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## Guest editorial: Politics of big data in agriculture

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## 1. Introduction

Over the last forty years, the global population has nearly doubled – owing in part to the continuous technological innovation that has encouraged agricultural productivity (Dodge, 2018: 46). This process continues today at high speed, as farming is being reshaped by the ever-increased pervasiveness and trivialisation of ‘smart’ technologies. Think of self-driving tractors or hacking robots, autonomous drones for spraying pesticides, user-aware smart-phone applications for farming guidance, satellite-enabled image analysis for the detection of plant disease, or sensors inbuilt in water pipes or other farming-related infrastructure. All these technologies work through the accumulation of data. Gralla (2018) estimates an average 4.1 million data points per day and per farm generated in 2050. Furthermore, the actual ‘smartness’ of farming technologies in the age of big data is being associated with the computerised analysis and software-based processing of data (Ribarics, 2016; Carolan, 2018a). This points at an understanding of smart farming as an ensemble of Foucauldian ‘techniques of power’ (Foucault, 1982), that work through the systematic and routine accumulation, transfer, analysis and software-mediated processing of data, with a view to automate everyday farming practices and processes.

To clarify, current efforts towards the increased digitisation and computerisation of farming are not new. From the early 1980s, the term ‘precision agriculture’ was put forth to talk about the use of sensing technologies to monitor and manage practices and sites of food production (Daberkow and McBride, 2001; Sonka and Cheng, 2015). More recent technology advances further increased the computerisation of agriculture, while also spawning a number of novel terms. These range from ‘data-driven farming’ (Bolman, 2016) to ‘digital agriculture’ and ‘big agriculture’ (Van Es and Woodard, 2017; Carbonell, 2016). The most common terms today are ‘smart farming’ (Vate-U-Lan et al., 2016) and ‘big data in agriculture’ (Protopop and Shanoyan, 2016). Although they both suffer a great deal of definitional elasticity, these latter terms add at least two crucial aspects to ‘precision agriculture’, relating to (1) *interconnectivity* (of differing points of data collection and analysis), and (2) *automation* (of the data-based management of farming practices and

processes) (Klauser, 2018). Both aspects will be discussed in more detail below.

Contemporary forms of software-driven farming technologies are thus novel in degree rather than in kind, but are gaining momentum and increasing socio-political relevance, as well as raising increasing hopes and fears about their potential for transformative capacity in agri-food (Carbonell, 2016; Klerkx et al., 2019). On the one hand, smart-farming ‘advocates’ reiterate the possibilities of technology-induced precision, reliability, effectiveness and efficiency, related to environmental protection and sustainability (Bongiovanni and Lowenberg-Debowler, 2004; Jullien and Huet, 2005; Moreira, 2017; Wolfert et al., 2017), refined traceability of food products, improved animal welfare, and enhanced knowledge exchange and learning for farmers (for an overview see Carbonell, 2016; Klerkx et al., 2019). On the other hand, critical debate revolves around fears of techno-dependency and loss of data and food sovereignty (Dürr et al., 2004; Carolan, 2018b, 2018c), questions about data security (Wolfert et al., 2017), privacy and accountability (Bronson and Knezevic, 2016), as well as around wider considerations regarding the implications of smart technologies on agricultural employment rates (Van Es and Woodard, 2017), farming diversity (Walter et al., 2017), and the divide between capital intensive farms benefitting from smart technologies, and those unable or unwilling to follow this particular transition pathway (Fraser, 2018; Rijswijk et al., 2021; Ingram et al., 2022).

## 2. Aims of the special issue

In light of these societal and scholarly debates, this special issue aims to examine the benefits, limitations and problems of smart farming and to question the wider ecological, economic, political, social and spatial implications of the field. More specifically, the six papers that make up the collection are all concerned with the risks and opportunities associated with smart farming as ‘techniques of power’ moving beyond the assumption that smart technologies simply pave the way for a “prosperous and sustainable future” (IBM, 2010). Together, the papers investigate in empirical detail the relations and processes behind ‘smart

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farming' and the implications of the current proliferation and intensification of smart-farming technologies. In addressing these two strands of investigation, the papers adopt a specific power sensitivity, studying and questioning smart farming as both the product and producer of myriad power dynamics and relations between differing public and private parties. In this endeavour, the collection is necessarily exploratory in ambition and scope, knowing that it is only a start on the road towards a richer and more systematic engagement with the contemporary politics of big data in agriculture. It connects with a revealing if still limited literature that has emerged in recent years to examine the power issues evoked by and inherent in current smart farming evolutions (Bolman, 2016; Fraser, 2018). In particular, a systematic debate on these issues is still missing in rural studies and in critical IT-studies more generally (as in other social sciences). This special issue brings together an agenda-setting collection of papers to fill this gap, particularly with a focus on critical lines of inquiry related to digital agriculture, automated food systems and rapidly evolving technological developments in rural areas.

Before moving to outline in more detail the contributions of the individual papers, more explanation is needed on the two aforementioned key aspects of smart farming: *interconnectivity* and *automation*. In the process, we connect the discussion with existing social science literatures in the field to open up an initial understanding of the power dynamics that lie behind and that are produced by novel software-mediated techniques of farming.

### 3. Interconnectivity in smart farming

Although there are different readings of smart farming in terms of assumed benefits and normative rationales for engagement as socio-technical practice, the 'smartness' or 'big data' aspect of farming is commonly set in relation to increased interconnectivity, as opposed to the management of isolated technological abilities or fields (Bolman, 2016; Carolan, 2016: 138). Consider, for example, John Deere's online platform [myjohndeere.com](http://myjohndeere.com), which offers farmers access to real-time generated data from sensors attached to their own machines and integrated in their own fields, as well as aggregated data from other farmers, and external datasets including weather and financial data. In the platform, various tools and databases relating to differing agricultural practices and processes come together within an explicit holistic approach and coalesce into an apparent 'whole' architecture. The resulting 'data-assemblages' (see Carolan, *in press*) relate to a wide array of places and phenomena, from machines, fields and infrastructures to other farmers' datasets and contextual information. The ambition pursued is to optimise individual farming practices – taking into account their internal specificities, regularities, effects, and problems – within, and in interaction with, their wider context of food production and demand.

Thus, by its very functioning, such an 'approach to farming through interconnectivity' implies a permanent dynamics of expanding data collection and analysis, aiming to interlink ever more extensively and intensively deciphered components of reality, across an ever-wider range of spheres. The more comprehensively farming practices or patterns of cultivation are 'known', i.e. translated into data, the better they can be optimised within their respective agro-food context. The 'smart farm' is also a surveillant farm, if we understand surveillance as "focused, systematic and routine practices and techniques of attention, for purposes of influence, management, protection or direction" (Lyon, 2007: 14; Klauser, 2018).

These efforts of interconnected decipherment of farming-related practices and processes work on all spatial scales. They are intrinsically interwoven into the texture of everyday farming life and are embedded into the infrastructural systems that underpin agricultural production and demand at the local, regional and national level. They also work through global communication networks and logistic chains (Protopop and Shanoyan, 2016). The 'smart farm' is both the product

and producer of specific ways of accumulating and analysing data on all kinds of social and spatial scales, reaching beyond national jurisdictions and political contexts.

This raises important questions of data sovereignty and ownership, and of transparency and accountability (Carolan, 2018c). Whether we are talking about autonomous tractors, sensors inbuilt in irrigation infrastructures or handheld smart phones, the key point is that data are being generated and accumulated somewhere and subsequently transferred and 'grabbed' elsewhere (Fraser, 2018). What we see emerging is a form of geographically, socially and institutionally distributed agency with regard not only to who generates data, but also who can access these data as they become fused and interconnected within the complex 'surveillant assemblages' that emerge around everyday farming practices (Haggerty and Ericson, 2000). From a practical perspective, it becomes increasingly difficult to know who has access to what data and who knows what about specific agricultural practices and processes. These uneven 'politics of knowledge' (Gardezi and Stock, 2021: 6) in data-based agriculture raise major questions in terms of trust (Jakku et al., 2019; Rijswijk et al., 2021; Ingram et al., 2022), which in turn has a strong impact on how novel smart-farming solutions are being adapted (or not) by farmers and indeed wider society (Jithin et al., 2019; Eastwood and Renwick, 2020). From a legal perspective, it is ever more difficult to regulate which party has ownership over what kind of data and which party has what kind of authority to act on and with the accumulated data.

Exploring these questions critically is even more important today, if we consider the intrinsic combination of public and private actors, interests and forms of expertise that lie behind smart farming projects (Pauschinger and Klauser, 2021). These public-private imbrications come along with complex power relations between IT-companies and public authorities or between IT-advisors or experts and farmers more specifically (Eastwood et al., 2019). Indeed, the agri-food sector today depends ever more on the technical expertise necessary to understand, repair and optimise the systems that operate seamlessly in the background of everyday farming life. This gives certain (private) parties more weight (Sykuta, 2016) and puts traditional modes of governance at stake in challenging decision-making processes that were traditionally placed under the exclusive responsibility of the nation state.

### 4. Automation in smart farming

Efforts towards smart farming not only aim at interconnected data generation, but also at software-based data analysis and automatic response. For example, smart tractors or hacking robots can be pre-programmed to operate in automated ways. Smart-farming apps are designed to automatically provide user- or context-specific information and/or services. It is worth pointing towards two general sets of power issues emerging here.

The first set of power issues revolves around the classifications and orderings of reality, produced by the automated 'software sorting' (Graham, 2005) of agricultural decisions, practices and processes (Carolan 2018a; Carbonell, 2016). Whether we are talking about smart-farming platforms such as the aforementioned [myjohndeere.com](http://myjohndeere.com), about specific apps for nutrient or field management, or about the prediction of risks such as plant disease, software-driven smart-farming technologies differentiate their content and services depending on what their algorithms understand about where their users are (location- and context-aware apps), who they are (user-aware apps) and what they do (practice-aware apps). Thus, rather than providing standardised and predefined recommendations or information to all users, smart applications aspire to the provision of personalised content, depending on their users' profiles (preferences, activities, context, financial prowess, etc.). We are moving, in other words, from a universalist model of services to an individualistic model, in which the basic spaces and services of everyday life increasingly become commodities that can be differentiated and adapted to the profile of each user (Graham, 2005: 565;

Klauser and Widmer, 2017). As Graham underlines, ‘code-based technologized environments, continuously and invisibly classify, standardize, and demarcate rights, privileges, inclusions, exclusions, and mobilities and normative social judgements across vast, distanced, domains’ (2005: 563). Smart technologies thus not only invoke multiple opportunities, but also raise a series of critical issues in terms of social and spatial justice, prioritisation and discrimination, which affect farming-related decisions and practices in ways that are often opaque and that easily evade conventional scrutiny.

The second set of power issues derives from the temporal logics inherent in the orchestration of everyday (farming) life through software. Software, as a predefined ‘normative grammar’ (Miles, 2019), simplifies reality into a legible order, derived from the analysis of the past (Budd and Adey, 2009: 1369) and then, as a means of automatic response, performs everyday life through this order (Morais, 2014: 1). As Thrift and French (2002: 311) argue, ‘software is deferred ... it expresses the co-presence of different times, the time of its production and its subsequent dictation of future moments’. The critical issue here lies in the fact that software acts on the present and thus produces the future in ways that necessarily reflect and indeed reproduce the past (Galloway, 2004; Kitchin and Dodge, 2011). Software is unable of anticipating anything fundamentally different or new, which has not already happened before. This raises the question of the actual adequacy of software to govern the internal complexities and dynamics of reality. As Carolan puts it, ‘I do worry about the extent to which certain anticipatory futures foreclose on alternative futures, which thus risks making them not even thinkable to say nothing of their do-ability’ (Carolan, 2020: 200).

In sum, there are a number of critical power issues emerging from the algorithmic logic of automation, inherent in smart farming, which relate not only to how software acts on farming practices and processes in real time (classifies, sorts, orchestrates, etc.), but also how (and to what effects) software anticipates, performs, and as such limits the future and the anticipatory logics that make futures possible or not (Klauser and Albrechtslund, 2014).

## 5. Contributions to the special issue

As argued, smart-farming solutions are never neutral, whether aimed at greater efficiency, profitability, convenience, or security (Klauser, 2018). Rather, they are both the product and producer of specific orderings of the contemporary farming reality. The papers brought together in this collection connect with this problematic in two main ways: first, the special issue focusses on the power issues and micro-politics involved in the ‘making’, i.e. innovation and diffusion of new smart-farming solutions; second, the special issue explores the power dynamics that unfold from the current proliferation of smart technologies in farming.

### 5.1. Smart farming as the product of specific power relations and micro-politics

Based on the study of particular smart-farming examples, the first part of the special issue consists in the critical investigation of the organisational settings and situated coalitions of authority underpinning current efforts towards the digitisation and software-mediation of agriculture. The approach pursued is essentially multi-scalar, focusing on specific sites or projects of smart farming as well as on the global forces, connections and imaginaries that tie these sites to each other. Key questions are: What actors, interests and sources of authority come together in the field of smart farming? How do these shape specific initiatives, processes of policy imitation and exemplification? What does this analysis tell us about the actor networks, interests and relations of power that lie behind the farm of the future?

There are two papers in the collection that address this problematic in complementary ways. Dennis Pauschinger and Francisco Klauser’s

paper explores in empirical detail the interacting forms of expertise and public-private coalitions of authority that underpin the introduction of novel smart technologies in Swiss agriculture (Pauschinger and Klauser, 2021). This investigation is channelled through the study of two high-profile initiatives: first, the Swiss Future Farm, an experimental and demonstration farm in Eastern Switzerland, set up as a joint public-private initiative in 2018; and second, the development and commercialisation of the first authorised drone system in Europe for the automated application of pesticides. The paper shows that specific initiatives, anchored in specific sites of experimentation, play a fundamental role in assembling the actor networks that carry forward the broader evolutions around smart farming. The authors unpack the chain of mediations through which relevant actors, ideas and things connect and interact in the co-production of the studied initiatives, and investigate the relationships and mechanisms that tie them to each other and to other sites and initiatives.

Alistair Fraser’s paper further pursues this investigation into the logics and modalities of innovation in current smart-farming matters (Fraser, in press). It focusses on the power dynamics that underpin and arise from the ‘iterative interplays’ between providers and users of smart farming technologies in Ireland. Framed around the notion of ‘mis-configured innovations’, this discussion shows that in many cases, the networks behind novel smart farming solutions reproduce pre-existing (capitalist) production models, and as such reinforce existing power asymmetries and intensify problems around social and environmental sustainability. Following from this critique, the paper reflects on the possibility of an alternative smart farming approach that works in more inclusive, emancipatory and empowering ways, in which new technologies ‘activate’ farmers as digital subjects that actively contribute to the processes of innovation in the agricultural sector, and in turn truly benefit from it.

### 5.2. Smart farming as the producer of specific power relations and micro-politics

The second part of the special issues explores the power dynamics that unfold from the current proliferation of smart technologies in farming. This focus leads to the critical question of how smart farming solutions change the ways in which farming is being lived, perceived, and conceived. Key questions are: How do smart-farming techniques intervene in the control and regulation of the agricultural everyday? What do they produce? What does this then tell us about the benefits and problems associated with their evolution?

Michael Carolan’s paper lays the foundation for the study and discussion of these problematics (Carolan, in press). It offers an innovative conceptual approach and vocabulary for engaging sociologically, ontologically and politically with data assemblages in farming, that goes beyond the usual distinction between ‘big’ and ‘small’ data. Drawing on interviews with farmers, farm labourers, hacktivists, investors and engineers from different countries, the paper develops an alternative distinction between ‘weak’ and ‘strong’ data assemblages. This distinction is based on four main criteria: (1) access to data (broader in the case of weak data than in that of strong data), (2) logics of participation (more inclusive in weak data assemblages), (3) politics (more political in the case of weak data), and (4) the commitment to engaging stakeholders by asking questions (more present in weak data assemblages). Consequently, the two types of data assemblages are shown to differ fundamentally in the ideals of governance they convey and – consequently – in their effects and indeed ‘world-making potential’. Foregrounding the human and more-than-human worlds associated with differing types of data assemblages in farming, the paper also takes up the task of reflecting on the possibility of a more emancipatory, inclusive, and collaborative digital future in agriculture.

Andrew Donaldson’s paper addresses the power implications of smart farming from an infrastructural viewpoint (Donaldson, in press). It examines the use of digital devices aimed at improved traceability,

transparency and integrity in the food supply chain, from production to consumption. The paper identifies questions of power around the ongoing process of ‘infrastructuring’ that generate a requirement for more labour by some actors; the possibility of new politics and relationships built around increased circulation of quality information; and questions of who controls access to information that are obscured by different understandings of transparency. This leads back to the aforementioned aspects of access, participation, politics and user engagement, which not only distinguish differing approaches to smart farming, but also highlight different problematics of power around these approaches.

*Terje Finstad, Margrethe Aune and Kine Ariela Egseth’s* paper explores the impacts of big data in agriculture from a perspective that places centrally the processes of learning in smart farming (Finstad et al., 2021). Drawing upon an STS-inspired conceptual approach and channelled through the example of automatic milking systems (AMS) used by dairy farms in Norway, the paper shows that the introduction of novel smart technologies in farming implies a dynamic process in which all elements – machines, animals and farmers – continuously ‘learn’ and evolve. This opens up a post-human perspective on farming as a dynamic socio-material process where humans, animals and machines are fundamentally entangled. In turn, this points at an understanding of the impacts of and power issues around smart farming that moves beyond the mere question of whether specific technologies are useful, desirable or problematic per se, but focusses instead on the interplays between differing human and non-human, social and technical entities assembled. The specific question to ask then becomes what exactly is required from the assembled actants (the cow, the farmer and the robot, in the case at hand) to optimise the functioning and impacts of smart technologies (such as automated milking robots).

*Francisco Klauser and Dennis Pauschinger’s* paper adds a distinct ‘spatial curiosity’ to this relational and processual engagement with smart farming (Klauser and Pauschinger, 2021). Space plays a fundamental role in both the functioning and implications of smart technologies. Specifically, their analysis shows that space has to be understood not merely as an earth-bound planar surface, but as a multi-dimensional volume, which has manifold material, aerial, political, affective and socio-economic qualities. To develop this argument the paper explores in empirical detail the use of spray drones in Swiss agriculture and associated power issues arising from the discovery and instrumentalisation of ‘the air’ for agro-entrepreneurial purposes. Spray drones, the paper shows, make the air relevant in novel, inherently functionalised and commercialised ways for agricultural practices and processes. The aerial realm is being territorialised as an object of not only pragmatically motivated alliances and coalitions of authority but also of tensions and competitions arising from the involved stakeholders’ agendas and organisational structures. This raises the critical question of the ‘right to the air’ in contemporary agriculture, and of the possibility of a ‘volu-metric’ rural studies more generally.

Together, the six papers provide a critical engagement with the driving forces behind different smart farming initiatives, including their functioning and their implications as sociotechnical devices, in turn generating a more detailed picture of the possibilities, limitations and problems evoked by the increasing digitisation and software-mediation of agriculture. From this analysis emerges an inherently relational and processual understanding of smart farming, as always-emergent heterogeneous assemblages of humans and more-than humans, in which data, infrastructures, animals, machines, ideas and even the air come together in co-constitutive and mediated relationships. We believe that such an understanding of smart farming should represent the starting point and basic posture from which to further advance the themed issue’s initial foray into the power issues and relations inherent in and emerging from the encounter of smart technology and agriculture in the present-day world of big data.

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