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SYMPOSIUM/SPECIAL ISSUE

Contested agri-food futures: Introduction to the Special Issue

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Abstract

Over recent decades, influential agri-food tech actors, institutions, policymakers and others have fostered dominant techno-optimistic, future visions of food and agriculture that are having profound material impacts in present agri-food worlds. Analyzing such realities has become paramount for scholars working across the fields of science and technology studies (STS) and critical agri-food studies, many of whom contribute to STSFAN—the Science and Technology Studies Food and Agriculture Network. This article introduces a Special Issue featuring the scholarship of STSFAN members, which cover a range of case studies and interdisciplinary and transdisciplinary engagements involving such contested agri-food futures. Their contributions are unique in that they emerged from the network's specific modus operandi: a workshopping practice that supports the constructive, interdisciplinary dialogue necessary for critical research and rigorous analyses of science and technology in agri-food settings. This introduction offers an overview of STS and critical agri-food studies scholarship, including their historical entanglements in respective studies of food scandals, scientific regimes and technological determinism. We illustrate how interdisciplinary engagement across these fields has contributed to the emergent field of what we term agri-food technoscience scholarship, which the contributions of this Special Issue speak to. After a brief discussion of STS concepts, theories and methods shaping agri-food policy, technology design and manufacturing, we present the eleven Special Issue contributions in three thematic clusters: influential actors and their agri-food imaginaries; obfuscated (material) realities in agri-food technologies; and conflictual and constructive engagements in academia and agri-food. The introduction ends with a short reflection on future research trajectories in agri-food technoscience scholarship.

Keywords Agrifood studies · Science and technology studies (STS) · Food · Agriculture · FoodTech · AgTech · Agritech · Agrifood tech · Agri-food-tech · Agri-food technology · Agri-tech imaginaries · Interdisciplinarity and transdisciplinarity · Collaboration

Introduction

In recent years, growing agri-food tech sectors and their actors have begun shaping imaginations about, and the material realities of, food and agriculture. Venture capitalists, philanthropists, scientists, engineers, as well as politicians have become some of the key actors cultivating vanguard visions and sociotechnical imaginaries (see Hilgartner 2015) in the agri-food space. Such visions and imaginaries position scientific approaches and novel technologies as central to the development of healthier and more sustainable agri-food futures. Critical agri-food studies and science and technology studies (STS) scholars have been studying these sociotechnical transformations in laboratories, on farms, in food factories, at industry events, and in policy spaces, among other locations. Concurrently, social scientists in these fields have been enlisted to participate as researchers

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within interdisciplinary and transdisciplinary agri-food tech projects; here, they must reckon with tensions and power dynamics that arise from being both collaborators and critical analysts (Burch et al. 2023b).

This Special Issue focuses on these and other forms of research that highlight how agri-food and STS scholarship can contribute to critical analyses of agri-food tech and contested agri-food futures. Its contributions also discuss research cultivated through collaborative engagements within intellectual communities and interdisciplinary research teams that aim for more equitable agri-food presents and futures. STS has much to offer the study of agri-food tech. First, and most obviously, STS takes science and technology as its central object of analysis. Through this lens, food and agricultural systems serve as important domains for studying how scientific knowledge and technologies are entangled with structural phenomenon (e.g., global capitalism, colonialism) and changes in people's everyday lives.

Further, there are several theoretical contributions that STS makes to the study of science and technological change in food and agriculture. Since STS scholars position technologies as situated and open to inquiry, rather than fixed tools that can be put to good or bad uses (Haraway 1988), they also recognize that technologies embody and replicate the values of the people who shape them—notably funders, designers, policymakers and users (Bijker et al. 2012 [1987]). Through this lens, there has emerged a growing body of scholarship applying STS concepts to study agri-food technologies (e.g., biotechnologies, agrochemicals, AI and robotics) in an attempt to highlight how values inform (and ought to inform) the design, governance and use of these tools, as well as the data they collect (Bronson 2014; 2022; Bronson and Sengers 2022; Burch and Legun 2021; Carolan 2010; 2020b; DiSalvo 2014; Duncan et al. 2022; Guthman 2019; Hernández Vidal 2018; Higgins et al. 2017; Rotz et al. 2019; Taiuru et al. 2022).

In this Special Issue introduction, we begin with an overview of both STS and critical agri-food studies scholarship, their historical entanglements, and their respective studies of food scandals, scientific regimes and technological determinism. We illustrate how interdisciplinary engagement across these fields has contributed to the emergent field of what we term agri-food technoscience scholarship, which the contributions of this Special Issue speak to. The Science and Technology Studies Food and Agriculture Network (STSFAN), the forum through which this Special Issue emerged, is an intellectual community to many such agri-food technoscience scholars. The eleven contributions to this Special Issue come from STSFAN members and were developed through the network's specific modus operandi: a workshopping practice that supports the constructive, interdisciplinary dialogue necessary for critical research and rigorous analyses of science and technology in agri-food settings. After a brief discussion of STS concepts, theories and methods shaping agri-food policy, technology design and manufacturing, we present the Special Issue contributions in three thematic clusters: influential actors and their agri-food imaginaries; obfuscated (material) realities in agri-food technologies; and conflictual and constructive engagements in academia and agri-food. We end with a short reflection on future research trajectories in agri-food technoscience scholarship.

The roots of STS: Food scandals all the way down

In 1980, STS scholar Langdon Winner published a now classic article on the question of whether technologies have inherent politics. He poignantly illustrated technopolitics by using the infamous case of the mechanical tomato harvester introduced by the University of California, which led to massive job losses and increasing profit for the few growers that were able to afford them. At the same time, it resulted in the breeding of sturdier, less tasty tomatoes that were harvester-compatible, while solidifying the land-grant university and agribusinesses as authoritative actors in agriculture and research. From this example, Winner (1980, p. 126) inferred a larger "ongoing social process in which scientific knowledge, technological invention, and corporate profit reinforce each other in deeply entrenched patterns that bear the unmistakable stamp of political and economic power."

Both modern agriculture and science embody attempts to control, discipline and systematize the natural world (Henke 2008). Further, as James Scott argues in *Seeing like a State* (2008), with the power of scientific agriculture, a state may also better 'see'—govern—land and people. Agri-food settings have thus been a fertile ground for STS-inspired theorization of sociotechnical transformations, political contestations over knowledge, and varied value regimes. With roots in the sociology and anthropology of science, STS scholars have also long argued that perceptions of risk (scientific, affective, or political) embed deeply ingrained cultural values and worldviews that require a sensitivity to the complex social, material and power relations at play when scientific facts or technologies enter different contexts (Bronson 2014; Douglas and Wildavski 1983; Iles et al. 2017).

Genetic engineering and the introduction of genetically modified organisms (GMOs) were among the most prominently discussed (agricultural) technologies among STS research in the 1990 and 2000s. Scholars studied GMO regulatory controversies (Winickoff et al. 2005), but also leveraged novel methods for bringing a greater diversity of values into tech design (e.g., Consensus Conferences, Marris and Joly 1999). Other analyses adopted Winner's technopolitical approach to uncover the corporate value systems embedded in the design of and the infrastructures surrounding GMO seed systems (Bronson 2015). The outbreak of the food-borne disease bovine spongiform encephalopathy (BSE) (Law and Mol 2008), nuclear pollution of farming environments (Callon et al. 2011; Wynne 1996), and carcinogenic risks in food additives (Nelkin 1995; Pinch and Leuenberger 2006) provided further sites for discussions about the role of scientific and corporate value regimes as they influence agri-food, agri-tech and technology governance.

Perhaps most well-known is the work of Brian Wynne who highlighted (nuclear) scientists' deficit framing of sheep farmers who had to deal with nuclear pollution from multiple sources. Wynne (1996) illustrated how scientists affirmed the universality of nuclear science as a trusted knowledge source by framing sheep farmers' knowledge as inadequate (i.e., deficient of scientific knowledge). This deficit model has since been applied widely to study the construction of publics and consumers (Biltekoff and Guthman 2023; Broad and Biltekoff 2022; Bronson 2014; Irwin and Wynne 1996; Wynne 2006). Such examples have provided fertile sites for exploring questions of central importance to STS theorization, including how certain knowledge hierarchies are produced through technopolitical processes.

Critical agri-food scholars' engagement with scientific regimes and technological determinism

Concurrent to theoretical work in STS, scholars in critical agri-food studies have likewise explored epistemological tensions between farming communities, agri-tech developers, policymakers, and/or scientists. Particularly the so-called 'Green Revolution' has to this day sparked much debate on the rhetoric of agricultural technologies as silver bullet solutions to tackle global hunger (Patel 2013; Shiva 1991). In the early 1980s, agricultural sociologists Lawrence Busch and William B. Lacy brought attention to the role of partiality and bias in determining what technologies got developed under the guise of post-war global food system repair, and which scientific studies were conducted by the United States agricultural research system (see also Clapp 2016). In *Science, Agriculture, and the Politics of Research*, Busch and Lacy (2019 [1983]) laid out the mechanisms of how certain research problems get prioritized over others, and consequently shaped what agriculture (and research) became standardized—and thus unavailable for further debate and inquiry (see Bijker 1997 for similar discussions in the field of STS). Similarly, Jack Kloppenburg laid out the historical processes by which a particular technology-intensive, globalized and capitalist form of food production has become, over time, such a taken-for-granted paradigm in food that it appears to be value-free and come from nowhere in particular (Kloppenburg et al. 1996).

Agri-food scholars have also studied how farmers' tacit, experiential knowledge and expertise may contrast with scientific and agri-tech developers' ways of reasoning, and the ways in which developers assume a necessary good coming from technology, presuming adoption as both inevitable and always desirable (Riley 2008; Tsouvalis et al. 2000). Just as STS scholars have critiqued technology transfer as a one-directional endeavor of science and technology (De Laet and Mol 2000; Latour 1999), agri-food scholars have problematized the linear model of technology adoption as narrow and simplistic, as it fosters a "treadmill" of technology adoption (Ward 1993). Levins and Colchrane (1996, p. 550) clearly articulate these insights:

> As more farmers adopt the technology… production goes up, prices go down, and profits are no longer possible even with the lower production costs. Average farmers are nonetheless forced by lower product prices to adopt the technology and lower their production costs if they are to survive at all. The 'laggard' farmers who do not adopt new technologies are lost in the price squeeze and leave room for their more successful neighbors to expand.

Said differently, the treadmill logic underlying dominant views and advice to farmers impels them to adopt the newest, most 'efficient' farming technologies. This leads to a situation where farmers who do not follow the treadmill logic are easily dismissed as irrational 'laggards.'

Critical agri-food studies meets STS

The synergies between STS and agri-food studies are becoming more evident and necessary with growing trends toward digitalization in food and agriculture.[1] In a widely cited editorial, Bronson and Knezevic (2016) call on agri-food scholars to attend more closely to how big data may be transforming agri-food systems, and Chris Miles argues that these emergent technologies perpetuate a "deeper grammar of capitalist organization of production" (Miles 2019, p. 3; see also Bronson 2018, 2019; Carolan 2017; Clapp 2016).

[1] Digital agriculture can be grouped into the mechanical and biological domain (ETC Group 2016). Here, computerized farm machinery and management tools, or what is commonly referred to as precision agriculture, forms the mechanical domain, while computerized agricultural biology and manipulation of seeds, livestock, and pesticides forms the biological domain (see Miles 2019). Precision agriculture has been around since the 1990s (Wolf and Wood 1997), and continues to be used synonymously with 'smart farming,' though critical observers recognize this conflation as "ill-defined and semiotically gravid" (Miles 2019, p. 10).

Similar to chatbots like ChatGPT, ‘data grabs’ now also turn farmers into paying customers for, and producers of, free data (Bronson and Sengers 2022; Fraser 2022). At the same time, neo- and settler colonial land grabs are exceedingly underpinned by the use and production of area, crops, or yield data for financial speculation (Duncan et al. 2022; Fraser 2019; Sippel 2023).

Work in this area reflects a steadily growing body of scholarship produced by an emerging group of agri-food technoscience scholars.[2] Despite a few early exceptions (e.g., Bronson 2014; Busch and Juska 1997; Carolan 2010), agri-food scholars have only recently begun engaging with STS concepts and theories (e.g., Bronson 2022; Higgins et al. 2017; Klerkx et al. 2019) to study knowledge, expertise, values, inequity, and power transformations in agri-food networks (Loconto et al. 2022, p. 3). *Agriculture and Human Values* has become a key intellectual venue for these interdisciplinary discussions (Burch et al. 2023a; Carolan 2020b; Driessen and Heutinck 2015; Fairbairn and Guthman 2020; Forney et al. 2022; Kinchy 2010; Legun et al. 2023; Prause et al. 2021; Sippel and Dolinga 2023). In particular, work engaging with deficit models, expertise/sovereignty, imaginations/visions, and ontology/socio-materiality have emerged as key themes of inquiry:

First, building on early work on the deficit model (Hansen et al. 2003; Irwin and Wynne 1996) has been generative for analyzing lay and expert attitudes to food risks (Bronson 2014), knowledge deficits in farmer initiatives (Calo 2018), tech entrepreneurs’ imaginaries of consumer publics (Biltekoff and Guthman 2023), or science communication on genetic engineering and cellular meat (Ahteensuu 2012; Broad and Biltekoff 2022). Scholars are studying deficit framings beyond simplistic pro-/anti-tech categories, for example, how agricultural industry actors describe ‘confused farmers’ overwhelmed with data overload (Duncan et al. 2021), or stressed farmers in need of automation (Baur and Iles 2023). Related discourses of digital education and ‘open’ data often assume too quickly that allegedly ‘deficient’ farmers want to become data analysts (Miles 2019, p. 4), while obfuscating questions of whether control over their ‘open’ farm data is feasible (Fraser 2019).

Second, related to questions of expertise/sovereignty, Higgins et al. (2017) describe how farmers neither accept nor refuse precision agriculture tools, but rather—drawing on an STS concept—‘tinker’ (Mol et al. 2010) with them according to their own tacit knowledge and capabilities. Similarly, dairy farmers may use satellite data for grazing management to compare, and thus improve, their own measurement methods (Eastwood and Kenny 2009). This scholarship describes how many farmers combine embodied, site-specific knowledge with scientific data, tools and reasoning to fit their own farming practices rather than subjecting to a dominant knowledge regime (Higgins et al. 2023; Legun et al. 2023; Riley 2008; Tsouvalis et al. 2000).

Third, there is a growing body of scholarship attending to the ‘promissory futures’ underpinning technoscientific advancements (Rajan 2006), most prominently by applying the concept of sociotechnical imaginaries (Jasanoff and Kim 2015) to such domains as: sustainable intensification (Thompson 2018), agricultural gene editing (Bain et al. 2020; Middelveld and Macnaghten 2021), precision agriculture (Duncan et al. 2021), agri-food policymaking (Lajoie-O'Malley et al. 2020; Levidow et al. 2012; Sippel and Dolinga 2023), agri-food tech pitches (Fairbairn et al. 2022), data-driven agriculture in the so-called Global South (Fairbairn and Kish 2022) and settler colonial states (Bronson 2022), and as presented in this Special Issue, in assetization of farming (Sippel 2023; see also Duncan et al. 2022), and automation (Baur and Iles 2023). Different epistemic communities may also contest dominant agricultural sociotechnical imaginaries that solidify certain (technocratic, capitalist, colonial) logics over others (Goulet 2020; Gugganig 2021). This aligns with critical agri-food scholarship that conceives of food and agriculture as “inherently futured” in that anticipatory action, such as insurance policies, and wider capitalist imaginaries “*make worlds* that are distinctly different from [farmers’] imaginaries on solidarity, reciprocity, and simple reproduction” (Carolan 2020a, p. 188, original emphasis; Nimmo 2022).

Fourth, many scholars have begun engaging with the political ontology, socio-materiality and care in diverse agri-food settings. This includes scholarship grappling with questions about the ontological politics of ‘smart’ farming (Carolan 2018), farming in settler colonial contexts (Campbell 2020), the role of pathogens and chemicals in making or breaking the strawberry industry (Guthman 2019), the politics of care in human–soil relations (De La Bellacasa 2017) and almond orchards (Reisman 2021), as well as an array of work on how alternative proteins both differ from and simulate animal products (Guthman et al. 2022; Jönnson 2016; Mouat and Prince 2018; Sexton et al. 2019). A theoretical contribution evoking much debate among STS scholars (Joerges 1999), socio-material analyses have also been employed to explore food safety in the aftermath of a nuclear disaster (Burch 2019), how agri-tech design can illuminate political expression and action (DiSalvo 2014), the dynamic agri-food materials which actors attempt to enclose within capitalist intellectual property regimes (Carolan 2010), and relatedly, how human agency is shaped by the agency of

[2] Indeed, our network STSFAN is a product of these processes. For more information, see the accompanying Field Report on intellectual community-building within this Special Issue (Burch et al. 2023c), and our homepage at https://stsfanetwork.wixsite.com/stsfan.

potential intellectual properties in agri-tech design (Burch et al. 2023a).

Shaping more equitable agri-food futures: Applying STS insights to policy, technology design and manufacturing

Similar to the abovementioned scholarship, policy schemes in food and agriculture governance have likewise turned scholars' attention to the constitutive power of governmental analytical systems, policy biases, rentiership, and food labels, and how these are co-produced with visions of what agriculture and food *ought* to look like (Forney et al. 2018; Frohlich 2017; Ghosh 2023; Guthman 2004; Wolf and Ghosh 2020). There has also been much work done to translate STS insights into policy, technology design, and technology manufacturing. One example is how the responsible innovation (RI) framework advocating for more socially responsible technology design emerged in parallel with the development of responsible research and innovation (RRI) policies—such as in European Union's Horizon 2020 research program (EU 2020; see also Owen and Pansera 2019). Reflecting RI's recommendations on the need to take "care of the future through collective stewardship of science and innovation in the present" (Stilgoe et al. 2013, p. 1570), RRI policy calls on scientists, technologists and societal actors to become "mutually responsive" through research and innovation processes (von Shomberg 2013, p. 51). Notably, just as agri-food scandals inspired theoretical debates, they have likewise inspired RI scholarship and RRI policy. This can be seen in how controversies surrounding BSE and GMOs are often used as examples of innovation that did not engage adequately with the social contexts they were expected to enter into (Stilgoe et al. 2013).

On the flip side, RI/RRI concepts and methods have been applied to analyze emergent agricultural innovations, or so-called 'smart farming' (e.g., Bronson 2018; Fielke et al 2022; Fraser 2022; Rose and Chilvers 2018). Some of this scholarship attends to questions about how to anticipate the effects of new technologies based on farmers' conceptualizations of expertise (Legun et al. 2023) and how landscapes, work and institutions shape adoption (Legun and Burch 2021). This work also questions how to better align agri-tech development with the environmental and social commitments of agroecology (Ditzler and Driessen 2022). RI has also supported scholars to attend to questions of equity and ethics in agri-tech design (Bronson 2019; Burch and Legun 2021; Burch et al. 2023a), as well as to questions of ethics and agri-food governance regarding smart farming (Brunori et al. 2019; Driessen and Heutinck 2015; van der Burg et al. 2019).

Responding to this 'responsibility turn' in food and agriculture, Arnold and colleagues (2022) critically note, however, that a rather narrow notion of responsibility is generally taken for granted, which is often based on socio-technical devices, including regulations, rankings, audits, or codes of conduct (p. 83; see also Brock 2023; Freidberg 2023; Strube et al 2021). This is particularly crucial in the context of the so-called Global South, where RRI commitments should instead include local innovation systems, such as in the case of rice straw burning in Punjab (Mamidipudi and Frahm 2020). As Fraser (2022) similarly asserts, within the realm of 'agricultural innovation' there may be limits to RRI, particularly in its ability to lead to real systemic and structural change. These limits, and shifting technological and policy environments, have led to a situation where critical STS and agri-food scholars also find themselves enlisted as collaborators within interdisciplinary and transdisciplinary technology research and design processes that are in need of further discussion and conceptual work (Burch et al 2023b; Fielke et al. 2022),

Special Issue contributions

STSFAN is a global, online intellectual community for scholars who take a collaborative approach to scholarship. This is most evident in our monthly online workshops, where members share rough drafts of their work to be discussed among their colleagues (Burch et al. 2023c). All of the eleven contributions to this Special Issue were developed through STSFAN's workshopping process. In this section, we present the papers in three thematic clusters: Influential actors and their agri-food imaginaries; obfuscated (material) realities in agri-food technologies; and conflictual and constructive engagements in academia and agri-food. While these clusters do not perfectly match the full content of each paper, we see them as useful categories to think with, and relevant themes to consider within wider agri-food technoscience scholarship.

Influential actors and their agri-food imaginaries

The first thematic cluster concerns the role of powerful actors in policy, industry, technology development and finance, and their future visions of food and farming, which have substantive purchase for shaping the (material) worlds of today and tomorrow (Bronson 2022; Carolan 2020a, b; Rajan 2006). In the first contribution, Samara Brock (2023) demonstrates that given their diverging underlying expectations, transnational food systems experts may not always agree on what constitutes a food system when working together to develop food policy. Yet she argues that it is the term's unexamined use that may in fact sharpen divides between actors, and their food system visions, thus calling for a thorough reflection on assumed systems that often remain implicit. In the second contribution, Patrick Baur and Alastair Iles (2023) turn to agri-tech manufacturers and their image of farming as a supposedly burdensome vocation for which automation is envisioned to be the right response. Their analysis reveals manufacturers' liberatory sociotechnical imaginaries which cultivate a promise of freedom and autonomy for farmers through autonomous machines, while conveniently disguising the power they gain in the process.

Julie Guthman and Michaelanne Butler (2023) take up the theme of solution–problem mismatch in the world of Silicon Valley tech entrepreneurs who often enter the agri-food sector with both vaguely defined problems and digital technologies imported from other ICT (information and communication technology) domains. Their work shows that digital 'solutions,' such as to facilitate marketing, do not in fact address the actual biophysical materialities of food and farming (pests, crop growth, etc.), while the import of digital ICTs concurrently generates simplistic techno-utopian visions of agri-food. Continuing with the theme of material–digital amalgamations, Sarah Sippel's (2023) paper turns to farmland assetization in Australia, where farmland investment brokers render land fit for investment despite its 'stubborn materiality.' Like the other papers, her analysis shows the need to research influential, elite actors—or socio-technical vanguards (Hilgartner 2015)—and their potentially pervasive visions; here, brokers cultivating "investor-suitable farmland imaginaries" (Sippel 2023, p. 2) that condition farmland, farmers and food into fertile grounds for future investment, increased automation, or data grabbing (see also Duncan et al. 2022).

Obfuscated (material) realities in agri-food technologies

The second thematic cluster concerns instances where agri-food technologies, as well as scholarship thereof, may obfuscate other aspects of food and farming. In the fifth contribution to this Special Issue, Cornelius Heimstädt (2023) offers an ethnographic study of the development of image recognition algorithms that render plant pathologies legible. His case demonstrates how the inscription of a narrow lens of 'plant pathology' into an app encourages increased pesticide use, while (albeit inadvertently) obfuscating the possibilities of more environmentally and socially sustainable agroecological farming practices (see also Nimmo 2022). Mark Bomford (2023) presents a case among vertical farming advocates who see high-tech, indoor, controlled growth systems as capable of returning land back to 'wild nature,' arguing along the popular land sparing hypothesis (Loconto et al. 2020). Yet Bomford demonstrates how arguments for increased vertical farming are not substantiated by available evidence. Rather, he argues that the popularity of vertical farming is based on the enormous venture capital flowing into this startup-industry, which arguably allows investors to ignore the essential question of whether vertical farms can actually spare land for conservation efforts.

Obfuscation takes on a different meaning in Hilary Faxon's (2023) contribution on small-scale farmers in Myanmar and their use of social media. As the author shows, the predominant understanding of 'digital agriculture,' even in critical scholarship, entails the usual suspects of GPS-steered tractors, weed robots, or so-called cloud farming (see Forney et al. 2022 for a similar argument). By this, critical agri-food/STS scholars have perhaps inadvertently overlooked the role of social media platforms as key agri-food technologies, particularly but not only, in the context of the so-called Global South. Paying more attention to ICTs *as* digital agriculture technologies is thus an invitation for future analyses to notice forms and flows of information in new ways.

Conflictual and constructive engagements in academia and agri-food

The final thematic cluster brings together contributions from a variety of practical and intellectual settings in food and agriculture. Along the case of a university agri-tech–agroecology collaboration, a commentary on disciplinary tensions between STS and agri-food studies, a manifesto on social science–STEM collaborations, and a proposal to cultivate inclusive intellectual communities, this cluster considers what can be learned from both conflictual and constructive engagements in inter- and transdisciplinary agri-food settings and within academia.

First, Summer Sullivan (2023) transports us to a Central California university campus where scientists and university administrators envision how agroecology may be combined with agri-tech. Her study shows that the scope, scale, and social impact of a specific collaborative research endeavor are key aspects for comprehending their respective failures and successes. Next, in his Commentary, Garrett Broad (2023) notes that scholars in STS, science communication, and critical agri-food studies could contribute to a constructive conversation on emerging agri-food biotechnology—if the goal is to reach a healthy, equitable and sustainable food system. He argues that while these fields may have different agendas, in increasingly inter- and transdisciplinary research settings it is paramount to respect disciplinary specificities, while better engaging practical and critical research.

Related to this tension, the third contribution of this thematic cluster starts from STSFAN members' practical experiences in inter- and transdisciplinary social science–STEM agri-food collaborations (Burch et al. 2023b). The STSFAN Manifesto lays out barriers and ways of addressing them to foster better collaborations between scholars and practitioners from different disciplines and/or sectors. Epistemological differences matter, and they require careful deliberation on distinct commitments. The final contribution, a Field Report, builds on this ethos by proposing the cultivation of inclusive intellectual communities in academia through regular engagements, such as a monthly writing workshops, which creates much needed interdisciplinary engagement (Burch et al. 2023c). Here, members of STSFAN foster a non-hierarchical co-thinking space to support scholars of all career stages and corners of the world to work across disciplines, research cases, and applied settings.

Reading the contributions together shows that the various settings and actors—agri-tech entrepreneurs, investors, engineers, STEM scientists, agroecologists, social scientists, etc.—are defined by epistemological differences and intersecting (e.g., institutional, politico-economic, disciplinary, gendered) power dynamics. STSFAN members' monthly writing workshops is a move towards practicing critical yet caring engagement that encourages much-needed interdisciplinary attention to the study of food and agriculture. Building on Broad's argument (in the case of public debates on genetic engineering), a key aspect of these collaborations and engagements is a willingness to build and rebuild room for discourse and action, where the goal is not conformity and consensus, but accountability and participants' willingness to reflect on their privileges and positionalities.

Future research trajectories in agri-food technoscience scholarship

As previous sections have illustrated, the field of agri-food technoscience scholarship is growing in a number of directions. We will use this final section to outline some of the future research trajectories that may be of interest to scholars of this emerging field.

To begin, while the topic of big data has become more prominent among those working at the intersections of STS and agri-food, we agree with Bronson and Sengers (2022) that, overall, critical scholarship on big data in the agribusiness sector has been scant compared to other sectors. At the same time, as the mechanical domain of digital agriculture has risen in popularity, this hype should not distract from the need for continuing research on pressing topics in biological domains, such as genetic engineering, (e.g., in the form of CRISPR Cas 9) (Bain et al. 2020; Müller et al. 2022), or environmental and nutritional epigenetics (Guthman and Mansfield 2013; Landecker 2011). Food and nuclear pollution (Kimura 2016), as well as considerations of equity and biopolitics in food provisioning (Nally 2011) and agricultural labour (Burch and Legun 2021; Guthman and Brown 2016; Schneider and Gugganig 2021) constitute other domains in need of further research.

As pointed out by Guthman and Butler (2023) in this Special Issue, the bioeconomy and biophysical materialities likewise require continued attention: on the one hand in food, where alternative protein and 'clean meat' rely on other sources than animals (Guthman et al. 2022; Levidow et al. 2012; Sexton et al. 2019), and on the other hand in agriculture, where a material extractivism maintains high-input industrial agricultural systems (Teaiwa 2014). Related to that, the seeming immateriality of so-called 'cloud' or 'smart' farming—which depends on energy-intensive computation of algorithms and massive infrastructures to store data (Cobby 2020; Gugganig and Bronson 2022)—is a field ripe for more empirical studies. More critical work is also needed on carbon sequestration and accounting (Wolf and Ghosh 2020), agri-food governance strategies and underlying technoscientific norms in setting (and enforcing) standards and metrics (Bain et al 2011; Burch 2019; Burch et al. 2018; Freidberg 2020b; Lajoie-O'Malley et al. 2020), as well as the commercialization of sustainability practices and regenerative agriculture by large agri-food corporate players (Freidberg 2020a, 2023).

As STS and critical agri-food scholarship has also shown, there is a need to explore the various contextual differences of digital agriculture across settings in the so-called Global South and North (Akram-Lodhi 2007; Stone 2022), each with their respective histories, power dynamics and associated inequities (Hernández Vidal 2018; Liu and Sengers 2021). Just as STS theories evolved through engaging with the particular empirical complexities of agri-food's social, material and political worlds, attending to these globally situated differences provides scholars working at the intersection of agri-food and technoscience opportunities to contribute theoretical and methodological insights to agri-food technoscience studies. Here, it is key that scholars in the so-called Global South have the required resources to conduct such research, and for those from the so-called Global North to engage in ways that are ethical and equity-promoting in all cases, and especially when claiming to engage in respoinsible forms of innovation (Kumar and Basu 2022; Mamidipudi and Frahm 2020). Emerging provocations on the need to ground the promises of agricultural big data in anti-colonial STS approaches (e.g., through the principles of Māori Data Sovereignty [Taiuru et al. 2022]), point to ways in which agri-food technoscience scholars can better address how colonial logics and land relations shape agri-food presents and futures (see Fairbairn and Kish 2022). These insights might allow future scholarship to also attend to situated questions related to the climate crisis, which will ultimately shape the trajectory of possible agri-food futures.

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Declarations

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