulties finding financial backing (AgFunder, 2024; Nolet & Pryor, 2021).

However, digital farming is also associated with exacerbating economic inequality and power imbalances and the changes brought on by the digital transformation of the agricultural sector have been critically researched in terms of a change in the political economy of farming (Bronson & Sengers, 2022; Carolan, 2020; Hackfort, 2024; Rotz et al., 2019), socio-ecological implications (Hackfort, 2023; Wolfert et al., 2017) and data usage (Montenegro De Wit & Canfield, 2024; Wilgenbusch et al., 2022; Wiseman et al., 2019). The agricultural sector is characterised by few global companies dominating their respective fields and entrenching their oligopolistic positions through horizontal and vertical integration. This concentration, resulting from acquisitions and mergers, has led to the situation where the four largest global companies in the fields of seeds, agrochemicals, and grain trading control over 70% of the market, while in the area of agricultural machinery, the figure is just under 50% (Hackfort, 2021; Mooney, 2018). Closely linked to these agricultural machines and the data collected by them, are incumbent-owned platforms. Farmers wanting to improve their operation by employing the analyses provided by services running on these platforms must agree to Terms of Service that give the platform owners the rights of data usage and economic exploitation, sparking questions about data sovereignty and privacy. The lack of data interoperability between different software products may additionally lead to lock-in effects and unwanted dependencies on digital platforms (Klerkx et al., 2019; Rotz et al., 2019; Wolfert et al., 2017). Patterns of inequality in a digitalised agriculture therefore include unequal control over the technology, unequal distribution of economic benefits of said technologies and uneven sovereignty over generated data and hardware (Hackfort, 2021, 2023).

However, a platformisation perspective focused on data infrastructures and multi-sided markets, with the notable exception of Sauvagerd et al.'s study on oligopolistic platformisation in agriculture (Sauvagerd et al., 2024), is missing. Further research has been focused on value capture and generation through agricultural platforms, showing how it is increasingly created through platforms owned by actors beyond industry boundaries (Klingenberg et al., 2022; Wysel et al., 2021) or questioning how powerful companies try to transform data into value (Hackfort et al., 2024). The identified strategies show the companies vying for lock-in effects, using data for price-setting and profit-oriented sharing, and applying it in product development and marketing (Hackfort et al., 2024). This illustrates how agriculture provides a valuable empirical setting for platform studies, as platform strategies

familiar from information-good-dominated sectors encounter distinct constraints in non-information sectors characterised by physical production processes.

Focusing on Germany provides an analytically useful case because it combines a highly industrialised agricultural sector with a dense regulatory environment and a strong presence of incumbent machinery and input manufacturers. These characteristics make Germany particularly well suited for analysing incumbent-led forms of platformisation. Three features make the German case distinctive within Europe. First, agricultural competence is administered across sixteen federal states, and interviewees described how this disperses technical and administrative standards in ways that aggravate the interoperability problems discussed below, a fragmentation less pronounced in more centralised systems. Second, the farm base respondents engaged with is markedly heterogeneous in size, structure and degree of digitisation, so that the diversity of users a platform must serve is more pronounced than in sectors built around more uniform holdings. Third, several of the machinery and input incumbents best positioned to drive platformisation are domestically rooted or strongly present, which lends the incumbent-led pattern observed here a particularly concrete form. These specificities should be borne in mind when weighing the transferability of the findings, as platform dynamics may unfold differently where farm structures are more uniform, administration more centralised, or domestic incumbents less entrenched.

Against this backdrop, the empirical case examined in this study is defined as the emerging platform economy around digital agriculture in Germany. Rather than analysing a single firm or platform, the study investigates sector-level platform dynamics by examining how different actor groups understand and shape platformisation processes. The analysis centres on platform types that mediate data aggregation, coordination, and value creation in agricultural production, while excluding on-farm user practices. This case definition provides the analytical frame for the empirical investigation outlined in the following section.

Research design and methods

The following empirical analysis connects two institutional dimensions of platformisation – data infrastructure development and reorganisation of economic relations around multi-sided markets – to the collected interview data (Poell et al., 2019).

Data collection involved semi-structured expert interviews with stakeholders from the German agricultural platform economy, exploring platformisation dimensions

alongside broader themes such as digital farming trends, start-up challenges, and incumbent roles. Expert interviews were chosen because the study aims to capture practitioners' interpretations, considerations, and knowledge regarding platformisation processes that are not fully observable in documents or survey data, especially considering the early stage of sectoral transformation. The German-language interviews were conducted online in 2024 and generated roughly 12 hours of recorded material. An interview guideline was developed based on prior experience in the field of digital agriculture and observed dynamics of platformisation in other sectors. It was piloted with the first three interviews and underwent minor adaptations. The interview guide covered four core thematic areas: perceptions of digitalisation and platformisation in agriculture, data generation, interoperability, and infrastructure, platform business models, monetisation, and scalability, and relationships between incumbents, start-ups, and external technology providers. Interviewees were identified via online searches, LinkedIn, previous research contacts, and recommendations from industry events, associations, and start-up networks. Between June and August 2024, 16 interviews were conducted across four stakeholder categories. Table 1 summarises the organisational types, sub-sectors and general roles of the interviewees. To protect confidentiality, only aggregated categories and pseudonymous IDs are reported. Some interviewees held multiple roles but were categorised by their primary occupation.

TABLE 1: Overview of Interviewees

ID	ORGANISATIONAL TYPE	SUB-SECTOR	ROLE
EC 1	Company	Data exchange platform provider	Managing Director
EC 2	Company	Machinery manufacturer (Incumbent)	Digital Strategy Manager
EC 3	Company	Agricultural marketing agency	CEO/Founder
EC 4	Company	FMIS provider (Incumbent)	Product Manager
EC 5	Company	Digital start-up (agricultural software)	Founder/Managing Director
EC 6	Company	Digital start-up (agricultural platform)	Co-Founder
EC 7	Company	FMIS provider (Incumbent)	Business Manager

ID	ORGANISATIONAL TYPE	SUB-SECTOR	ROLE
EC 8	Company	Agrochemical & digital farming platform (Incumbent)	Digital Agriculture Manager
EC 9	Company	Machinery manufacturer (Incumbent)	Digital Innovation Manager
EC 10	Company	Machinery manufacturer (Incumbent)	Digital Platform Specialist
G 1	Federal Government	Digital agriculture department	Policy Officer
IA 1	Industry Association	Digital industry association	Project Manager
IA 2	Industry Association	Regional agri-tech cluster	Managing Director
R 1	Research Institute	Digital agriculture research	Researcher
R 2	University	Digital agriculture research	Researcher
R 3	University	Digital agriculture research	Researcher

Source: Own design. IDs refer to interview partners. EC = Economic stakeholder, G = Governmental actor, IA = Industry Association Stakeholder, R = Researcher.

All participants possessed comprehensive technical or business expertise and sectoral knowledge. Economic stakeholders ranged from global corporations to small start-ups actively operating FMIS or transaction/innovation platforms. Farmers were not included as interview participants. This is not due to a disregard of their perspectives but because the focus of this study lies in understanding the broader sectoral dynamics of digital farming through the lens of platformisation. The aim is not to capture on-farm practices or day-to-day user experiences, but to examine how digital platforms and corporate strategies are reshaping the agricultural sector. This necessarily entails engaging with actors who play a formative role in these processes such as industry representatives and platform developers. That said, this choice does create a methodological and epistemological limitation, particularly in terms of excluding farmers' direct voices. This blind spot is partially mitigated by the fact that many interviewees maintain ongoing, often close working relationships with farmers, and regularly draw on their feedback. Their insights therefore offer indirect access to farmers' concerns and practices – though these accounts are, of course, mediated and shaped by the interviewees' own professional agendas and institutional positions. This dynamic is acknowledged and treated

as part of the analysis, rather than overlooked. The paper does not assume neutrality or objectivity on the part of these actors, but rather treats their input as indicative of broader discursive and structural shifts within the sector.

A set of core questions was asked in all interviews, the focus in the interviews with economic actors was more on practical aspects like platform monetisation and struggles of the platform ecosystem. The interviews with the non-economic stakeholders were more concerned with general developments and theoretical aspects and proved especially insightful when accessing the experts' forecasting abilities. Example guiding questions included: “Who are the users and beneficiaries in the field of digital agriculture at present?”, “Have you observed any new digital business models in agriculture in recent years and how many of those were successful?”, “Where in the entire agricultural production chain do you see the greatest potential for digital platforms or digital start-ups?”, “Is platformisation only a matter of time?”.

The empirical data was transcribed verbatim with the open-source software NoScribe and analysed and coded according to qualitative content analysis using MAXQDA. The analysis followed a primarily abductive, platformisation-driven approach, emphasising the synthesis of findings and linking the data to the framework to identify likely explanations. Coding was done in an iterative process that yielded inductive categories that were included in the analysis as they provided meaningful insights and explanations. Initial deductive coding was guided by the platformisation framework, especially the dimensions of data infrastructures and multi-sided market reorganisation. During iterative rounds of analysis, empirical observations that did not satisfyingly align with the theoretical expectations were used to refine and, where necessary, specify inductive categories until repetitive content and the lack of new categories indicated thematic saturation (Mayring, 2022).

Results

Development of data infrastructures: advanced data generation and limited data flows

The most striking result of the empirical analysis was the discrepancy between data generation and data flow. In the interviews, “data” primarily referred to farm-level production data, machine telemetry generated by agricultural equipment, and regulatory or administrative data. While on the individual farm level the possibilities of digitising processes and interactions, the datafication, can be quite ad-

vanced through an IoT and FMIS-Integration, on a sector-level, basic infrastructure for data-sharing or provision is non-existent. Sharing, however, is a necessary condition for any kind of platform economy as data needs to flow if it ought to be intermediated or capitalised. The issues begin on a fundamental level, as the different states of Germany use different technical and administrative terminology which creates hurdles for data-exchange[2]:

This lack of standards continues through all levels of data exchange resulting in a fragmented ecosystem making it quite arduous for platform developers to provide data interfaces. The diversity of European and especially German machine manufacturers, input companies and software providers without connective standards yields interoperability problems regarding the necessary comprehensiveness of platforms:

I believe that this diversity that we have in the economy makes it difficult to scale solutions [...] If I have three players that talk to each other, then I might have two connections each. But if I somehow have 20 players who want to communicate with each other, I have 190 bilateral connections. And mastering this [...], is something that we perceive as a scaling problem and therefore rely massively on the standards. (EC 1)

While data spaces run in collaboration between governmental and economic actors, like GAIA-X, are seen as a viable solution for interoperability problems, as they would allow the upload and sharing of data and serve as standardised infrastructure, their feasibility is questioned. There are ongoing approaches to establish these data spaces, but progress is slow as again fragmentation hinders effective organisation:

There is not a single standardised data space in agriculture. In the mobility sector, for example, they have managed to develop a standardised data space. This is not possible in agriculture, it's really crazy. I don't think any other area is as complicated as agriculture. There are so many data platforms in agriculture and they all work at cross purposes. (IA 1)

Interviewees, while being open and responsive to the idea of platformisation and platform power per se, repeatedly mentioned the lack of basic data infrastructure that would allow free data flow in the first place, as a crucial reason for their negative assessment regarding platformisation in agriculture. Despite this, the current

2. Original German quotes were translated by the author.

approaches towards data spaces are one side of the coin regarding data infrastructures as a dimension of platformisation. With so many different stakeholders involved and standards hard to establish[3], effective data spaces would not only allow for the B2B exchange of data but also empower farmers to give access to their data in a controlled and, if necessary, anonymised way.

The other side of the coin is the potential setting of de facto standards for interoperability by powerful companies. By leveraging the ease of use within the company's platform ecosystem, they could accumulate a critical mass of users, prompting other companies – particularly smaller and more specialised ones – to ensure interoperability with the dominant system. Interviewees made comparisons to the iOS-ecosystem, that excels in user retention, with John Deere being tentatively heralded as the Apple of the agricultural sector, as they are in a prime position to achieve this threshold. Nevertheless, practical usability is still in its infancy, despite increased efforts to enable interoperability.

Characterising FMIS as platforms warrants brief justification against the definition adopted above, which, on the basis of the interviews, they appear to satisfy unevenly. They function most clearly as data intermediaries, aggregating and concentrating machine- and sensor-generated farm data within the proprietary ecosystem of a single provider, and they exercise a degree of governance through technical and contractual arrangements, notably limited interoperability, that tie farmers to a given system. Their multi-sidedness, by contrast, appears more nascent: rather than mediating established interactions between distinct user groups, most FMIS still primarily serve the individual farm, with more genuinely multi-sided markets suggested only as a gradual prospect as incumbents extend their ecosystems. On this reading, FMIS resemble platforms more along the dimensions of data intermediation and governance than in their multi-sided character, a configuration consistent with the incremental rather than disruptive platformisation the interviews describe.

In conclusion, the dimension of data infrastructure resonated with the respondents on the one hand in terms of datafication of processes and interactions on the farm level. Farmers employing a FMIS for analytical purposes are primed to feed it with as much data as possible to enhance results. On the other hand, this data often remains siloed away in data sinks, either on the farm or in the ecosystem of the

3. Standard-setting in agricultural data is hampered by several structural factors such as the semantic-interoperability problem discussed above, the heterogeneity of machine manufacturers, input suppliers and software providers and the limited incentive for incumbents to convene on open standards.

FMIS. Interviewees consistently described the current state of agricultural data infrastructures as fragmented and technically immature, arguing that basic standards and interoperable interfaces are not yet in place to support scalable platform models.

Reorganisation of economic relations: Same, same but different?

The reorganisation of economic relations was the dimension of platformisation that respondents felt most inclined to talk about and extrapolate from current developments. Key themes emerging were the developmental state of digital farming as the foundation business models are built on, strategies of platform monetisation and the possibilities of a future platform economy revolving around present incumbents.

User base and adoption constraints

Interviewees consistently contrasted the possible digital advancements in agriculture with their own assessment that digital adoption and platform use remain uneven and limited in practice. From an economic point of view, farmers don't need to digitalise their operation yet, as on the one hand profits can still be made without digitalisation and on the other, the direct economic impact is hard to quantify when operating in a biotic environment. Especially smaller to middle-sized farms are simply not complex enough for a farmer's experience and know-how to be not on par with algorithmic analysis and actual monetary gains per acre or livestock unit are small, if one can measure it at all. Additionally, it does not help that user experiences often are not up to standards and digital support can be difficult to come by. With word-of-mouth still being a strong driver for products' or services' reputation and farming being a trust-based business, past bad experiences influence the perception of the whole smart farming sector. While this stagnation is likely to change in the coming years with demographic change and technological maturation, interviewees stressed that farmers actually need to benefit on a day-to-day basis from any technical developments, whether in terms of profits, saved time or comfortability. Business ideas or innovative approaches need to start from there, not be put on top afterwards:

So when I, as a digital-savvy person, come around the corner with a cool app and then always realise, okay, it doesn't really work in practice, there's actually no real need for it, why shouldn't I be surprised? I think that has often happened. That's simply because the farmers were perhaps not asked enough, were not involved enough, they simply didn't look at it closely enough. (IA 2)

The result is a somewhat sceptical and shaky user-base, making the establishment of platforms and platform economy harder, as data entry often competes with farmers' time-critical operational tasks, while perceived economic benefits remain uncertain.

Monetisation strategies and platform failure

The monetisation strategies of both incumbents and start-ups were a central focus for interviewees. Start-ups face well-documented challenges (Fairbairn & Reisman, 2024) in entering the sector, securing funding, and standing out in a crowded market. A lack of service differentiation and aggressive pricing tactics, such as offering free or low-cost subscriptions to attract users, have led to downward pressure on prices and margins. These practices have lowered farmers' willingness to pay and saturated the market with similar offerings. As a result, the platform landscape is undergoing consolidation, with incumbents likely to prevail due to their ability to absorb losses and leverage existing customer relationships. Both start-ups and incumbents struggle with the structural constraints of farming: a small, highly diverse user base and limited scaling potential. German farms vary widely by size, crop, and environmental conditions, necessitating highly specialised hardware and software. Given how heterogeneous and fragmented the farm base described by interviewees is, the addressable user pool for any single platform is correspondingly smaller, further weakening the network effects on which scaling depends. In software development, the absence of interoperability standards creates a dilemma: build a niche platform for a small audience or attempt a universal solution: an expensive, technically demanding task requiring ongoing support.

Scaling remains difficult, as the addition of new users is costly and complex, unlike in typical platform models where marginal costs are minimal. Respondents highlighted limited transferability of platform models developed in digital consumer markets. Unlike Airbnb, which serves a uniform user base through a single tech stack, farming demands tailored solutions, complicating the potential for scalable, platform-driven disruption. Respondents also highlighted how during the early phase of platform business models' implementation in agriculture, many stakeholders believed that user growth alone would generate viable revenue streams, and that data, being perceived as an asset on its own, would directly translate into revenue. Monetisation strategies were described as not thought through, ill-conceived and technologically limited, which made the platforms' failure and struggles to be expected:

A lot was often forgotten at the beginning and then some monetisation points

cannot be used at all because the platform was not technologically equipped to monetise this in concrete terms. And that is of course a bitter pill to swallow. [...] So I asked some of the digital platforms that have given up and asked them a simple question, who is actually your customer? Then they always got into quite a mess because they had this multi-stakeholder setup and it wasn't entirely clear who was billing whom for what at the end of the day. (EC 5)

Incumbents, lock-in, and incremental platformisation

When monetisation proved difficult, many start-ups either closed or were integrated into larger companies, who themselves were adjusting their expectations and use cases. The adapted approaches towards platforms are described as more about generating lock-in effects and keeping the farmer in the platform ecosystem of the company, not only via a lack of interoperability but increasingly via ease of use, practicability and a pro-active customer support system. The business model of the platform and its purpose is shifting more towards customer retention, data extraction and ultimately the sale of additional goods and services. Profits are generated through indirect platform effects as they are not expected to make money through subscriptions or direct sales:

And as I've heard from other major manufacturers, they're all making a loss with the software. So nobody is really making money with it. They all just want it to somehow integrate their users or customers into their ecosystem and, on the other hand, of course, to collect all the data and, based on the data, they can then develop new use cases, offer new services and thus secure their market positions or expand them further. (EC 6)

In the bigger picture, reorganisation of economic relations is not perceived as a current or likely future development by interviewees. Next to the described difficulties for start-ups, incumbents are in too strong a position to be displaced or even challenged from out-of-sector actors. Increasing digitalisation is therefore rather seen as a driver for cementing their powerful market positions and creating more comprehensive ecosystems. The goal of customer attraction and retention through the platform ecosystem seems to slowly take off, as respondents shared experiences of farmers actively deciding to buy products for the seamless software integration:

I heard from former colleagues that this was the first trade fair where they realised that purchasing decisions were not made on the basis of the individual product, but that people said, I'm buying this, not because it's a good tractor, but because this ecosystem, i.e. this platform in which the tractor is integrated, actually works

really well. […] Before that, it was always dismissed a bit, but now it seems to be influencing purchasing decisions, and so of course I also have a kind of feedback loop, if I have more machines in a system like this, then the system gets better, so I can also see these classic network effects, which then also lead to concentration. (R 3)

While farming is still a machinery-centred business, meaning the machine determines the software and not the other way around, the relevance of seamless integration is expected to grow. This was voiced in worried terms regarding companies, becoming data sinks that collect and control, but don't share, at least not without a price.

Across interviews, two central patterns emerge. First, despite advanced on-farm data generation, fragmented data infrastructures and limited interoperability prevent scalable, multi-sided platform models. Second, platformisation in German agriculture proceeds primarily through incumbent-driven FMIS ecosystems, reinforcing existing market structures rather than enabling disruptive entry. These two patterns, the limits of scalability and the consolidation of incumbent power, structure the discussion that follows.

"Platforms can't sow a field": The curious case of platformisation in German agriculture

Based on 16 expert interviews, this exploratory study provides empirically grounded explanations for the absence of disruptive platform-based business models in German agriculture and the forms through which platformisation is nevertheless unfolding. Starting with the former, respondents pointed out the sectors' idiosyncrasies that hinder economic scaling efforts, and the lack of digital infrastructure and interoperability standards that are necessary for an economically exploitable dataflow. Additionally, business models around platforms are just now shifting away from failed direct monetisation towards user retention and attraction through the creation of a seamless, easy-to-use, and practical platform ecosystem that focuses on the sale of core analogue products, further analytical platform-based services and data collection. Furthermore, interviewees reported that in agriculture, a non-information sector, platforms are not essential to do business:

The digital business models are not crucial for me to be able to cultivate fields. They are supportive and they are also important in part for further development. But at their core, they are not decisive for me being able to go out into the fields, work the soil, sow and ultimately have a harvest. They are simply not crucial for

that and that is why this disruption did not happen. (EC 9)

Looking ahead, the question remains whether that statement will still hold true in the years to come, meaning that increased datafication could gradually transform agriculture into a sector more akin to an information industry. Digital tools will provide datapoints that will need a platform for aggregation, analysis and prediction. Correspondingly, platforms will become more important but they and the digital tools will, as the most likely scenario, be made and run by already existing dominant players in their respective sub-sectors that will capture or generate value through platforms. Although disruption was described as unlikely, the platformisation of the sector is arguably progressing. Examining the two institutional dimensions, it becomes clear that data infrastructures, particularly FMIS as centralised hubs for the datafication of processes and interactions, are gaining prominence, along with the affordances these platforms offer. This connects directly to the second dimension of reorganisation around multi-sided markets. Platformisation in this sense is sustaining incumbents' market power and advantage (Fairbairn & Reisman, 2024), which has been conceptualised in the agricultural sector as oligopolistic platformisation (Sauvagerd et al., 2024). Farmers might now buy inputs or machinery via platforms but whom they buy from doesn't change as relevant players are few and trust in established brands is high. As of now, compatibility among machines is more important than software interoperability and even if that changes, what difference does it make when both are made by the same company?

This study contributes to platform studies in three interrelated ways. First, it provides empirical evidence from a non-information sector in which platformisation is observable but does not result in disruptive, sector-wide intermediation. While platform studies have predominantly examined information-good-dominated sectors characterised by low marginal costs and rapid scaling (Kenney & Zysman, 2020; van Dijck et al., 2018), the German agricultural case demonstrates that platform dynamics can unfold under materially and institutionally constrained conditions. The findings show that datafication and platform-based coordination are advancing, yet without displacing incumbents or producing winner-takes-all outcomes. This extends work on platformisation by showing that platform power may develop even where disruption remains limited.

Second, the study refines debates on scalability and network effects by identifying concrete mechanisms that limit their operation in agriculture. Interviewees consistently pointed to heterogeneous production practices, high onboarding and support costs, and fragmented data infrastructures as barriers to scalable, multi-sided platform models. In contrast to sectors such as mobility or accommodation, where

rapid user aggregation can compensate for early losses (Cusumano et al., 2019), agricultural platforms face structurally weaker and more localised network effects. These findings qualify assumptions about scalability as a general property of platform business models and support calls to account for sector-specific cost structures and data characteristics.

Third, the analysis contributes to understandings of platform power and incumbency by showing how platformisation can proceed primarily through incumbent-owned platforms. In the German case, FMIS operated by machinery manufacturers and agricultural conglomerates function as focal points for data aggregation and coordination, supporting customer retention and complementary sales rather than direct platform monetisation. This pattern aligns with emerging accounts of oligopolistic platformisation in agriculture (Sauvagerd et al., 2024) and complements political economy perspectives on platform power that emphasise consolidation through ecosystem integration rather than disruptive entry (Fairbairn & Reisman, 2024). More broadly, the findings demonstrate that platformisation does not necessarily entail market reorganisation in favour of new intermediaries, but can reinforce existing market structures under conditions of limited scalability.

Returning to the research questions posed at the outset, the answer to the first (RQ1), why digital platforms in German agriculture have not developed scalable and disruptive business models, lies in a set of converging sectoral conditions. Fragmented data infrastructures and absent interoperability standards restrict the data flows that scalable models require; a small, heterogeneous user base with high onboarding costs weakens network effects; and, as direct monetisation has largely failed, business models are shifting towards retention and lock-in within incumbent-owned ecosystems. The answer to the second research question (RQ2), what these dynamics reveal about scalability and disruption as core assumptions in platform studies, is that neither is intrinsic to platform business models. Both are contingent on the low marginal costs, informational character, and comparatively homogeneous user bases of the sectors platform studies have mostly examined. Where these conditions are absent, as in materially and biologically grounded agriculture, platformisation may still advance through datafication and the accumulation of platform power, but incrementally and in ways that consolidate rather than unsettle existing market structures.

In conclusion, the limits of scalability and the persistence of incumbent power structures emerge as the two overarching takeaways of this study for platform studies. The platformisation of German agriculture is advancing incrementally, shaped by sectoral characteristics that constrain scalability and disruption while

favouring the consolidation of incumbents' market power. As digital transformation progresses, platforms are likely to become more central, yet their role may remain defined by sustaining existing structures rather than introducing fundamental change. Future research should examine how these dynamics evolve across national contexts, regulatory frameworks and other materially grounded sectors, to establish how far these limits extend beyond agriculture.

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