

# Being Granular, Becoming Sustainable: A Preliminary Inquiry into the Wor(l)ds of Smart Farming Developers

Mylène, Tanferri

## Abstract

This article examines the integration of digitization and environmental concerns in digital agriculture from the perspective of actors in smart farming in Switzerland. Those actors, previously unconnected to farming, promote the use of granular data to achieve more sustainable practices. Considering granularity as a practitioner-made achievement rather than a technical property alone, I draw on interviews and ethnographic observations, and rely on material-semiotic insights from STS (Law, 2008; Mol, 1999; Lien & Law, 2011) to examine how granularity data is brought into existence through heterogeneous practices. I first analyze how the connection between digital agriculture and more sustainable practices is operated as a *motto*, an aspirational principle that draws from different sources and comparisons. I then show how the production and interpretation of granular data depend on experimental infrastructures, interdisciplinary collaboration, and ongoing human interpretation, all of which contribute to the existence of granularity while enacting specific definitions of sustainability.

**Keywords:** digital agriculture, smart farming, sustainability, data practices, granularity

Mylène Tanferri, Center for Climate IT, Technologies in Practice section, IT University of Copenhagen, Denmark 

---

## Introduction

This article focuses on the integration of digitization and environmental concerns from the perspective of Switzerland-based actors developing smart farming devices, the latest trend in digital agriculture. In this realm, the use of digital technologies to address climate issues has become obvious across engineering, computer science, and policymaking circles. The United Nations Food and Agriculture Organization and the European Union, for example, not only strive to advance digital agriculture more broadly but also fund numerous projects in this area. Building on previous decades of precision agriculture and Agricultural Knowledge and Innovation System (AKIS) developments (Touzard et al., 2015), this trend now develops into innovations such as real-time monitoring of crops through various tools, including sensors, drones, and other mapping and controlling techniques (Balafoutis et al., 2017; Wolfert et al., 2017; Knierim et al., 2019). These different options all assume that data should be incorporated into human and machine decisions. Coupled with big data analytics

and complex algorithms, continuous monitoring would not only enhance growers' decision-making (e.g., when to harvest or water, and how much fertilizer or pesticide to use); this large amount of data would also contribute to feed so-called smart systems, capable of acting autonomously and intelligently by adjusting directly to it (Abinaya et al., 2024, for a critical discussion see: Gugganing et al., 2025).

To promote digital agriculture and large-scale monitoring, several discourses have been mobilized alongside technical developments. In the 80s and 90s, greater precision and better control were the core justifications. Over the past decades, digital agriculture has taken on an additional purpose: addressing climate issues, mainly under the banner of smart farming. There, the intensive use of data would contribute to keeping or increasing crop yields while at the same time diminishing agriculture's climate impacts (Walter, 2017; Nazirul Islam Sarker et al., 2019; Krutilin et al., 2022; Finger et al., 2019), as a way of decoupling economic growth from its often-accompanying environmental damages (Dalsgaard, 2022). For some, these connections between climate issues and agricultural technologies fall under the umbrella of technological fixes (Rosner, 2004; Ruser & Machin, 2016; Guthman & Butler, 2023), where technologies would solve any environmental issue, while putting social or political problems (or solutions) in the background.

Considered through a techno-fix lens, claims about smart farming's ability to solve climate issues in large-scale agricultural production rely on and contribute to a broader cultural economy focused on "technological and economic response to notions of climate crisis". (Caprotti, 2012: 3). Yet, while fixes and claims for sustainable outcomes in digital technologies for agriculture are often studied through published reports, policies, public declarations, and commercial pitches (Newell & Taylor, 2018; Fairbairn et al., 2022), this article relies on private interviews and preliminary observations in smart farming development settings. I do not aim to sharply contrast public and private discourse (as we will see, these are more blurred categories), but to suggest that proximity with the actors who produce these claims yields specific understandings. While acknowledging potential issues, such as over-identification or the risk of missing broader patterns, I contend that these understandings often remain unavailable to critiques from a distance. In the specific case presented here, a closer examination of participants' words and the wor(l)ds they construct revealed infrastructural and collaborative work, organized around a central element: *granularity*, the ability to provide fine-grained measurements.

Granularity is the main proposition these actors use to link smart farming to sustainability. It is what makes digital technologies legible as environmental solutions for the set of actors I met, which I take to be at least partially representative of the broader field in Europe. Yet what 'granularity' concretely means requires further exploration. Drawing on material-semiotic insights from STS (Law, 2008; Mol, 1999; Lien & Law, 2011), I examine granularity not as a static, externally defined notion, but analyze how its practitioners bring it into existence through heterogeneous practices, both discursive and material, including comparisons, collaborations, and disciplinary exchanges, as well as infrastructures and experimental materials. This approach follows granularity not as a fixed technical property but as something actively made and defined through situated practices.

To better understand granularity from the perspective of its practitioners, and to demonstrate the importance of examining their wor(l)ds closely, I begin by reviewing how digital agriculture and its claim to sustainability have been met by different traditions, such as

(agrarian) political economy and ethnographic approaches of digital agriculture implementation. I then sketch out an ethnographic approach of granularity, which includes examining the collaborations and new networks that have emerged around the projects I observed.

From these, I follow on the connection between digital tools and sustainability as a *motto*, an affirmation often repeated but not specifically substantiated, where “being granular; becoming sustainable” works as *aspirational talk* (Christensen et al., 2021), stabilized through comparisons and metaphors between granularity and other modalities of knowing and intervening in plant growth, sustainable outcomes remain conditional to specific situations and contexts such as water scarcity or regulations and incentives. To complement findings from participants’ words, I then sketch out what it takes to produce and interpret granular data in their worlds. As these activities rely on existing infrastructure – from energy grids to greenhouses – and established knowledge, granularity illustrates the well-established mutual shaping between “new” technologies and existing elements (Star & Ruhleder, 1996; Pickering, 1995). This demonstration remains crucial for challenging the grand narratives of digital disruption and reminds us that technologies depend on, and must integrate with, pre-existing configurations. As Gabrys, Westerlaken, and Fatimah (2024) propose, *actually existing* smart environments are not seamless technological systems; they must accommodate existing infrastructures and multiple ways of knowing. Following how actors speak about their technologies, how this discourse relies on and contributes to new networks, and how granular data practices depend on and need to happen within existing infrastructures and prior knowledge, allows for a more complex picture than the one often painted by both critics and promoters of smart farming and big data.

## Sustainability claims and their discontents

Although a detailed examination of how green claims have become intertwined with digital agriculture and its financialization falls beyond the scope of this article (but see: Oui, 2024; Duncan et al., 2022; Sippel & Dolinga, 2023), it is worth noting that such claims have been met with considerable skepticism (Bronson and Knezevic, 2016; Miles, 2019; Carolan, 2022; Fraser, 2022). For example, 30 years ago, Wolf and Buttel (1996) already noted the lack of clear evidence supporting the economic and environmental claims surrounding these innovations. They described these innovations as solutions looking for a problem and argued that they might, at least maintain, if not further, economic and political distributions that support the use of harmful chemicals in agriculture while diminishing farmers’ autonomy. Today, these considerations still hold if we follow Rotz and colleagues (2019) in their review of the politics of smart and digital farming innovations, while some argue that the claimed sustainable outcomes of digital agriculture and smart farming are addressed solely to financial actors, as growers and growing practices have never been a direct concern for their developers (Duncan et al., 2021). Yet, as Clapp and Ruder (2020) proposed, broad appraisals of digital agriculture, whether in favor of or critical of it, often start from smart farming as a unified phenomenon to be discussed at a conceptual level. In this perspective, the development or acquisition of an agricultural technology would either automatically yield more sustainable outcomes or immediately lead to deleterious consequences. In line with this reappraisal, Forney et al. (2022) proposed in the introduction to a symposium on the everyday digitalization in food and agriculture, that the focus on “spotlight” digitization, such as recent innovations not yet implemented, leads to forgetting the everyday engagements with digital modalities on the farm (ibid: 418).

Future forecasts of smart farming's benefits or detriments can be contrasted with ethnographic work seeking to re-situate these tools in specific spaces and places, demonstrating that their actual adoption is not as straightforward as it may seem and complicating the very notion of access to technology as the only potential issue to adoption (Gugganig et al. 2026). Focusing on the daily work and opinions of growers in digital agriculture, ethnographies have explored how such tools both configure and are reconfigured by their users (Higgins et al., 2017; Rose et al., 2018), including as they prepare for an automation yet to come (Legun and Burch, 2021). Ethnographies also helped make clear the human interpretations needed to make sense of precision agriculture tools (Tsouvalis et al., 2000), while recent notions such as the *distributed* farmer (Comi, 2020) or the *cyborg* farmer (Velden et al., 2024) have been used to observe how growers and their decisions are part of a broader network, and how digital tools are incorporated and reinterpreted in farming practices. These different propositions complicate the picture of digital agriculture by examining situated uses and specific cases. Yet similar attention to the practical, situated work of agriculture technology developers remains scarce (but see Heimstädt, 2023a, 2023b, focused on a startup; and Roevers et al., 2024, focused on academic developers). What happens in the daily work of those who directly contribute to developing agricultural technologies and make claims about their sustainable outcomes? Alongside ethnographies of farmers' engagements with digital tools, examining the work of those who develop smart farming solutions helps shape a clearer picture, notably by revealing *how* they connect sustainability and digitization.

## Following smart farming developers ethnographically

In preparing for my current project, I conducted 17 interviews with actors in the field of smart agriculture, including policymakers, agronomic research centers, and other organizations in France and Switzerland. This helped refine the sites that would provide ground for long-term ethnographic observations. The contents and topics of these interviews recurrently evoked sustainability and green issues. I thus began to inquire more specifically into what these terms encompassed, where they originated, and how they would translate into practice. Starting in the Fall 2024, I met several actors involved in developing a specific type of smart-farming device: *plant sensors*. Plant sensors are developed to enact phenomena such as leaf transpiration (Z. Li et al., 2024), real-time leaf movement and growth (Geldhof et al., 2021), real-time diameter growth in fruit or stems (Fernández & Cuevas, 2010; Hahn, 2021), or electrophysiological signals (Volkov & Markin, 2012; Tran et al., 2019). This phenomenon, discovered by Chandra Bose and his team in the 1900s (Lenoir, 1986), can be correlated with plant behavior in ongoing measurements of plant responses to various internal and external stimuli, such as water shortages or pest attacks. "Wearable plant sensors" (Lee et al., 2021; Banerji et al., 2023; X.-H. Li et al., 2024), their nickname, points to the fact that these sensors are directly "worn" by plants, in contrast with environmental sensors capturing elements surrounding the plants, such as temperature or humidity. Specialized articles emphasize their potential to produce granular data by monitoring plants' internal processes, drawing comparisons to smartwatches and the ongoing tracking of detailed human physiological data.

Green claims surround smart farming innovations in general, and plant sensors are no exception. Companies' websites, public documents, and press articles all include hints that these sensors will foster more sustainable agricultural practices. For example, consider dendrometers, sensors that continuously monitor the circumference of a fruit or stem as it grows,

recording regular, minute-to-minute measurements. Captured on a single tomato fruit, one of the most cultivated plants for food consumption, measurements are then translated into growth trajectories, which may help determine thresholds before the fruit peel explodes under too much combined water and heat, an important issue in commercial production, which can largely diminish yields. Determined thresholds could trigger an alarm warning growers it is time to intervene (by harvesting or reducing watering, for example). Translated into sustainable outcomes for dendrometer-related claims, this means they would help improve sustainability in tomato production by preventing yield losses, thereby reducing food waste at the production level, where economic and environmental concerns would go hand in hand.

In developing dendrometers and other plant sensors, the agronomists and biologists I met have been collaborating with, and in some cases were employed by, sensor engineers alongside data scientists, who often worked in the digital human health sector before their current work. As Latour (2005) argues, rather than replacing human labor, technologies redistribute and often multiply the connections and intermediaries required in sociotechnical systems. The appearance of newcomers who have seldom worked with plants and are now collaborating with established actors in agriculture, such as growers and agronomists, also implies the circulation of expertise and knowledge from other fields into plant cultivation, bringing along specific terms and modes of working. Before moving into plant applications, these actors contributed, for example, to the development of technologies for monitoring human sleep patterns or to the study of human neurons involved in decision-making. Some of them participated in machine learning research on human and animal electrocardiography (ECG) or neuroimaging. A few of them returned to human applications after a labor contract or a project partnership focused on plant sensor development.

Paying attention to who these new participants are and what they bring in terms of concepts and infrastructures provides a crucial historical perspective on the development of digitization and big data (Dalton & Thatcher, 2015). As Dalton and Thatcher argue, understanding who controls data production and what historical conditions enable current data practices helps demystify these technologies. In the case of digital agriculture, this is particularly important as new actors bring terminology and corresponding practices from other domains into agricultural practices and knowledge. Health sciences data practices, in which many of my interlocutors are trained, certainly informed the idea of recording data not only at a single point in time but also measuring and recording it continuously, autonomously, and at an individual level (compare, for example, the stethoscope with electrocardiography). This brings plant sensors in digital agriculture closer to personalized medicine (Oui, 2024), where they would enable individualized, targeted treatments.

Circulation across fields and application domains thus implies that relatively new terms and propositions circulate across specialties. *Granularity*, a term used in computing and sales analysis, is also related to another widely used notion: *information*, which has long been used to draw parallels and facilitate collaboration between biological sciences and engineering. These circulating terms shape how developers make sense of plant data and the algorithms they use (Seaver, 2017; Schinkel, 2023). Framing biological processes as encoded and decoded information, conceptualizing plants as complex information systems, and adopting an information-based understanding of life across living entities help render plants amenable to engineering knowledge and intervention. This not only allows my interlocutors to flesh out – and enact – similarities and differences between humans, animals, and plants within the parameters and constraints of their activities, but, as Dalton and Thatcher (2015) proposed for

spatial big data, these circulations may also contribute to commodification processes. In the meantime, if notions of information help shape common understandings among biologists, engineers, and agronomists and probably contribute to economic circulations, scientific boundaries (Gieryn, 1983) remain at play. While introducing me to the dendrometers presented above, an agronomist told me that some aspects of the explanation are outside her area of expertise. Her portion of it concerns the biophysical aspects of plant growth, she explains. Beyond a certain threshold, she knows the fruit peel might implode, while the “reasons” for this implosion lie with the molecular biologists involved in the project. They might, she said half-jokingly, blame her if she were to answer my questions on this aspect. While considering the origins of data granularity as a concept helps us understand its circulation into agriculture and plant behavior and the boundaries that are still at play, further steps are needed to track the links between granularity and sustainable outcomes.

### **"Being granular, becoming sustainable": Establishing the motto through comparison**

In working with my interview data, I began to engage with these materials slightly differently than if they were a direct source of information about participants' daily work. Inspired by Brice (2022) and Jerak-Zuiderent (2015), I adopted an approach that attends not only to the content of the interviews but also to tones and modes of engagement, treating these as revealing underlying positions and assumptions. It led me to realize that the often-repeated connection between sustainable outcomes and data granularity functions less as an empirical claim and more as a *motto*, as defined by the Cambridge Dictionary: “a word, phrase, or sentence that expresses the principles or beliefs of a person, group, country, or organization.” Importantly, as a motto, the connection between sustainable outcomes and data granularity need not be elaborated or substantiated: being granular necessarily entails sustainability. This reframing helps define the proposed connection not as a demonstrable relationship but as an aspirational or ideological statement, akin to management scholars' description of Corporate Social Responsibility as *aspirational talk* (Christensen et al., 2021): a form of organizational discourse offering ideals and intentions without necessarily being in direct relation with current practices, where realization can remain deferred and uncertain.

In my first interviews in 2024, which were also my first direct contact with participants, the self-evident connection between the digital and sustainable outcomes was largely established through comparisons that appeared well-rehearsed<sup>1</sup> and likely honed for non-specialist audiences. As Deville, Guggenheim, and Hrdličková (2016) remind us, comparison is not a neutral analytical tool but an active practice that makes things comparable, changing them along the way, practically, conceptually, or often both. Comparisons were offered to help me, a social scientist, grasp the sustainability promised by granular data and to favorably contrast it with other approaches. As a well-rehearsed modality of engaging with outsiders, comparisons were used to assign positive value to sensors by contrasting them with less-preferred solutions, rather than to clarify specific processes. Indeed, in these accounts, concrete, technical explanations of how this connection would work were much less prevalent. While all the interviews included some form of rehearsed comparison, the most exemplary

---

<sup>1</sup> Spontaneous speech presents signs that can be easily recognized, such as more interruptions and fillers (“um,” “uh”), hesitations, and non-linear organization, while rehearsed speech flows more smoothly without self-interruptions or restarts (Corley & Stewart, 2008).

case was a sales manager who, near the end of fieldwork in 2025, gave me a tour of a smart-farming lab. The polished discourse and green narrative seemed so heavily rehearsed that it left no space for spontaneous interaction or concrete answers to the questions I had then learned to ask. I found myself seeking opportunities to engage with the technical staff so I could at least begin to understand what was needed for the device to actually work.

While values such as precision, adequacy, and targeted capacities were present in all comparisons and linked to more sustainable practices, value attribution was particularly evident in a discussion with a technological adviser (who advises growers), who contrasted granular data production with genetic modifications. During our discussion, he proposed that data granularity, which provides direct, real-time knowledge about plants, would undoubtedly be considered by the public as a harmless modality compared with recent genetic technologies. While biotechnologies have long provoked public discontent, data-driven approaches could, in my interlocutor's view, appear less controversial because they do not fundamentally alter plant DNA, which would also help secure public funding for R&D in the sector. But while qualifying granular data as harmless and more acceptable is done through contrast, its benign character need not be clarified. It is the comparison itself that creates the quality, similar to what valuation studies have shown in how (commercial) goods gain value (Callon et al., 2002).

Another kind of contrast used to support the motto employs a metaphor comparing human vaccination and the possibilities of individual-level sensors to current chemical application practices. Granular interventions, as one of my interlocutors at a startup explains, can improve the application of pesticides: "Or you vaccinate your whole population, even those that might not need it, or you go and treat only the weakest individuals to ensure they don't get sick if a specific weather event occurs, such as a dropping of temperatures." (Startup 1, 2024).<sup>2</sup> The human health interventions comparison shows the extent to which treatments could be applied by using granular data. Plant sensors could enable targeted interventions at the single plant level, providing the right amount of chemicals to the right plants. This contrast underscores the value of granularity, framing sensor-based approaches as more sustainable than existing practices by highlighting their capabilities at the individual level.

Comparisons were also used to qualify the accuracy of granular data by contrasting it with agronomic and practical knowledge. Another startup owner (Startup 2, 2024) detailed the capabilities of the sensors his company has developed and is currently commercializing with several large-scale agriculture clients. To elaborate on the sensors, he compares them to the perceptual practices of industrial growers. The sensors, he explains, work at a granular level by providing continuous measurements. This would enable more precise irrigation and chemical applications, as growers' decisions would be directly tied to the plant's immediate reactions captured by the sensors. This contrasts, he continued, with relying on inferences or traditional recommendations about appropriate rates and levels of water, sunlight, and other elements in plant growth. In this comparison, the signals emitted by the plants are more accurate in indicating their current physiological state: while a visual appraisal might focus on the color or shape of the leaves, signals might indicate that the plant is not currently growing more roots or "caring for its fruits" and thus does not need more water, he tells me. Such an access, he continues, would let the grower know that, even if the plant's overall appearance suggests a lack of water, they can wait before irrigating. When comparing sensors with

---

<sup>2</sup> According to the terms offered to research participants, this article avoids all means that would lead to identification. To do so, names, settings, locations, and specific job descriptions have been deleted.

agronomic knowledge, based on external factors such as surrounding humidity and temperature (as well as drain calculations), plant signals appear to be a direct readout of plants' real-time internal needs rather than some general recommendation. If we follow this comparison, direct information about plant states would then lead to more sustainable decisions, as irrigation would be tied directly to plant needs rather than to human assumptions based on environmental measurements – while the assumptions used in interpreting plant signals, and the infrastructure required do not need to be described in details.

Through such comparisons, granularity is also progressively framed in relation to intensive production modes, which then appear less attuned to actual plant needs. At Startup 2 lab, a team member explained in an interview that the team conducted systematic experiments to answer this curious question: “What happens if you let a plant take control of a water system using its signals?” (Startup 2, 2024). When the plant needs water, its signals deviate from a previously established baseline, which can then directly trigger the irrigation system, making the plant responsible for its own irrigation. After a few days of adaptation, I am told, “the plant drinks every few hours, not more, not less” (Startup 2, 2024). The plants developed a very stable behavior, taking care of their own irrigation needs. The underlying assumption of the experiment was that plants may do better at determining their needs than systematized agronomic recommendations focused on yields and growth.

Yet my interlocutors at startup 2 made an important remark: it is only when water is scarce and costly that granular data can fully play a role in reducing irrigation. Granularity in that matter, they explain, only becomes interesting where the lack of water is an issue, for example, in North Africa, where the company has several clients. In Europe, they go on, growers often ask what they would gain from reducing their water use, since water is cheap enough not to affect their overall budget, while their European clients usually have what my interlocutors consider a proactive mindset: they want to test the sensors to prepare for a near future in which water might indeed become scarce and therefore more expensive. Here, the people I am talking with acknowledge that the motto linking granularity to sustainability is also premised on specific contexts. They are also aware of what has been termed the knowledge-action gap (Kollmus & Agyeman, 2002), which posits that greater knowledge does not systematically lead to more sustainable actions. These different examples of comparisons show not only how participants frame the device in a specific light. But also depict also depict a particular environment in which sustainable outcomes could appear. In comparing the potential of granular data for agriculture to vaccine applications in human health or to genetic modifications and contrasting granularity-based decisions with current irrigation practices in conventional agriculture, participants not only frame their technologies to address climate issues with the words they use; they also constitute worlds around plant sensors where granularity could achieve more sustainable outcomes.

### **Producing granular data: Controlled environments and experimental infrastructure**

While discursive comparisons allow granular data to link sustainability and digitization in plant sensors, granularity also requires efforts and relies heavily on existing infrastructures. These practical dimensions reveal nuances between granularity as an aspirational notion and granularity as achieved in practice. This distinction further complicates how sustainability claims tend to be received: either rejected as greenwashing or taken for granted as inevitably

realized. These readings miss what practitioners know and share when asked more questions about their daily practices, a contrast that has long been observed in expectation studies (Brown & Michael, 2003). Once I started observations, I could see how much granular data depends on situated, contingent, and collaborative work. This work, in turn, shapes whether and what kind of sustainability emerges. The labor, infrastructures, interpretations, and collaboration required to operationalize data granularity also mediate its sustainable outcomes.

For example, while participants described their circulation across disciplines and human/plant projects with apparent ease, this narrative became more complex when I pressed for specifics about collaborative work. I learned more about this through discussions with participants working on machine learning for plant signals. In the sensor projects I followed, repartitions in task attributions between data scientists and plant specialists often occurred and were premised on spatial separation, with distinct atmospheres and modes of engagement perceptible between the lab and the fields (Calkins, 2021). In a specific project, expertise was partitioned between data scientists designing the data collection and its conditions to ensure the quality and cleanliness of the data sets (Boumans & Leonelli, 2020) in their offices, on one side, and agronomists caring for both the plants and the data collection process at an agronomic/research greenhouse, on the other. Making data circulate across spaces and research fields can be complex and is often accompanied by descriptive protocols. Labeling data is a process closely aligned with what Vinck (2011, 2012) has described as the equipping work of intermediary objects, which enables coordination and knowledge translation across disciplines. This equipping work can be as simple as adding an etiquette to a sample to record elements such as the date of collection, yet without it, the sample becomes useless once it is circulated widely. In the same way, data scientists need data labeled with contextual elements so that it becomes usable for training algorithms (Pasquinelli, 2019; Jaton, 2021b). For algorithms to recognize specific patterns in plant signals this qualification is essential, for example, to determine exactly when a pest began attacking a sensor-monitored plant in an experiment. Only with this label can the machine be trained to identify patterns correlated with the attack and, eventually, with its intensity. The same applies to marking precisely when watering was terminated in irrigation trials, so that the machine can match it to specific pattern changes by comparing it with another set of plants where irrigation was continued. In the project just mentioned, data labeling was carried out by agronomists at the greenhouse, who work more closely with the plants, both spatially and by training. Obtaining well-labeled data from agronomists working directly with the plants required further clarification of exactly what was needed and in what form.

Yet, labeling practices are embedded in infrastructures, which also play a crucial role in making granular data readable and useful. To provide the contextual information for machine learning processes, the agronomic team could rely on an existing infrastructure, the agronomic greenhouse. I discovered it while participating in plant sensor installation, a preparation (Riom and Tanferri, 2024), with important implications for the main activity of capturing plant signals. As with their commercial counterparts, agronomic greenhouses rely on extensive control and automation. Industrial large-scale food production relied on specialized knowledge and on the pursuit of ideal conditions for plant growth through the control of the environment and its components (Fitzgerald, 2003; for greenhouses, see Blancaneaux, 2022). This longstanding control generates the contextual data required by machine learning to recognize specific patterns in plants: temperature and humidity levels are automatically recorded, regulated, and displayed to a central computer that can be accessed from distant offices.

The agronomic research greenhouse exemplifies how granular data production depends not only on existing experimental infrastructure but also on disciplinary expertise. Heavily equipped to conduct controlled trials, the greenhouse was saturated with markers and pointers to delineate specific plants in space (Lynch, 1988). This experimental culture relies on knowledge-production practices in which one knows how to organize spaces and materials to produce results recognized as objective and valid (Tabouret, 2024). Logbooks and the widespread use of recording instruments in plant sciences and agronomy suggest that longstanding practices of experimental control and documentation support the needs of digital innovation. The labeling of data for machine learning builds upon agronomic production-of-proof conventions and the infrastructures that support this work. The production of models to interpret plant signals thus relies on decades of automated environmental management. Greenhouses actively contribute to the production of granular data by creating conditions in which small variations can be tracked and made intelligible. The lab properties of the greenhouse are thus constitutive of granular data, while labeling the data and determining thresholds also depend on disciplinary expertise. Granularity thus emerges through collaborations among agronomists, data scientists, and plant scientists, pattern-recognition machines, and their infrastructures. There is no granular plant data waiting to be captured by sufficiently advanced sensors; rather, granularity is an outcome of practices, collaborations, and materials.

The granular data thought to lead to sustainable outcomes thus cannot be separated from the knowledge, expertise, collaborative practices, and experimental infrastructures that participants mobilize to produce, make sense of, and inquire into plant data. This dependency also shapes what sustainable agriculture would look like when supported by granular data, as an activity centered on environmental control and rationalized production. The connection between granularity and sustainability can thus be seen as neither automatic nor false, but as enabled and dependent on preexisting materialities and knowledge practices that strongly shape what sustainability means in practice.<sup>3</sup> The role of knowledge practices in developing models leads us to explore the roles of interpretation, where the implicit meaningfulness attributed to granularity - the fact that granular data can make sense - depends not only on agronomists' labels, recognized patterns, and the infrastructural requirements to produce granular data, but also on how growers interpret and use sensors and their granular outcomes to eventually turn to more sustainable practices (Gorissen, et al., 2025).

## Interpreting granular data: inquiries and the importance of contexts

While the previous sections highlighted essential elements for understanding that producing granular data requires significant human work and relies on existing infrastructure, the next section concerns the interpretation of such data. Indeed, work is not only required to prepare usable datasets for machine learning; it also includes interpreting the machine's outputs, as presented in different visual renderings and calculations, such as graphs and thresholds. To observe this work, I draw from research on environmental data users and their inquiries. Through this lens, granular data on plant lives can be seen as fully-fledged agents prompting further actions and arrangements (Rosin et al., 2017; Ascui et al., 2018). As Hannah Knox (2020, 2021) observed, energy data users do not treat energy data as factual or definitive

---

<sup>3</sup> While new plant sensors prototypes are underway to operate in outdoor growing conditions, a full range of other sociotechnical dependencies is likely to arise.

knowledge; instead, they open further inquiries to investigate their behavior, question the quality of measurements, and probe other factors that could be affecting their consumption, such as the building materials of their homes. Knox's research also challenges the assumption that energy data provides "a stable description of the world upon which decisions can be made." Instead, when examined within the human practices that produce and interpret it, data "bec[o]me actively constitutive of an experience of living in an environment characterized by complex, extensive, and often unknowable relations" (Knox, 2021: 114). To draw a comparison myself: rather than a fixed energy expenditure amount shown on a monthly bill from the energy provider, which is difficult to engage with or qualify, granular data offers more opportunities to engage experimentally with one's own practices, as data is continuously available to the users as feedback, where tests can be led and their results immediately available.

Growers led similar inquiries using plant sensors, as I first learned from a developer at another digital agriculture startup who was keen to cite early STS studies on innovation. If we follow his descriptions, experiments take place not only in startup labs and agronomic greenhouses but also in growers' fields. He explained that his company's mobile application, which provides hourly, detailed information on plant growth, ended up creating far more heterogeneous behaviors than the company had intended. The app would give growers access to graphically engaging data visualizations to help them track their plants' behavior. His startup aimed to use the app to scale the solution to multiple European countries while maintaining the same level of information precision. But what happened instead, he told me, was far from expected: "it re-exploded, we were faced with a proliferation of questions, opinions, and practices." (Startup 3, 2024), as recently equipped growers returned to talk about what they were doing with the app. For example, the growers reported significant variations in plant signals from one day to the next, even with similar weather conditions. This prompted their investigations into other factors that could explain the discrepancies, such as recent treatments. It also led them to compare their current practices with what they learned from their inquiries, he recounts. Visser and colleagues similarly found that "the accuracy of sensors is far from given but rather has to be actively established by farmers based on their experience" (Visser et al., 2021: 5), while noting that this human work may be overlooked in accounts that foreground technological capacity. This creates what the authors suggest calling a *precision trap*, the misleading assumption that large amounts of data automatically lead to more precise information, while the interpretive work required to establish such accuracy is dismissed – a trap we should avoid by echoing public claims surrounding automatic results in digital agriculture too quickly. Similar findings are echoed in other domains as well. Dudhwala and Larsen, for example, described the human *recalibration* of administrative AI decisions, where algorithmic outputs are not treated as absolute truths but considered alongside "expectations about a normal condition" (2019: 3), a normal condition established by human experience.

On another occasion, while talking with a grower about sensors, I learned that, far from replacing his diagnostic and decision-making practices, he often questioned the sensors' accuracy, especially when suggestions conflicted with his habitual practices. This was particularly the case with his decisions to apply chemicals, which so far have been largely based on state regulations and an application calendar.<sup>4</sup> Again, the granularity that potentially leads

---

<sup>4</sup> While my observations are very limited, this finding can help address concerns that such tools might diminish farmers' capacity to read and understand their own fields (Carolan, 2020; Krzywoszyńska, 2024).

to sustainable outcomes is not a fixed technical property. Rather, it is the ongoing work of matching specific measurements to specific contexts and events, calibrating granular data by incorporating it into actual practices, knowledge about plants, commercial and regulatory issues, and specific understandings of what sustainability could mean.

The observations presented on the production and interpretation of granular data show how much context is needed to make it meaningful. This complicates some conclusions about big data that would “focus human attention and decision on particular persons and things of interest, whilst annulling or discarding much of the material context from which they are extracted” (Amoore & Piotukh, 2015: 360). In the cases presented here, this material context remains necessary for making sense of granular data about plant lives. This meaning is constituted through interpretive practices such as formulating potential explanations for wide variations in plant signals, questioning sensor accuracy against other means of evaluating plant needs, and (re)connecting granular data results to one's own practices. In that sense, granular data seems to expand, rather than contract, human attention, opening inquiries very similar to those of the energy sensor users observed by Knox (2022): engaging with granular data, they did not treat it as definitive answers but led further inquiries into the kind of changes they could make to be more sustainable. Overall, the sensor developers I met acknowledged human interpretation at every step, from data production to its uses. Once the rehearsed discourses linking digitization to sustainability were reopened, I discovered a situation far more nuanced than bad developers offering technofixes to reluctant growers. If we shift our attention away from grand claims made in public, we discover more subtle appraisals and questions, leading us to be more granular in our own critique.<sup>5</sup>

## Becoming granular, being sustainable?

Three main points emerged from mapping smart farming actors and analyzing the connections they establish between sustainability and digitization. Together, these elements show how digital transformations in agriculture may exceed promised (or feared) simplifications, generating new questions and forms of attention. First, these connections do not arise out of nowhere; they derive from developers' prior knowledge and expertise in digital technologies and granular approaches in other domains, such as medical applications. This offers important insights into the links between digitization and climate concerns, as these actors share a central understanding of how plant sensors can benefit sustainable agriculture: their ability to collect granular data on plant life. Hence, the motto I proposed to summarize participants' propositions: *becoming granular, being sustainable*. Second, this understanding emerges through different practices, including rhetorical ones. In my analysis, comparisons

---

This grower's inquiry into the potential causes of discrepancies between his established diagnostic practices and the sensor readings represents a specific instance of recalibration (Dudhwala and Larsen, 2019), where digital tools do prompt action, but not in a blindfolded or deskilled manner. He was simultaneously preoccupied with the validity of the data and open to revisiting his own practices, should the data prove correct. This raises the question of what drives over-reliance and closure rather than further inquiry, and we can probably not explain away this curiosity by solely considering prolonged use and habituation.

<sup>5</sup> Asking another set of questions regarding biases in AI, Florian Jatón proposed that concerns or nuances formulated by developers may not receive enough time and space to be voiced, recognized and collectively assessed, an issue he proposes to solve through techno-moral graphs, a tool that might serve in documenting collective issues as they appear in the constitution of algorithms (Jatón, 2021a).

across several domains, both within and beyond agriculture, do important work: they establish the value of granular data by positioning it favorably against alternatives rather than by demonstrating its concrete mechanisms. Comparisons and metaphors contrast individual-level sensor data with broad agronomic recommendations for irrigation and chemical applications, or position granularity against controversial genetic modifications. Through these moves, participants not only make things comparable; they also frame granular data as a better pathway to sustainability and bring up specific worlds where this could be the case. Third, observations of granular data production underscore the importance of prior experience and knowledge, as well as infrastructure and experimental processes. Finally, the developers and growers I followed engaged in ongoing work to determine what the data meant, how it should inform action, and what sustainability could mean in their specific contexts. Together, these elements provide decalage in how we consider digitization in agriculture and the sustainability claims attached to it by focusing on a specific entry point provided by the participants: granularity.

In conclusion, uncovering how granularity is enacted and made sense of, both discursively and in practice, opens at least three potential avenues for future research. In addressing the origins and modes of producing connections between environmental concerns and digitization through claims, we qualify their content, moments, and intended audiences, and we avoid conflating them with actual practices. While the broader cultural economy surrounding sustainability claims and their incorporation into public funding policies should be scrutinized, focusing solely on final formulations and public occurrences offers little basis for understanding how claims stabilize and circulate among various actors and their material, situated practices (Lippert, 2014). This point raises further questions about potential power imbalances among the parties we have examined – growers, developers, agronomists, data and plant scientists – and among them and their investors and business partners. What definitions of sustainability can or cannot be claimed in these networks *and* enacted in the infrastructure and knowledge they rely on?

In considering more closely data production and interpretation, we are led to follow Natasha Dow Schüll in her distinction between Foucauldian notions of technologies of *power* and technologies of *the self*, where she invites us to see (human) sensors as encompassing both categories: control and power, but also a form of (self-)knowledge that invites further exploration. Such a position “seeking to explore a space between the poles of boosterism and readymade critique, entertain[s] the idea that data tracking and quantification might serve as aids to self-understanding and new forms of living” (Schüll, 2019: 911). Through experimentation in growers’ fields and in different startup and research labs, plant sensors seem to occupy a similar space, potentially complicating the biopower narrative, where granular data leads to more questions than answers, and may intervene in the question of how to become more sustainable without solving it once and for all.

Finally, while sustainability claims carry a slippery moral character, involving both a pretension to do good and varying assessments of whether this pretension is genuine or deceptive, they contrast sharply with the diffuse ideal of neutrality and accuracy surrounding granular data. Often taken as the epitome of mechanical objectivity (Daston and Galison, 2010), sensors are seen as instruments capable of capturing ongoing, precise measurements at scales and frequencies beyond human biases or limitations – that is, without human intervention. By examining how data granularity is produced through collaborative work, controlled infrastructures, experimental practices, and continuous human sense-making, we find that granular data is inherently merged with human decisions and interpretations. As

Rob Kitchin reminds us, “data-driven endeavors are not simply technical systems but are sociotechnical systems [...], they are as much a result of human values, desires, and social relations as they are scientific principles and technologies” (Kitchin, 2021: 5). Yet, we may ask, if a closer look at digital agriculture shows that human values infuse both sustainability claims and granular data, why does our moral appraisal tend to fall only on the claims, not on the data practices?

## Acknowledgements

This research was supported by the European Union Horizon 2020 under the Marie Skłodowska-Curie Postdoctoral Fellowship grant number 101154733. I am grateful to the research participants who generously shared their time, expertise, and insights. I also wish to thank the editors of this special issue and the anonymous reviewers for their valuable feedback and overall patience. In addition, my thanks go to Romain Blancaneaux, Florian Jatón, Aaron Zielinski, and TiP writing workshop participants for their careful reading and suggestions at different stages of the draft, as well as to the members of the Decoupling IT group for their feedback and support on the final version of this article. While their engagement strongly improved this article, all errors remain my own.

## References

- Abinaya, M., G. Vadivu, A. Prasanth & G. Dhivyasri (2024): Role of Big Data Analytics in Intelligent Agriculture. In: Sumithra, M.G., Malathy Sathyamoorthy, M. Manikandan, Rajesh Kumar Dhanaraj & Mariya Ouaisa (Hgs.), *Computational Intelligence in Internet of Agricultural Things*. Cham: Springer Nature Switzerland, 19–48.  
[https://doi.org/10.1007/978-3-031-67450-1\\_2](https://doi.org/10.1007/978-3-031-67450-1_2)
- Amoore, Louise & Volha Piotukh (2015): Life beyond big data: governing with little analytics. In: *Economy and Society* 44/3, 341–366. <https://doi.org/10.1080/03085147.2015.1043793>
- Ananny, Mike & Kate Crawford (2018): Seeing without knowing: Limitations of the transparency ideal and its application to algorithmic accountability. In: *New Media & Society* 20/3, 973–989. <https://doi.org/10.1177/1461444816676645>
- Ascui, Francisco, Marcus Haward & Heather Lovell (2018): Salmon, sensors, and translation: The agency of Big Data in environmental governance. In: *Environment and Planning D: Society and Space* 36/5, 905–925. <https://doi.org/10.1177/0263775818766892>
- Balafoutis, Athanasios, Bert Beck, Spyros Fountas, Jürgen Vangeyte, Tamme van der Wal, Iria Soto, Manuel Gómez-Barbero, Andrew Barnes & Vera Eory (2017): Precision agriculture technologies positively contributing to GHG emissions mitigation, farm productivity and economics. In: *Sustainability* 9/8, 1339–1367. <https://doi.org/10.3390/su9081339>
- Blancaneaux, Romain (2022): Seasonality as value(s) in organic farming: On the conflict on heating greenhouses in France. In: *International Sociology* 37/6, 740–757.  
<https://doi.org/10.1177/02685809221115959>
- Banerji, Saoni, Hanna Hōrak, Janno Torop & Tan-Phat Huynh (2023): Unravelling the Secrets of Plants: Emerging Wearable Sensors for Plants Signals and Physiology. In: *Advanced Sensor Research* 3/3, 2300023. <https://doi.org/10.1002/ADSR.202300023>
- Baur, Patrick & Alastair Iles (2023): Inserting machines, displacing people: how automation imaginaries for agriculture promise "liberation" from the industrialized farm. In: *Agriculture and Human Values* 40/3, 815–833. <https://doi.org/10.1007/s10460-023-10435-5>

- Boumans, Marcel & Sabina Leonelli (2020): From Dirty Data to Tidy Facts: Clustering Practices in Plant Phenomics and Business Cycle Analysis. In: Leonelli, Sabina & Niccolò Tempini (Hgs.), *Data Journeys in the Sciences*. Cham: Springer International Publishing, 79–101. [https://doi.org/10.1007/978-3-030-37177-7\\_5](https://doi.org/10.1007/978-3-030-37177-7_5)
- Brice, Jeremy (2022): The unknowing expert: Talking to a man about supply chains. In: *Area* 55/2, 215–220. <https://doi.org/10.1111/area.12845>
- Brice, Jeremy, George Cusworth, Jamie Lorimer & Tara Garnett (2022): Immaterial animals and financialized forests: Asset manager capitalism, ESG integration and the politics of livestock. In: *Environment and Planning A: Economy and Space* 54/8, 1551–1568. <https://doi.org/10.1177/0308518X221121132>
- Bronson, Kelly & Irena Knezevic (2016): Big Data in food and agriculture. In: *Big Data & Society* 3/1, 2053951716648174. <https://doi.org/10.1177/2053951716648174>
- Calkins, Sandra (2021): Between the Lab and the Field: Plants and the Affective Atmospheres of Southern Science. In: *Science, Technology, & Human Values* 48/2, 243–271. <https://doi.org/10.1177/01622439211055118>
- Callon, Michel, Cécile Méadel & Vololona Rabearisoa (2002): The economy of qualities. In: *Economy and Society* 31/2, 194–217. <https://doi.org/10.1080/03085140220123126>
- Caprotti, Federico (2012): The cultural economy of cleantech: environmental discourse and the emergence of a new technology sector. In: *Transactions of the Institute of British Geographers* 37/3, 370–385. <https://doi.org/10.1111/j.1475-5661.2011.00485.x>
- Carolan, Michael (2020): Acting like an algorithm: digital farming platforms and the trajectories they (need not) lock-in. In: *Agriculture and Human Values* 37/4, 1041–1053. <https://doi.org/10.1007/s10460-020-10032-w>
- Carolan, Michael (2022): Digitization as politics: Smart farming through the lens of weak and strong data. In: *Journal of Rural Studies* 91, 208–216.
- Christensen, Lars Thøger, Mette Morsing & Ole Thyssen (2021): Talk–Action Dynamics: Modalities of aspirational talk. In: *Organization Studies* 42/3, 407–427. <https://doi.org/10.1177/0170840619896267>
- Comi, Matt (2020): The distributed farmer: rethinking US Midwestern precision agriculture techniques. In: *Environmental Sociology* 6/4, 403–415. <https://doi.org/10.1080/23251042.2020.1794426>
- Corley, Martin & Oliver W. Stewart (2008): Hesitation disfluencies in spontaneous speech: The meaning of um. In: *Language and Linguistics Compass* 2/4, 589–602. <https://doi.org/10.1111/j.1749-818X.2008.00068.x>
- Daston, Lorraine & Peter Galison (2010): *Objectivity*. New York: MIT Press.
- Deville, Joe, Michael Guggenheim & Zuzana Hrdličková (2016): *Practising Comparison: Logics, Relations, Collaborations*. Manchester: Mattering Press. <https://doi.org/10.28938/9780993144943>
- Dudhwala, Farzana & Lotta Björklund Larsen (2019): Recalibration in counting and accounting practices: Dealing with algorithmic output in public and private. In: *Big Data & Society* 6/2, 2053951719858751. <https://doi.org/10.1177/2053951719858751>
- Duncan, Emily, Alesandros Glaros, Dennis Z. Ross & Eric Nost (2021): New but for whom? Discourses of innovation in precision agriculture. In: *Agriculture and Human Values* 38/4, 1181–1199. <https://doi.org/10.1007/s10460-021-10244-8>

- Duncan, Emily, Sarah Rotz, André Magnan & Kelly Bronson (2022): Disciplining land through data: The role of agricultural technologies in farmland assetisation. In: *Sociologia Ruralis* 62/2, 231–249. <https://doi.org/10.1111/soru.12369>
- Fairbairn, Madeleine, Zenia Kish & Julie Guthman (2022): Pitching agri-food tech: performativity and non-disruptive disruption in Silicon Valley. In: *Journal of Cultural Economy* 15/5, 652–670. <https://doi.org/10.1080/17530350.2022.2085142>
- Fernández, J.E. & M.V. Cuevas (2010): Irrigation scheduling from stem diameter variations: A review. In: *Agricultural and Forest Meteorology* 150/2, 135–151. <https://doi.org/10.1016/j.agrformet.2009.11.006>
- Finger, Robert, Scott M. Swinton, Nadja El Benni & Achim Walter (2019): Precision Farming at the Nexus of Agricultural Production and the Environment. In: *Annual Review of Resource Economics* 11, 313–335. <https://doi.org/10.1146/annurev-resource-100518-093929>
- Fitzgerald, Deborah (2003): *Every Farm a Factory: The Industrial Ideal in American Agriculture*. New Haven: Yale University Press.
- Forney, Jérémie, Angga Dwiartama & Diana Bentia (2023): Everyday digitalization in food and agriculture: Introduction to the symposium. In: *Agriculture and Human Values* 40/2, 417–421. <https://doi.org/10.1007/s10460-022-10382-7>
- Fraser, Alistair (2022): "You can't eat data"? Moving beyond the misconfigured innovations of smart farming. In: *Journal of Rural Studies* 91, 200–207. <https://doi.org/10.1016/j.jrurstud.2021.06.010>
- Gabrys, Jennifer, Michelle Westerlaken & Yuti Ariani Fatimah (2024): Actually existing smart forests: A proposal for pluralizing eco-technical worlds. In: *Environment and Planning F* 4/2, 26349825241264393. <https://doi.org/10.1177/26349825241264393>
- Galvin, Shaila Seshia & Diego Silva Garzón (2023): The political life of mitigation: from carbon accounting to agrarian counter-accounts. In: *The Journal of Peasant Studies* 50/6, 2259–2282. <https://doi.org/10.1080/03066150.2022.2153043>
- Geldhof, Batist, Jolien Pattyn, David Eyland, Sébastien Carpentier & Bram Van de Poel (2021): A digital sensor to measure real-time leaf movements and detect abiotic stress in plants. In: *Plant Physiology* 187/3, 1131–1148. <https://doi.org/10.1093/plphys/kiab407>
- Gorissen, Lenn, Kornelia Konrad & Esther Turnhout (2025): Sensors and sensing practices: shaping farming system strategies toward agricultural sustainability. In: *Agriculture and Human Values* 42/3, 1477–1495. <https://doi.org/10.1007/s10460-024-10686-w>
- Gugganig, Mascha, Kelly Bronson & Vardit Mirza (Hgs.) (2025): *The Smartification of Everything: Critical Perspectives in Sciences, Arts, and Society*. Toronto: University of Toronto Press.
- Gugganig, Mascha, Sarah Marquis, Olivia Doggett & Kelly Bronson (2026): Against 'technology adoption': troubling a dominant concept through biodiverse farmers' in-difference to digital agriculture. In: *Agriculture and Human Values* 43, 28. <https://doi.org/10.1007/s10460-025-10833-x>
- Guthman, Julie & Michaelanne Butler (2023): Fixing food with a limited menu: on (digital) solutionism in the agri-food tech sector. In: *Agriculture and Human Values* 40/3, 835–848. <https://doi.org/10.1007/s10460-023-10416-8>
- Hahn, Federico (2021): Dendrometer Stem Monitoring of Tomato Plants Attacked by Whiteflies in Greenhouses. In: *Modern Concepts & Developments in Agronomy* 8/5, 861–867.
- Heimstädt, Cornelius (2023a): Making plant pathology algorithmically recognizable. In: *Agriculture and Human Values* 40/3, 865–878. <https://doi.org/10.1007/s10460-023-10419-5>

- Heimstädt, Cornelius (2023b): The exploratory assetization of a crop protection app. In: Environmental Science & Policy 140, 242–249. <https://doi.org/10.1016/j.ENVSCI.2022.12.014>
- Higgins, Vaughan, Melanie Bryant, Andrea Howell & Jane Battersby (2017): Ordering adoption: Materiality, knowledge and farmer engagement with precision agriculture technologies. In: Journal of Rural Studies 55, 193–202. <https://doi.org/10.1016/j.jrurstud.2017.08.011>
- Humby, Clive, Terry Hunt & Tim Phillips (2008): Scoring Points: How Tesco Continues to Win Customer Loyalty. 2nd ed.. London: Kogan Page.
- Hussey, Kristin D. & Rachel Douglas-Jones (2024): Introduction: Laboratory times. In: Time & Society 33/3, 237–250. <https://doi.org/10.1177/0961463X241246397>
- Jaton, Florian (2021a): Assessing biases, relaxing moralism: On ground-truthing practices in machine learning design and application. In: Big Data & Society 8/1, 20539517211013569. <https://doi.org/10.1177/20539517211013569>
- Jaton, Florian (2021b): The Constitution of Algorithms: Ground-Truthing, Programming, Formulating. Cambridge, Massachusetts: The MIT Press.
- Jerak-Zuiderent, Sonja (2015): Keeping Open by Re-Imagining Laughter and Fear. In: The Sociological Review 63/4, 897–921. <https://doi.org/10.1111/1467-954X.12221>
- Kitchin, Rob (2021): Data Lives: How Data Are Made and Shape Our World. Bristol: Bristol University Press.
- Knierim, Andrea, Maria Kernecker, Klaus Erdle, Teresa Kraus, Friederike Borges & Angelika Wurbs (2019): Smart farming technology innovations – Insights and reflections from the German Smart-AKIS hub. In: NJAS: Wageningen Journal of Life Sciences 90–91, 1–10. <https://doi.org/10.1016/j.njas.2019.100314>
- Knoll, Lisa (2024): Valuation and sustainability. In: Krüger, Anne, Thorsten Peetz & Hilmar Schaefer (Hgs.), The Routledge International Handbook of Valuation and Society. Abingdon: Routledge, 316–325. <https://doi.org/10.4324/9781003229353-37>
- Knox, Hannah (2020): Thinking Like a Climate: Governing a City in Times of Environmental Change. Durham: Duke University Press.
- Knox, Hannah (2021): Hacking anthropology. In: Journal of the Royal Anthropological Institute 27/S1, 108–126. <https://doi.org/10.1111/1467-9655.13483>
- Krutilin, Alexander A., Aliia M. Bazieva, Tatiana A. Dugina & Aydarbek T. Giyazov (2022): Sustainable Agriculture for Food Security: Conceptual Framework and Benefits of Digitalization. In: Popkova, Elena G. & Bruno S. Sergi (Hgs.), Sustainable Agriculture (Environmental Footprints and Eco-Design of Products and Processes). Singapore: Springer, 35–42. [https://doi.org/10.1007/978-981-16-8731-0\\_4](https://doi.org/10.1007/978-981-16-8731-0_4)
- Krzywoszynska, Anna (2024): "You can't manage what you can't measure": Regenerative agriculture, farming by numbers, and calculability in soil microbiopolitics. In: Environment and Planning E: Nature and Space 7/4, 1691–1710. <https://doi.org/10.1177/25148486241246498>
- Latour, Bruno (1995): La science en action: introduction à la sociologie des sciences. Nouv. éd. rev. (Folio. Essais, 267). Paris: Gallimard.
- Law, John (2008): Actor-network theory and material semiotics. In: Bryan S. Turner (Hg.), The New Blackwell Companion to Social Theory. 3rd ed. Oxford: Blackwell, 141–158.
- Lee, Giwon, Qingshan Wei & Yong Zhu (2021): Emerging Wearable Sensors for Plant Health Monitoring. In: Advanced Functional Materials 31/52, 2106475. <https://doi.org/10.1002/ADFM.202106475>

- Legun, Katharine & Karly Burch (2021): Robot-ready: How apple producers are assembling in anticipation of new AI robotics. In: *Journal of Rural Studies* 82, 380–390.  
<https://doi.org/10.1016/j.jrurstud.2021.01.032>
- Lenoir, Timothy (1986): Models and Instruments in the Development of Electrophysiology, 1845–1912. In: *Historical Studies in the Physical and Biological Sciences* 17/1, 1–54.  
<https://doi.org/10.2307/27757574>
- Li, Xiao-Hong, Meng-Zhao Li, Jingyi Li, Yangyang Gao, Chunrong Liu & Ge-Fei Hao (2024): Wearable sensor supports in-situ and continuous monitoring of plant health in precision agriculture era. In: *Plant Biotechnology Journal* 22/6, 1516–1535.  
<https://doi.org/10.1111/pbi.14283>
- Li, Zhikang, Hanping Mao, Lizhi Li, Yazhou Wei, Yongsheng Yu, Mingxue Zhao & Ze Liu (2024): A Flexible Wearable Sensor for In Situ Non-Destructive Detection of Plant Leaf Transpiration Information. In: *Agriculture* 14/12, 2174.  
<https://doi.org/10.3390/agriculture14122174>
- Lien, Marianne Elisabeth & John Law (2011): Emergent aliens: On salmon, nature and their enactment. In: *Ethnos* 76/1, 65–87. <https://doi.org/10.1080/00141844.2010.549946>
- Lippert, Ingmar (2014): Studying Reconfigurations of Discourse: Tracing the Stability and Materiality of "Sustainability/Carbon". In: *Zeitschrift für Diskursforschung* 2/1, 32–54.
- Loconto, Allison, Scott Prudham & Steven Wolf (2024): Environmental governance through metrics: guest introduction. In: *Science as Culture* 33/1, 1–15.  
<https://doi.org/10.1080/09505431.2024.2312703>
- Lupton, Deborah & Sarah Maslen (2018): The more-than-human sensorium: sensory engagements with digital self-tracking technologies. In: *The Senses and Society* 13/2, 190–202. <https://doi.org/10.1080/17458927.2018.1480177>
- Lynch, Michael (1988): The Externalized Retina: Selection and Mathematization in the Visual Documentation of Objects in the Life Sciences. In: *Human Studies* 11/2–3, 201–234.  
<https://doi.org/10.1007/BF00177304>
- Miles, Chris (2019): The combine will tell the truth: On precision agriculture and algorithmic rationality. In: *Big Data & Society* 6/1. <https://doi.org/10.1177/2053951719849444>
- Mol, Annemarie (1999): Ontological politics: A word and some questions. In: Law, John & John Hassard (Hgs.), *Actor Network Theory and After*. Oxford: Blackwell, 74–89.
- Sarker, Nazirul Islam., Shahidul Islam, Arshad Ali, Saiful Islam, Abdus Salam & Hasan Mahmud (2019): Promoting digital agriculture through big data for sustainable farm management. In: *International Journal of Innovation and Applied Studies* 25/4, 1235–1240.
- Newell, Peter & Olivia Taylor (2018): Contested landscapes: the global political economy of climate-smart agriculture. In: *The Journal of Peasant Studies* 45/1, 108–129.  
<https://doi.org/10.1080/03066150.2017.1324426>
- Oui, Jeanne (2024): Agriculture de précision et tournant environnemental: Enquête sur l'épistémologie d'un modèle agricole appuyé sur des données numériques. In: *Réseaux* 244/2, 117–149. <https://doi.org/10.3917/res.244.0117>
- Pasquinelli, Matteo (2019): How a machine learns and fails. In: *Spheres: Journal for Digital Cultures* 5, 1–17.
- Pickering, Andrew (1995): *The Mangle of Practice: Time, Agency, and Science*. Chicago: University of Chicago Press.
- Riom, Loïc & Mylène Tanferri (2024): Sur la piste des préparations. In: *Revue d'anthropologie des connaissances* 18/2. <https://doi.org/10.4000/11r9q>

- Roeven, Lara, Steven A. Wolf, Phoebe Sengers, Jen Liu, Gloire Rubambiza, Donny Persaud & Hakim Weatherspoon (2024): Analyzing abstraction in critical agri-food studies and computer science: toward interdisciplinary analysis of digital agriculture innovation. In: *Agriculture and Human Values* 42/2, 1009–1026. <https://doi.org/10.1007/s10460-024-10655-3>
- Rose, David C., Carol Morris, Matt Lobley, Michael Winter, William J. Sutherland & Lynn V. Dicks (2018): Exploring the spatialities of technological and user re-scripting: The case of decision support tools in UK agriculture. In: *Geoforum* 89, 11–18. <https://doi.org/10.1016/j.geoforum.2017.12.006>
- Rosin, Christopher J., Katharine A. Legun, Hugh Campbell & Marion Sautier (2017): From compliance to co-production: Emergent forms of agency in Sustainable Wine Production in New Zealand. In: *Environment and Planning A: Economy and Space* 49/12, 2780–2799. <https://doi.org/10.1177/0308518X17733747>
- Rosner, Lisa (Hg.) (2004): *The Technological Fix: How People Use Technology to Create and Solve Problems*. New York: Routledge. <https://doi.org/10.4324/9780203501351>
- Rotz, Sarah, Emily Duncan, Matthew Small, Janos Botschner, Rozita Dara, Ian Mosby, Mark S. Reed & Evan D.G. Fraser (2019): The Politics of Digital Agricultural Technologies: A Preliminary Review. In: *Sociologia Ruralis* 59/2, 203–229. <https://doi.org/10.1111/soru.12233>
- Ruser, Alexander & Amanda Machin (2016): Technology can't save us, can it? The Emergence of the "Techno-Fix" Narrative in Climate Politics. In: *Proceedings of the International Conference 'Technology + Society = Future?'*, 437–447.
- Schinkel, Willem (2023): Steps to an Ecology of Algorithms. In: *Annual Review of Anthropology* 52/1, 171–186. <https://doi.org/10.1146/annurev-anthro-052721-041547>
- Schüll, Natasha D. (2019): The Data-Based Self: Self-Quantification and the Data-Driven (Good) Life. In: *Social Research: An International Quarterly* 86/4, 909–930. <https://doi.org/10.1353/sor.2019.0050>
- Seaver, Nick (2017): Algorithms as culture: Some tactics for the ethnography of algorithmic systems. In: *Big Data & Society* 4/2, 2053951717738104. <https://doi.org/10.1177/2053951717738104>
- Sippel, Sarah Ruth & Moritz Dolinga (2023): Constructing agri-food for finance: startups, venture capital and food future imaginaries. In: *Agriculture and Human Values* 40/2, 475–488. <https://doi.org/10.1007/s10460-022-10383-6>
- Star, Susan Leigh & Karen Ruhleder (1996): Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces. In: *Information Systems Research* 7/1, 111–134. <https://doi.org/10.1287/isre.7.1.111>
- Tabouret, Sophie (2024): Mise en place d'une expérimentation in situ: Ethnographie d'un groupe de travail sur les cépages résistants. In: *Revue d'anthropologie des connaissances* 18/4. <https://doi.org/10.4000/12swk>
- Touzard, Jean-Marc, Ludovic Temple, Guy Faure & Bernard Triomphe (2015): Innovation systems and knowledge communities in the agriculture and agrifood sector: a literature review. In: *Journal of Innovation Economics & Management* 17/2, 117–142.
- Tran, Daniel, Fabien Dutoit, Elena Najdenovska, Nigel Wallbridge, Carrol Plummer, Marco Mazza, Laura Elena Raileanu & Cédric Camps (2019): Electrophysiological assessment of plant status outside a Faraday cage using supervised machine learning. In: *Scientific Reports* 9/1, 17073. <https://doi.org/10.1038/s41598-019-53675-4>

- Tsouvalis, Judith, Susanne Seymour & Charles Watkins (2000): Exploring Knowledge-Cultures: Precision Farming, Yield Mapping, and the Expert–Farmer Interface. In: *Environment and Planning A: Economy and Space* 32/5, 909–924. <https://doi.org/10.1068/a32138>
- van der Velden, Daniël, Laurens Klerkx, Joost Dessein & Lies Debruyne (2024): Cyborg farmers: Embodied understandings of precision agriculture. In: *Sociologia Ruralis* 64/1, 3–21. <https://doi.org/10.1111/soru.12456>
- Vinck, Dominique (2011): Taking intermediary objects and equipping work into account in the study of engineering practices. In: *Engineering Studies* 3/1, 25–44. <https://doi.org/10.1080/19378629.2010.547989>
- Vinck, Dominique (2012): Accessing Material Culture by Following Intermediary Objects. In: Naidoo, Loshini (Hg.), *An Ethnography of Global Landscapes and Corridors*. Rijeka: InTech, 89–108. <https://doi.org/10.5772/34719>
- Visser, Oane, Sarah Ruth Sippel & Louis Thiemann (2021): Imprecision farming? Examining the (in)accuracy and risks of digital agriculture. In: *Journal of Rural Studies* 86, 623–632. <https://doi.org/10.1016/j.jrurstud.2021.07.024>
- Volkov, Alexander G. & Vladislav S. Markin (2012): Phytosensors and Phytoactuators. In: Alexander G. Volkov (Hg.), *Plant Electrophysiology: Signaling and Responses*. Berlin: Springer, 173–206. [https://doi.org/10.1007/978-3-642-29110-4\\_7](https://doi.org/10.1007/978-3-642-29110-4_7)
- Walter, Achim, Robert Finger, Robert Huber & Nina Buchmann (2017): Opinion: Smart farming is key to developing sustainable agriculture. In: *Proceedings of the National Academy of Sciences* 114/24, 6148–6150. <https://doi.org/10.1073/pnas.1707462114>
- Wolf, Steven A. & Frederick H. Buttel (1996): The Political Economy of Precision Farming. In: *American Journal of Agricultural Economics* 78/5, 1269–1274. <https://doi.org/10.2307/1243505>
- Wolfert, Sjaak, Lan Ge, Cor Verdouw & Marc-Jeroen Bogaardt (2017): Big Data in Smart Farming – A review. In: *Agricultural Systems* 153, 69–80. <https://doi.org/10.1016/J.AGSY.2017.01.023>

## Author Information

Mylène is a Marie Skłodowska Curie Postdoctoral Fellow at the Technologies in Practice & Center for Climate IT at the University of Copenhagen. Her broad topic concerns perceptual practices in digitization processes. DIGIPHYT, her current project, examines plant sensors for agriculture, the non-human entities involved in their development, and the roles of sustainability claims attached to them.