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## Feminist political ecologies of agrarian technologies: knowing the digital differently

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### ABSTRACT

As digital technologies become increasingly ubiquitous on farms, we need to reconsider relationships between technology and agriculture. Critical agrarian studies offers some analyses of digital technologies, but rarely engages feminist perspectives, risking the repetition of problematic assumptions about scale, subjectivity and power. We draw from the strengths of feminist political ecology to think through three digital technologies – remote sensing satellites, agricultural advice apps, and automatic milking systems – that are transforming agrarian policy, practice, and social life. In doing so, we expand critical agrarian studies' approach to the digital by attending to situated knowledges, gendered labor, and emotional, intersectional, multi-species relations.

### KEYWORDS

Agrarian technologies;  
critical agrarian studies;  
digital technologies; feminist  
political ecology

## Introduction

The farm is going digital. From satellite soil analyses to farmer advice apps and automated milking systems (AMS), new technologies are inundating agricultural systems. At a time when a growing number of farmers make more money from social media posting and simulated farming games than from growing physical food (GIANTS Software 2021), we need to update how we approach an old question in agrarian studies about the relationships between technology and agriculture, often framed in terms of debates over capitalism (Kautsky 1899/1988; Rigg 1998). This work has begun. For example, Kelly Bronson and Phoebe Sengers (2022, 15) use a Science and Technology Studies (STS) approach to interrogate the contractual and data-sharing relationships between major agribusiness corporations as they 'become data powerhouses', while scholars such as Michael Carolan (2022) and Sarah Rotz and colleagues (2019a, 2019b) analyze labor shifts that accompany automation on farms.

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The resurgence of techno-solutionist rhetoric, along with changes in the speed, scope, and capacities of the digital technologies themselves, brings new objects into old tensions over place-based power and gendered knowledge. New technologies can not only strengthen corporate capture, but also herald a new sort of farmer, with skills more akin to online dating than to plowing or planting. For example, Andrew Ofstehage (2018) notes that when transnational soy farmers in Brazil begin working with new machinery and social media, the transformation of both farm management and farming masculinities ensues. Such work suggests new lines of inquiry for scholars of agri-tech, exploring not only gendered identities but also issues such as situated knowledges, social reproduction, embodiment, and multi-species relations.

A vibrant tradition in Feminist Political Ecology (FPE) engages with exactly such concerns (Elmhirst 2011; Rocheleau 2011; Harcourt and Nelson 2015). As Farhana Sultana (2021, 161) writes:

FPE is overarchingly about feminist ethos - not a single focus on women or gender or a fixed set of ideas, but contextual understandings of histories, spaces, places, and socio-ecologies. FPE is about the everyday, emotional, embodied understandings of nature-society dialectics and politics. It interrogates power assemblages, undertakes multi-scalar analyses from the body to the planet, investigates counter-topographies of connections across spaces, scales, places, and species, and is explicit about its praxis.

FPE committed from its founding to interrogate the shifting power relationships between technology, environment and people (Rocheleau et al. 1996). More recently, the subfield has turned towards digital natures, using feminist approaches to understand how new technologies might mediate and produce socio-environmental relations at multiple scales (Nelson, Hawkins, and Govia 2022). In conversation with other contributors to this *JPS* special forum on *FPE in Conversation with Critical Agrarian Studies*, we bring an explicitly feminist lens to the proliferation of digital agriculture, arguing that FPE insights can inform critical study of agri-tech by offering concepts and approaches that help us to know the digital differently.

To do so, we draw on distinct cases of digital agriculture in geographically heterogeneous sites that resonate with FPE themes and emerge from our own experiences as researchers and individuals. Melf-Hinrich (Melf) lived his first 25 years on small family farms in the northwest of Germany and remains in close contact with the farming community there, because his brother took over the family farm. He is a social researcher at Agroscope with a focus on social sustainability and digital innovations in agriculture and agricultural policy. Uncertainties, bold promises, and the downsides of digital technologies leave him with an ambiguous view on these technologies, while he considers social implications under-explored. He is a core contributor to the remote sensing case. Hilary is a feminist political ecologist who grew up in the northeastern US and is currently based at the University of Montana. She has spent the last decade in Southeast Asia, studying and working alongside smallholder farmers and gender and land rights activists, and became curious about how digitalization was impacting their lives and livelihoods when Myanmar's military privatized communications, bringing millions of people in the agrarian nation online for the first time.<sup>1</sup> She is a core contributor to the agricultural

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<sup>1</sup>Hilary Faxon's research in Myanmar was approved by the Cornell University Institutional Review Board (Protocol # 1611006759R001).

advice app case. Ingrid is a feminist political ecologist based at the University of Vermont in the United States. She spent many of her pre-teen and teenage years with her younger siblings as active members of their 4-H Club<sup>2</sup> in eastern New York State where they raised Jersey cows, Border Leicester sheep and chickens and participated in making cheese and fruit preserves, canning vegetables and maple sugaring. Currently, her research examines how digital technologies and environmental expertise shape 'green' interventions in Mozambique and the United States and in virtual spaces. She is a core contributor to the automatic milking systems (AMS) case. Our positionalities, as well as our research experiences in Europe, North America, Africa, and Asia, inform our perspectives on individual cases. Through our conversations and collaborative writing process, we identify the resonances between the cases, tracing some of the insights that FPE concerns and approaches offer in order to understand agri-tech.

In this paper, we suggest that key analytics from FPE create opportunities to know technology differently. We propose a feminist political ecology of agrarian technologies, bringing FPE insights to bear on the new technologies proliferating across farmers' fields by highlighting situated knowledges, gendered labor and emotional intersectional and interspecies relations. While these are not the only FPE approaches that might be useful for exploring digital agriculture, they illustrate avenues of investigation that help us to de-spectacularize the digital and, in doing so, attend to the everyday and intimate ways that technology is transforming the expertise, social relations, and embodied practices of agrarian life. Such inquiries and interventions are particularly important at a time when technologies – from genetic engineering to smartphone app extension services – are changing rapidly and are heralded (again) as solutions for feeding the world.

In what follows, we turn to recent critical work on digital technologies within agrarian studies before providing a genealogy of studying technology within FPE. From these two literatures, we identify key concepts for knowing the digital differently. Next, we apply FPE approaches to three cases drawn from our disparate field sites: satellite-based remote sensing, agricultural advice apps, and automated milking systems. While the geographies, ecologies, and tools vary, all are updates of old technologies, repackaged as spectacular solutions to longstanding problems of agricultural production. Our goal is neither a completed framework nor comprehensive case analysis. Rather, our analyses and subsequent discussion aim to provoke renewed and reimagined forms of attention to these technologies as well as dialogue among scholars working in feminist political ecology and agrarian studies.

### Critical studies of agri-tech

An emergent literature on digital technologies within agrarian studies challenges notions of development through technology with a critical appraisal of the winners and losers of digitalization. While mainstream development actors have celebrated digital innovation – a recent FAO report, for example, declared: 'The next agricultural revolution ... without a doubt, will be digital' (Trendov, Varas, and Zeng 2019, 1) – the critical social science of digital agriculture highlights the potential for innovations such as sensor-enabled tractors

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<sup>2</sup>Nationally, 4-H is the youth development program of the Cooperative Extension System and United States Department of Agriculture.

or spray-drones to concentrate capital and disempower, or redefine, farmers. Much work on digital agriculture arrives at similar conclusions to Wolf and Buttel's (1996) article on the political economy of precision farming, which argues that the then-new technologies such as Geographical Information Systems (GIS) would likely result in the concentration of power and capital in the agricultural industry. The big players in the digitalization of the agri-food sector today include not only established farm input and equipment companies such as Bayer, Monsanto and Deere & Company, but also major tech corporations (Birner, Daum, and Pray 2021). However, instead of transforming the sector, increased participation by tech corporations like Amazon, Microsoft and Alibaba would shore up existing patterns in the political economy of agriculture: 'There is very little to indicate that digitalization will bring about profound changes in the dominant model of food production ... . The opposition between small-scale agro-ecological farming and large-scale industrial farming will be fortified by digitalization' (Prause, Hackfort, and Lindgren 2021, 651).

Recent calls to examine the proliferation of computers in many different aspects of farming highlight the arrival of new actors, forms of knowledge, and techniques of production, as well as the reshaping of relationships between farmers, scientists and corporations (Bronson and Knezevic 2016; Wolfert et al. 2017). These concerns with power, ownership and supply chains dominate much of the literature, though scholars have also examined the impacts of new digital technologies on agricultural knowledge, identities, and work (Klerkx, Jakku, and Labarthe 2019; Carolan 2020a, 2020b, 2022, 2023). The promise of digital technology to deliver accuracy and precision, for example, typically hides policy commitments to industrialized farming and its environmental impacts, whilst policy actors try to arrange favorable conditions for realizing these promises (Kuch, Kearnes, and Gulson 2020). A growing number of articles engage directly with analyses of platform capitalism or algorithms (see for example Miles 2019 and Bronson and Sengers 2022). Others highlight concerns around trust and data privacy (Jakku et al. 2019; van der Burg, Bogaardt, and Wolfert 2019; Wiseman et al. 2019). Alistair Fraser (2019) compares the farm data grab and the global land grab. Duncan and colleagues (2022) extend this point in a study detailing new modes of land governance based on digital surveillance. The digital surveillance of agriculture raises questions about peasant autonomy, because it transforms traditional farm decision-making from socialized rural practices to individualized responses to 'big others' as Stone (2022, 4) suggests, drawing from Zuboff (2019).

Beyond such concerns, agricultural digitalization can have both desirable and undesirable aspects (Lioutas, Charatsari, and De Rosa 2021). There is room for optimism: Digitalization could shape more effective and sustainable agricultural policy (Ehlers, Huber, and Finger 2021; Ehlers et al. 2022) or lead to more sustainable practices (Dong et al. 2019; Lioutas and Charatsari 2020). Digitalization changes agricultural knowledge and innovation systems, through creating new demands, relations, and tensions and also by providing possibilities for new kinds of learning (Ingram and Maye 2020). Scholars have advanced new principles for empowering participation in technological development for agriculture (van der Burg, Bogaardt, and Wolfert 2019; Rose et al. 2021) and food sovereignty (Fraser 2020).

This kind of work is vibrant now: Two special journal issues published as this article was under review focused on the multiple, mundane trajectories of everyday digitalization (Forney, Dwiartama, and Bentia 2023) and brought together critical agri-food studies and Science and Technology Studies (STS) (Gugganig et al. 2023), probing, for example,

the relationships between data and financial assetization (Sippel 2023) and robots and different forms of expertise (Legun, Burch, and Klerkx 2023). However, the growing critical engagement with digital technologies within agrarian studies rarely centers feminist perspectives. There are, of course, exceptions. Feminist approaches have been used to explore the involvement of digital technology in producing rural masculinities and intimate care for farm animals or gendered divisions of digital labor and expertise in farm households (Brandth 1995; Bear and Holloway 2015; Marshall 2021). The limited engagement with feminist approaches risks obscuring the gendered terrain upon which agrarian change takes place (Hart 1991) and risks failure to analyze connections between land and social reproduction (Shattuck et al. 2023). Such studies can benefit also from feminist attention to sensory, relational ways of knowing the land. Changes in labor demands are an important outcome of the arrival of autonomous farm equipment, yet so is the loss of the farmer's smell of the soil (Marinoudi et al. 2019), changing relations with farm animals and plants, and embodied experiences of farming. Below, we suggest that FPE can shape this growing subfield through new lines of inquiry.

### Tech genealogies in FPE

Feminist Political Ecology offers perspectives on the power relations and differential labor, identities and experiences of both technology and farming in heterogeneous geographical contexts. However, FPE is not a narrow or singular set of theory and methods. In 1996, the first co-edited volume declaring FPE as a coherent area of scholar-activist work was published (Rocheleau et al. 1996). The editors and contributors proposed four areas of focus, including a foundational commitment to engage technology, environmental relations, and equitable global development. In their account, FPE:

- (1) 'recognizes the interconnectedness of all life and the relevance of power relations – including gender relations – in decision-making about the environment' (296) ...
- (2) ... 'question[s] the presumption of a victory of technology over nature, thereby offering a critique of the technology-driven mainstream trajectory of development in most national politics ... These communities – and these authors – are examining the tradeoffs as societies opt for ever more complex, sophisticated ways of negotiating industrial and post-industrial life' (296–297).
- (3) '[examines how] Ideologies – particularly those formulated within a patriarchal mode – create gendered access to information, knowledge, resources, and the technologies for improving livelihoods' (297) ...
- (4) and 'question[s] the socially determined modes of specialization ... raising concerns about both the customary and newly imported ways of organizing economic production, access to resources, and environmental management' (299).

Through this attention to relationality, the non-deterministic possibilities of technology, and the power of ideology and social organization, FPE scholars and activists continue to question narratives of steady technological progress. Broadly, they ask, 'For whom and how do such technologies shape everyday, embodied lives, labor and more-than-human relations in both predictable and unexpected ways in the context of environmental problems and interventions?' Other fields grapple with aspects of this

question separately, while FPE is notable for its emphasis on the intersection of all of these (see Harcourt et al. 2023).

FPE encapsulates a multitude of approaches that share a common commitment to feminist praxis and attending to difference and marginality in nature-society relations. There is also a willingness to accept tensions, be they fruitful or grinding. At the time of the first FPE volume, an entrenched debate among feminists concerned the use of 'strategic essentialism'(s) (Spivak 1988) and ecofeminist perspectives to claim women are natural environmental defenders against technoscientific development interventions including industrialized agriculture (see Shiva 1989; Mies and Shiva 1993). In contrast, feminist critics of dominant science and technology paradigms asked how and why gender, technology and various natures were entangled and the possibilities of a transgressive, cyborg politics that refuses both technophobia and technophilia (Harding 1986, 1991; Haraway 1989, 1990). These tensions about so-called cyborgs, monsters and goddesses also reflected disagreements among what were at the time called 'First-World and 'Third-World' feminist perspectives in the context of pervasive 'sustainable development' discourses.<sup>3</sup> The initial FPE volume proposed to make space for these and other tensions within and between 'both essentialist and social constructivist rationales for the link between women and nature' (ecofeminism), 'feminist environmentalism,' 'feminist and poststructuralist critiques of science' and 'feminist alternatives for sustainable development,' without claiming to have resolved these tensions (Rocheleau et al. 1996, 296).

Over the last decade, FPE work has embraced questions of intersectional identity and interspecies relations while remaining committed to understanding and addressing access and exclusion in particular places (Sundberg 2004; Elmhirst 2011; Hawkins et al. 2011; Mollett and Faria 2013; Nyantakyi-Frimpong 2019; Caretta and Zaragocin 2020; Doubleday 2020). In a recent review, Sultana (2021) traces the expansion of feminist and decolonial work in political ecology, tracing the intellectual contributions and ongoing changes within FPE. While certain core contributions, including a focus on the everyday, the embodied, and the intersectional, have increasingly been incorporated into mainstream PE, FPE continues to break new intellectual ground. New scholarship extends to a broader selection of sites, social movements and methods of analysis, and it continues to welcome and 'trouble' new – at least among FPE circles – concepts such as care, degrowth and queer ecologies (Harcourt and Nelson 2015; Bauhardt and Harcourt 2019). The field remains a 'big tent' with enduring and new epistemological tensions, and embracing multiple methods and activist work (see Richardson-Ngwenya and Nightingale 2019 and many examples in Harcourt et al. 2022 and Harcourt et al. 2023). Yet while feminist political ecologists have remained committed to examining gender and, increasingly generational politics and knowledge, on agrarian landscapes (Chung 2017; Park and White 2017; Schoenberger and Beban 2018), they have more recently engaged less with questions posed by technology.

Some FPE scholarship has gone digital on topics beyond and intersecting with agriculture. For example, Nelson (2016a) examined the expansion of geospatial technologies and digital video recording services as troubling strategies for fixing messy kin relations

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<sup>3</sup>See Alaimo 1994, Lykke and Braidotti 1996 and Lykke 1997, as well as an intervention by Leach 2007 and a response by Moore 2008.

spatially and temporally in woodland peasant farming contexts amidst commercial land acquisition and illegal logging pressures in Mozambique. Recent studies have used an FPE lens to examine women's access to and exclusion from solar energy technologies in Mexico and the US (Buechler et al. 2020). FPE scholars have also engaged the proliferation of social media platforms as: (i) co-constitutive of conservation interventions and human-animal relations (Hawkins and Silver 2017; Nelson 2017a), and (ii) a key forum for land politics in the context of agrarian change in Myanmar (Faxon 2022; Faxon et al. 2023). Others explored self-tracking apps for intimate embodied knowing with menstrual cycles and fertility (Gaybor 2022), examined the role of vlogs in intersectional knowledge-sharing in the context of rare pregnancy-related illness (Iengo, Kotsila, and Nelson 2023), and posed anti-colonial questions of scalability and embodiment in digital outer space natures in popular digital games (Tait and Nelson 2021). These studies highlight wide-ranging possibilities for re-engaging FPE in a digital age (see Nelson, Hawkins, and Govia 2022). FPE raises key questions about methods, ethics, scale, embodiment, emotion, subjectivity, and intimacy that can help to redefine and understand digital agricultural technologies from the spectacular to the mundane. The sustained commitment of FPE to activist practice, dialogue across difference, and creating more equitable worlds can also inform diverse and rooted political engagements with these technologies.

### Knowing tech differently with FPE

To illustrate how an FPE lens helps shed new light on digital technology in agriculture, we explore three technologies – satellite-based remote sensing, agricultural advice apps, and automatic milking systems (AMS) – that operate at different scales. Drawn from our separate research and lived experiences, the cases cover a breadth of geographies, moving from German fields to Myanmar villages to New England barns. They illustrate, to various extents and in overlapping ways, the following themes: situated knowledges, gendered labor (including social reproduction), and emotional experiences of human-animal relations. Satellite-based remote sensing entails the monitoring of farming landscapes and activities at increasing detail from space and is increasingly used by governments and private companies worldwide. Yet, as Melf explores, the use of satellite images can not only produce disembodied knowledge, but also deepen intimate awareness of the farm, such as when he and his brother exchange on-the-ground and from-the-sky observations. Hilary's focus on social reproduction and gendered labor sheds new light on the unpopularity of production-focused agricultural advice apps in Myanmar, and invites analysis of the proliferation of photos, videos, essays, and poems celebrating, complaining about, and sustaining agrarian life on social media. Automated milking systems reconfigure core activities, labor organization and human-animal relationships on dairy farms. They yield big data for use at scales beyond individual farms, but they also evoke particular memories of Ingrid's childhood spent in youth industrial agricultural training clubs and events on similar landscapes.

Our research and writing practice is also indebted to FPE, which emphasizes the positionality of the researcher, starting from the premise that our own embodied relations shape the ways we know the world (Harcourt et al. 2023). FPE also experiments with and embraces heterogeneity of epistemologies, methods, and ways of communicating its co-produced knowledge (Harcourt et al. 2022). Rather than demand a fixed narrative



structure with a removed and singular authorial voice, FPE encourages diverse voices and new collaborations, including in the form of art exhibits, place-based events, blogs, and plays (WEGO 2022; Harcourt et al. 2023), as well as pausing to reflect and connect across generations of scholars. Our collaboration on this article reflects this ethos. As a member of the Well-being, Ecology, Gender and cOmmunity Innovative Training Network (WEGO-ITN)<sup>4</sup> with awareness of this special forum in JPS on FPE and critical agrarian studies, Ingrid noted the lack of focus on digital technologies in early forum discussions and in the broader scope of WEGO. She reached out to Hilary and Melf based on their research expertise and different sites and contexts of analyses to collaborate. Our heterogeneous training and writing approaches come through in our collective work, including auto-methods such as auto-biographical writing and shifting focus to our different voices across our writing (see Moss and Besio 2019 on the nuances and importance of feminist auto-methods, and Hawkins and Nelson 2022). We understand these heterogeneous interventions as providing greater nuance and depth to analyses of digital technologies in agriculture, as well as new collaborative pathways for engaging critically across typical disciplinary silos.

Together, these cases illustrate some of the ways digital technologies shape distinct agrarian socio-ecological settings. Approaching them from our own positions, through collaboration and with FPE themes helps us to understand how particular digital technologies play specific roles in shifting and rooted social relations, forms of knowledge, and work. We treat situated knowledges, gendered labor, and emotional relations not as static heuristics, but as concepts-in-the-making, providing examples of the kinds of inquiry that can challenge both agrarian studies and FPE to know technology differently.

### ***Remote sensing from somewhere: satellite imagery and situated knowledges***

Feminist approaches to embodied knowledge and intimacy of relations are prominent in the case of remote sensing.<sup>5</sup> In the 1980s, satellite-based remote sensing became the leading approach to track land cover changes at a large scale (Dong et al. 2019). There was already a satellite image in my grandma's kitchen in which, as a boy, I (Melf) could identify some of our family's fields as small dots in the north-west of Germany. But back then, it was just a picture without purpose to me. This changed around 2018, when I took up research in Switzerland on digitalization of agricultural policy and precision farming, focusing on the more capital-intensive farming systems typical for Europe. I became aware that concerted efforts greatly expanded the capabilities of satellite-based remote sensing to monitor agriculture, facilitated by open data initiatives, new satellites, computing infrastructure and analytics, and involving public and private sector investment (Whitcraft et al. 2019; Nost and Goldstein 2022).

The sites of my engagement with the topic included the universities and public research centers where I worked, the offices of the Swiss government that funded one of the projects, my brother's farm in north-west Germany and academic and professional

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<sup>4</sup>See the introduction to this special forum for more information.

<sup>5</sup>The following focuses on remote sensing based on satellites only, thus not considering airborne remote sensing such as the use of planes and drones, which has different characteristics such as less frequent flights, more targeted surveillance, flights closer to the surface being subjected to airspace regulation and delivering higher resolution images at various wavelengths (see e.g. Frankelius et al 2019; Pauschinger and Klausner 2020; Rejeb et al. 2022; Lowenberg-DeBoer et al. 2022).

workshops and conferences with local and international participants. At that time, technological enthusiasm (Kerschner and Ehlers 2016) dominated official documents. According to the Food and Agriculture Organization of the United Nations (FAO), 'Over the past 20 years the geographic information system (GIS), remote sensors and other new tools have moved farming ever further into a technological wonderland' (FAO 2018, 35). However, I realized that methods of data retrieval, exploration, and application of remote sensing in farming contexts are diverse and far from perfect, as they involve smoothing and gap-filling (Weiss, Jacob, and Duveiller 2020). In the interdisciplinary projects and conferences where I participated, researchers were keen to work on improving remote sensing applications for agriculture to ensure that they deliver their promises of increasing efficiency and mitigating the environmental impacts of farming, while farmers generally appeared less convinced. I saw that compared to the traditional approach of farmers documenting their inputs, outputs and practice, satellite-based remote sensing effectively enables the extraction of farm data without direct contact and permission from farmers. While buzzing drones provoke notice, satellites operate without our awareness, pulling the quintessential 'god's eye trick' (Haraway 1988). They provide an overhead view uprooted from life on the ground, including gendered everyday livelihoods, emotions, and other kinds of knowledge (Rocheleau 1995; Litfin 1997; Kwan 2002). Data are 'grabbed' (Fraser 2019) from farms at increasing resolution and frequency of observation. Experts in research organizations, public agencies and private firms process the data into spatially explicit indicators, such as land use, farming practices, soil, and vegetation attributes. The data processing is automated to a great extent and does not involve farmers, unless farmers manipulate the satellite data themselves or help in ground-truthing the indicators by providing access to sites or sending their own farm data and images to the remote sensing data processors (see Devos et al. 2018 for an agricultural policy application). Indeed, I observed scientists discussing technicalities and indicator accuracy at conferences and in projects, while much of the data appeared to be used by those other than farmers. I found it difficult to find my position between remote sensing professionals who embody technological expertise and promote their agency, and farmers who become mere objects for generation of disembodied knowledge and execution of external commands (see Hausermann and Adomako 2022). However, as I continued my engagements, I found more varied social relations, nuances, and ambiguities in satellite-based remote sensing in farming.

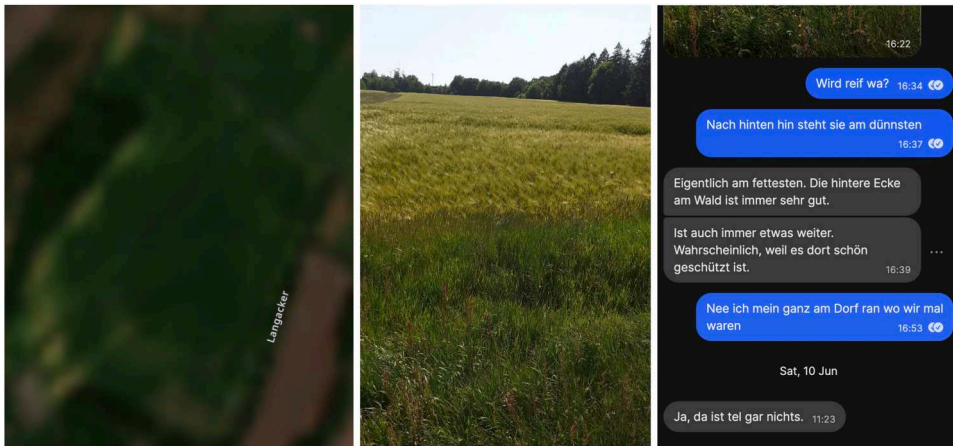
The issue of privacy was a multifaceted concern raised in my own research on digitalization with farmers and other stakeholders and in my personal network. Slonecker and colleagues (1998) noted several years ago that higher resolution remote sensing could infringe upon basic privacy rights. Privacy connects to the concept of the autonomous farmer, who has agency to farm according to her own experiences and liking (Forney and Epiney 2022). It implies that farmers feel uneasy as new possibilities of embodiment of themselves and their farms emerge with satellite scans and external interpretations (Murphy 2017). Critical researchers and practitioners in my surroundings feared that surveillance of farms via remote sensing leads to a new style of farming lifted out of local and social context, knowledge, and practice. A stronger reliance on and relations with a technological system that draws on very selective data and algorithms over relations with fellow farmers, extension services and the land farmed erodes the social fabric and knowledge of farming communities, especially when absentee landowners use these

technologies to farm the land via farmers who merely execute algorithm-based decisions (Duncan et al. 2022; Stone 2022). Personally, I found that more intimate scouting of fields and discussing crops together with fellow farmers, as I experienced it on our own and other farms, does not actually fit this system that challenges established notions of privacy and involves satellite-based remote sensing as an obscure other. However, more ambiguous relations emerged that can both deprive and empower the persons involved.

In my research I observed that monitoring eligibility for subsidies and compliance with agri-environmental policy with remote sensing technology changes social relations (Ehlers, Huber, and Finger 2021; De Leeuw et al. 2010; EU Court of Auditors 2020). It makes agricultural remote sensing political at multiple dimensions, similar to Gabrys and colleagues' (2022) analysis of digital forest technologies. Closer, more frequent and unannounced monitoring implies less leeway for farmers to adapt to personal and local circumstances. Consequently, they become incentivized to perform farming according to what policy prescribes or rewards, based on the monitoring capabilities of remote sensing, rather than based on (arguably) more flexible self-reporting and infrequent on-the-spot controls of public authorities that allow clarification on site (Ehlers, Huber, and Finger 2021). When remote sensing data on farms is in the public domain, it increases their transparency and can put social pressure on farmers.

New relations also emerge, when citizens are invited to provide street-level photographs for ground-truthing remote sensing-based policy compliance monitoring (D'Andrimont, Lemoine, and van der Velde 2018). I observed farming practices via the freely accessible Sentinel satellite hub that are subject to regulation and social concern, such as manure application. Farmers interpreted my observations as privacy infringement and feared incorrect interpretation by persons with whom they lack trusting relations. Indeed, satellite images can be powerful in policymaking when visualizing large-scale environmental problems, while they brush aside local relations and situated knowledge about problems and solutions (Rajão 2013) and trigger a 'culture of compliance' among farmers (Bretreger et al. 2021). As remote sensing moves into the social world of agricultural governance, it drives new wedges of disembodied knowledge into relations of farmers with other persons, including advisors, various authorities, citizens, and merchants that were formerly more intimate. It also entails more obscure relations with those making remote sensing technology workable.

But there are also instances of empowerment through new intimate relations that emerge through satellite-based remote sensing. I found that the effects of satellite imagery on the embodiment of knowledge and intimacy of relations between land, crops and persons depend on the situations and relationships of the persons involved. For example, I relate now more intimately again with the land where my brother operates the family farm about twelve hours away from where I live, as I provide him with updates of satellite images of his fields, including normal photographs and specific indices such as the Normalised Difference Vegetation Index (NDVI). We often discuss reasons for the remote observations and possible farming problems arising (see the image on the left in [Figure 1](#): Sentinel-2 satellite L2A true color photograph of barley field [accessed with Sentinel Hub EO Browser, 8 June 2023]). As a response, my brother scouts the specific sites of concern, sends me pictures of the sites or asks me for more recent satellite images (see [Figure 1](#) center image: Photograph of the same barley field, taken from



**Figure 1.** Barley field satellite image (left), photograph (center), and Signal conversation (right).

the North-East on 9 June 2023). Because this situation is based on pre-existing knowledge and relationships that support trust, openness, and confidentiality, it increases intimacy between the satellite images, the land, the farmer and the researcher/brother (see Figure 1 right image: an excerpt of our conversation about the field on Signal messenger app with translation).<sup>6</sup>

Often the satellite-based prescription maps offered by agricultural input and equipment companies and startups did not appear sensible to me and my brother. However, some online interfaces allow farmers to alter the maps based on their own knowledge. My brother and I altered fertilizer prescription maps, for example, to better reflect histories, crop, and soil conditions of specific sites. These interfaces invite farmers to feed data back for free and companies use their technologies to re-interpret the data and consequently the situated knowledge farmers and their farms use (Kuch, Kearnes, and Gulson 2020; Bronson and Sengers 2022). However, it is a limited option for farmers to make their stories count (Rocheleau 1995). Gaps in the data provided are silenced if farmers cannot connect the dots of remote sensing in their situated field knowledge (Nightingale 2003) and if they cannot communicate directly with the persons who process the remote sensing data. The lack of space for intimate relations needed to build mutual understanding among farmers and experts implies that the development of remote sensing technology for agriculture and the knowledge embodied cannot be scrutinized by its users (Arvor et al. 2019; Braun 2021). However, my brother and I typically reflect on the altered prescription maps again as new images and site visits come in. Even on the ground we cannot see everything.

While critiques of remote sensing are common in critical studies of digital agriculture, FPE facilitates new investigations of the ambiguities and tensions of satellite-based remote sensing. When we broaden our view to include the mundane everyday practices of sourcing and interpreting data, we can uncover limits and dynamics of both on-the-

<sup>6</sup>Translation: Me: It's (the barley) ripening, ey? Towards the back it is standing thinnest. Brother: Actually thickest. The corner in the back next to the forest is always good. It is also always a little more advanced. Possibly, because there is nice shelter. Me: No, I mean just next to the village, where we have been once. Brother: Yes, there is nothing (no barley crop) in parts.

ground and remote ways of knowing the farm, as well as the embodied and intimate relations that can be sustained through the exchange of remote information about familiar places.

### ***Beyond yields: reproducing gendered agrarian communities on Myanmar's mobile internet***

Agricultural advice apps proliferated around Myanmar during the short-lived quasi-democracy of the 2010s, when I (Hilary) worked with local activists and conducted dissertation fieldwork. On platforms like Green Way (2023), users could access information about soil and water management, sign up for weather alerts, download rice planting manuals, check daily crop prices by city, or post questions about pests and disease. Many of these apps were framed explicitly as vehicles for modernization: 'Agriculture old-fashioned? We are making it sexy!' one advertisement declared. This vision of the future was often tied up with corporate gain, for example in apps like Htwet Toe (2023) ('higher-yield'), affiliated with Myanmar's largest agrochemical company, sometimes bringing together the private sector with the international development community, such as with Site Pyo ('cultivation'), launched by the Qatari telecoms firm Ooredoo with funding from UK aid (GSMA 2017). By 2020, at least a half-dozen apps provided information and linked farmers to markets for inputs and products.

Like the remote sensing technologies explored above, these apps aimed to improve agricultural productivity and sustainability through targeted information. But unlike technologies employed in Switzerland and Germany, such interventions took place within a longer history of underdevelopment, consistent with other interventions that roll out 'smart farming' in the Global South (Fairbairn and Kish 2022). The apps promised to turn Myanmar's impoverished rural residents into modern, sustainable customers and suppliers, even as they depended on new telecommunications infrastructures and older relationships of agricultural capital and expertise (Faxon and Kintzi 2022). Notably, they also held the potential to shift gendered subjectivities and alter how farmers related to their fields, and to each other. The images and content, as well as the perspectives of their designers, proposed a particular vision of the modern Myanmar farmer. This was not only, often, a male farmer, but one tied to global markets and capable of empowerment through information.

For the young entrepreneurs and designers with whom I spoke in big cities, the apps offered an exciting way to reimagine agriculture and to contribute to Myanmar's so-called democratic transition. In rural areas, however, the apps were not popular. One 2018 survey found 21% of farmers in the study site in central Myanmar used agricultural mobile apps, though more than half opened the app only once a month (Thar et al. 2021). Perhaps more strikingly, the study found that use was more common among younger and more educated farmers, hinting at class and generational differences.

While the tale of agricultural modernization initiatives that sound sexy in the city falling flat in the countryside might be familiar to CAS, it was only over time that I began to see the gendered and social reproductive dimensions of this story. In 2017, I participated in a two-day conference in Myanmar's capital city focused on digital solutions. In an ornate hotel ballroom filled with business people, development professionals and entrepreneurial elites, we listened to roundtables on e-commerce, IP law (or lack thereof), and mobile

money. On the second day, I chaired a panel on digital solutions for marginalized populations. A representative from a social enterprise working to deliver agricultural advice explained a key difference in working with rural people. In the city, the phone is a private possession, she said. But in the countryside it is a collective household good, she explained. Children often held onto the physical phone and lent it out to older family members, and people switched SIM cards and numbers frequently, making it difficult to target users, she said. In my own travels in the countryside, I observed that young men were often put in charge of apps, just as they commanded the household's tractors and other agricultural machines. The social enterprise designer went on to confide that farmers had hated the company's pilot app, with its massive amounts of, often irrelevant, information. Her team had discontinued their app in favor of SMS text messages based on a decision tree when it became clear that the vast quantity of information was poorly suited to individual farmers' specific needs. Attempts at offering more information or automated targeting fell apart not only because data costs were prohibitive, but also because the family relations of farming, decision-making, and phone use in rural households did not map onto urban assumptions about individual behavior.

In the remote agrarian communities where I conducted ethnographic fieldwork, the almost total lack of adoption of agricultural apps was striking. Most villagers had gotten their first smartphones after telecommunications privatization drove down the price of SIM cards and data in 2014, but over the five years that followed, almost no one I met had heard of the apps being celebrated and promoted in the city. Instead, villagers used Facebook. Public and private groups devoted to farming featuring planting and pest management advice, tractor rentals, and seed selling. Live videos of combine harvesters and watermelon trading on the Chinese border proliferated. While the use of social media in farming was not necessarily all positive – content can be highly commercialized, and rumors, extreme speech and incitements to violence, and pornography circulate freely – these platforms provided an alternative space for learning about agriculture, one that moved beyond markets and filled a notable gap in government agricultural extension to consider the broader social and political qualities of agrarian life (Faxon 2023).

The paucity of apps and popularity of Facebook in rural areas is partially explained by centering agrarian social reproduction. While agricultural apps promise improved cultivation, marketing, and trading based on digital information, the focus on production failed to entice smallholders. Some apps included features where farmers could chat with extension agents, but these exchanges were brief and clinical. In contrast, a large amount of the content in public Facebook groups devoted to farming were personal accounts of the achievements and struggles of agrarian life. Essays complained about the government's lack of support for small farmers, poems expressed the beauty of the landscape, and colorful photos of verdant crops were captioned with pride and met with congratulations. Widely commented upon, these memoiristic posts served to cultivate a collective farming identity. Celebrations of life on the land flourished alongside planting tips on farmers' Facebook groups; there was no space for this type of exchange on apps focused on sustainable practices or higher yields.

For communities with high rates of migration, Facebook played a particularly important role (see also Faxon 2022). In the more intimate spaces of private groups and direct messages, families and villages kept in touch and forged new ties. On closed

village Facebook groups, farmers posted announcements of births and deaths, photographs of funerals, and live streamed church services and festivals for community members working abroad. One former domestic worker told me that she had met her fiancé, a pastor from a neighboring village, on Facebook while working in Macau; they planned to marry soon and settle down in the countryside. Farmers used Facebook not only to buy seeds and learn planting techniques, but also to fundraise for community development, mobilize for land justice, and even meet a mate.

While expanding the online domain of agriculture, this type of social media use often reinforced the traditional gendered division of labor in rural areas. For example, I interviewed several young women who used social media to search sewing patterns for home tailoring businesses. Meanwhile, their husbands, fathers and brothers gathered around phones to view videos of tractors and combine harvesters. While agricultural machinery shops often employed pretty girls to pose with large machines in professionally produced promotion videos, the farming Facebook groups I followed also featured amateur videos of girls in skirts driving tractors in circles or into the mud, accompanied with sexist jokes. Both marketing and mockery served to reinforce machinery as a male domain. Gendered divisions in agricultural knowledge were also reinforced by the role of ‘teachers’ who curated their own Facebook pages or commented across multiple popular groups on cultivation techniques. Like village heads and provincial officials, or even the colloquial use of the term ‘farmer’ (Faxon 2017), these online teachers were almost always men. Online patterns like these both reflected rural gender roles and reinforced them.

The arrival of the internet in rural Myanmar was intimately intertwined with the country’s attempted liberalization of the economy and modernization of agriculture. But adding a feminist lens can help us to understand how gendered norms and social reproductive functions shape the appropriation of the internet. Shahra Razavi’s (2009) important overview of feminist insights into agrarian political economy – the complexity of the rural household, the importance of social reproduction, and the power of gendered roles and relations amidst shifts such as mechanization and migration – provides a useful starting point for rethinking the scope and styles of agrarian life online. Beyond the failure of agricultural apps and the surprise of social media appropriation in Myanmar, farmers’ digital activities were extensions of existing strategies of social reproduction and, sometimes stereotypical, gender roles.

### ***Emotional experiences of shifting human-bovine relations in Vermont***

In August of 2013, I (Ingrid) joined a small group of new University of Vermont (UVM) faculty on a ‘Tour of Vermont’s Working Landscape’, led by UVM Extension. The rural Vermont landscapes with abundant sugar maple shacks and pungent dairy cow manure and silage were new to me, yet also viscerally familiar. I had raised Jersey cows, Border Leicester sheep and chickens about a four-hour drive due south in Columbia County, New York, when I was a teenager. I experienced simultaneous emotional nostalgia and surprise as my colleagues and I arrived at a Holstein farm where we encountered a Lely ‘Astronaut’ robotic milker or AMS. Our host combined narratives of grieving with a grounded techno-optimism. He explained how the tragedy of losing the barn and many cows to a fire also created an opportunity to rebuild the herd while installing

AMS and barn ventilation technologies. He praised how the AMS allowed him to pay more attention to individual cows (some favorites and others needing additional care) and to take a vacation by leaving a trusted family member in charge of the controls. We inspected the AMS and listened to him explain how the herd rapidly habituated with the machine, with cows entering the milking stall as they desired (an engorged udder is quite uncomfortable). We watched the AMS in action as it rejected a cow that the machine had identified as already having been recently milked. The equipment combines digital and robotic technologies to record output levels for each cow. The system interface design engages individual farmers as managers who make choices based on selected datasets produced by the robotic milker concerning last milking time or other information such as current treatment with antibiotics for mastitis (Bear and Holloway 2015).

Vendors of AMS technologies promise a more accurate interpretation of and care for lactating cows, and freedom for the autonomous farmer to escape the demands of the milking parlor; most dairy cows are milked by machine with migrant workers placing the equipment on and removing it from each cow's udder along with performing key sanitation tasks at least twice daily, on top of the requirements of feeding, watering, tending to injuries, barn sanitation, adequate movement, and sleep, a rhythm that ties farm workers physically and temporally to the farm. For example, the Dutch company Lely sells different models of their 'Astronaut' milking robot series with the following online pitch to US customers who find a white man in his gray farm hoodie and hat looking on at visitors to Lely's (2022) website:

Milking: More milk in the tank with less effort. Producing high-quality milk requires healthy and comfortable cows. Our solutions for automatic milking help you make the right choices for your herd and operation. All of our solutions can be used to achieve your specific goals, whether they are more efficient use of labor, better cow health or increased yields.

A bot on the site appears in the lower right corner and prompts: 'Are dairy robots right for you?'

I listened to the farmer's frank explanation of the challenges and successes his family experienced in implementing AMS on their small dairy farm and one of our university's top administrators' enthusiastic response concerning his new techno-vision for science, technology, engineering and mathematics (STEM) initiatives and our university's agricultural extension program. His bravado surrounding what was actually a tragic, hopeful, intimate and complicated story about loss and forming new intimate daily relations with cows and digital machines provoked many emotional memories for me. As we headed to a lunch break, my attention wandered to my memories of milking machine technology tensions before the arrival of AMS. My sister and I had won many dairy-related competitions in the 1990s during our time in 4-H, but we did so to the chagrin of several adult 4-H mentors, who viewed our family as outsiders amidst their promotion of dairy industry knowledge production and culture. While supportive of the youth with whom they worked, they disapproved of our small-scale family farming practices. Our parents embraced a different mix of technologies than others in the area, milking up to two family cows by hand and experimenting with making our own cheese. As a child, my father had supplemented his family's diet with milk from his family cow named Arabella in the 1950s. His nostalgia for a childhood spent milking and tending to his cow shaped



our many meaningful human-animal relations on our farm – from a rescued pigeon, to the turkeys and sheep my little sister insisted my parents never kill, all 8 of our named farm cats and at times more than 80 named chickens – all raised with few of the typical large farm technologies.

Yet we also ordered bull semen by catalog from companies such as Select Sires, based on myriad offspring production metrics to artificially inseminate our cows. Today, Select Sires sells bull semen with designations such as RobotPRO® for ‘sires that transmit the desired traits for robotic milking systems ... selected by focusing on components and milk yield, udder health, longevity and durability, as well as functional udder traits’ (Select Sires 2023a), and Elite Sexed Fertility™ for ‘sires that can help you achieve the highest sex-sorted semen conception rates, enhancing the return on your investment! This designation identifies gender SELECTED™ sires with above average conception performance ...’ (Select Sires 2023b). At the same time, beyond our tiny fields and milking stalls, some of my family members became relatively early adopters of dial-up internet services and digital games, as my older brother introduced the majority of computing technologies into our home and would eventually become a computer architecture scholar. Our curiosity about different ways of caring for our animals connected our local 4-H club trainings and farm connections with what we found in early search engines such as Yahoo! Search or America Online (AOL) chatrooms.

I remembered that despite our mixed approach to farming, we competed successfully in many local and national dairy events. In 1996, my sister won seventh place in the popular national Hoard’s Dairyman Cow Judging Contest (Hoard’s Dairyman 2023) and in 1997 we won second place in the family entry category, which involved judging and scoring a selection of dairy cows presented in a set of side-by-side photos of their full bodies and rear views of their udders and hips. My sister and I had also won several of the annual 4-H ‘Dairy Olympics’ events at the County Fair, which showcased different agricultural knowledge and practices expected of 4-H Dairy Club members. One year, the organizers of the event added a last-minute ‘milking parlor parts identification’ section to the competition to ‘level the playing field’. Our lack of milking machines at home left us guessing but winning nonetheless, as we had played and learned together with other kids in the milking parlors of the many farms that hosted our club’s activities. My relationship with milking machines is therefore emotionally-tied to my experiences of persistent disciplinary techniques of industrial agriculture youth training. My lack of milking machine relations were central to my experiences of inadequacy and discomfort while attempting to cultivate a ‘farmer’ subjectivity through technophilic agricultural extension youth programming. These memories reflect a largely analog farming context in the northeastern US in the 1990s within the continued promotion of a subsidized dairy market with industrial inputs, equipment, and large herd management practices. I only managed a deeper reflection and interrogation of 4-H culture and commercial dairy industry norms when I started reading early FPE literature, which inspired my enduring ambivalence and curiosity towards the myriad of environmental expert subjectivities cultivated and techno-scientific interventions deployed in ‘saving nature’ and transforming everyday places (Nelson 2016b, 2017b, 2021).

After lunch on the same new faculty tour, we witnessed another side of Vermont’s dairy industry that is often unseen in Lely AMS and Select Sires advertisements or in agritourist

brochures featuring red barns, white church steeples, and white maple sugarers and dairy farmers (see Vanderbeck 2006). Vermont's dairy industry relies upon precarious undocumented migrant labor (Radel, Schmook, and McCandless 2010; Mares 2018, 2019; Thompson 2021). We visited a much larger dairy farm that had invested in new equipment to capture and convert methane into electricity, and that had participated in a program to support the health needs of migrant farmworkers who were primarily from southern Mexico and Guatemala and who faced difficulties in accessing adequate health care services while living in on- or near-farm worker housing (UVM Extension 2023). Milking cows can be dangerous due to injury from cows kicking and from heavy equipment, frequent skin, eye or inhalation exposure to chemicals and other irritants, high stress from lack of sleep, social isolation and other problems (Keller, Gray, Harrison, 2017; Panikkar and Barrett 2021; Migrant Justice 2022; Sexsmith 2022).

The grassroots group, Migrant Justice, formed after 2009 'after young dairy worker José Obeth Santiz Cruz was pulled into a mechanized gutter scraper and was strangled to death by his own clothing' (Migrant Justice 2022). This movement works 'to secure these fundamental human rights to: (1) Dignified Work and Quality Housing; (2) Freedom of Movement and Access to Transportation; (3) Freedom from discrimination; (4) Access to Health Care' (Migrant Justice 2022). The group launched a 'Milk with Dignity' campaign, resulting in a signed agreement with Ben & Jerry's ice cream company in 2017 and sustained pressure on others such as Hannaford Supermarkets, that rely on dairy products produced by the approximately 1500 migrant dairy workers in the state (Thompson 2021; Migrant Justice 2022). The group leverages social media in their campaigns alongside in-person demonstrations for connecting with other justice movements in Vermont and beyond.

Thus, a day-long visit and set of conversations on dairy and other farms in Vermont highlighted changing farmer subjectivities amidst tragedy and AMS technologies within broader existing, racialized systems of work, care, and human-animal relations. Struggles over worker rights and digital technologies are happening simultaneously in Vermont. Rather than negating each other or one replacing the other, they complicate how we understand farming, identity, embodiment, and rural politics. The dairy farmer 'career' choice passed down through generations in the northeast is largely disappearing due to declining milk prices and competition with larger, consolidated farms reliant on more migrant labor than was ever present or mentioned in my 4-H Club trainings on smaller farms in the 1990s (although these farms were reliant on children and teens performing a range of tasks on the farm). Organic high-protein and high-fat dairy products are increasingly desired for earning higher profits, which are reliant on proliferating organic certification processes that require additional record keeping and inspections. In this context, AMS offers family dairy businesses more data and the promise of an occasional vacation. They can also allow smaller farms to avoid or shift their reliance on a migrant workforce amidst growing grassroots campaigns advocating for worker rights and racial justice. The introduction of technologies such as AMS requires spectacular sales pitches centered on the idea of a technologically-sophisticated, yet practical farmer who easily manages operations via touch screen (see Carolan 2023). FPE's attention to *combined* questions of subject formation, emotion, human-animal relations, and intersectionality can shift critical attention to the power relations obscured by such spectacular digital technology claims.

Those who farm have always experimented with different mixes of agricultural technologies, which have shifted some human-animal contact from hand to machine to AMS. Some technology ‘mixes’ are actively encouraged and trained into the farming youth in the US through 4-H and other extension programs, while other affective configurations, which are also problematic and contradictory in their own ways, are refused. These struggles over technologies are a key part of cultivating everyday emotional farming subjectivities, and of shifting human-animal-machine relations.<sup>7</sup> Increasingly *digital* technologies are a continuation of these kinds of struggles, and they invite further inquiry from FPE and other approaches.

## Discussion

Remotely sensing farmland from somewhere, mobile phone usage that reinforces both gendered division of labor and agrarian social reproduction, and shifting embodied relations in automated milking systems illustrate divergent and uneven digital practices in agriculture. We tell these agri-tech stories with a FPE lens, embedding them in our experiences and collaborative thinking. These stories invite new sorts of questions about technological development, refusal, adoption, appropriation and play as situated within a broader political economy and rooted relations. While satellites and milking machines are relatively old technologies, they have been newly automated and scaled; similarly, agricultural extension is a classic intervention newly digitalized and disseminated through gamified interfaces and mobile phones. Our questions are about the intersectional subjectivities, the interconnected scales at which they operate, gendered labor, and embodied, emotional knowledges created, displaced, and remade through the use of these technologies. Drawn from different locations, our cases resonate across several themes. For example, the erasure of social reproduction on mobile apps and satellite images and the introduction of AMS on dairy farms frame agriculture as a scientific process of production. These cases also provide instructive contrasts: for example, considering remote sensing and AMS moves us from a ‘god’s eye view’ (Haraway 1988) to human-animal intimacies, from the spectacular to the mundane made spectacular with ‘Astronauts’. We see other technologies that might benefit from our approach, including crop robots, digital fences, and the digitization of genetic information. Here, we aim not to be exhaustive, but rather to model thinking across interconnected scales, questioning shifts in embodied knowledges, and exploring new ways of writing collectively about agri-tech.

Both the locations of these interventions within particular agricultural systems and the specificities of the technologies themselves matter to the types of social, political, and ecological dynamics we see emerging. From the scientific institutes of Switzerland to the migrant labor on dairy farms of Vermont to the smallholder plots of Southeast Asia, technology takes place within existing global systems of capital, cultures, labor, ecologies, and expertise. Following agri-tech from its origins through its development and deployment can bring us to surprising places, connecting distinct regions and institutions in new

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<sup>7</sup>FPE scholars have long examined emotional subjectivities in subsistence livelihood contexts in forests and fisheries (see Gururani 2002; Nightingale 2011). Michael Carolan (2023) frames his recent analysis of emotion and affect in relation with digital technologies and farming through affective anticipatory politics of farming media.

or familiar ways. Tracing contour lines across seemingly disparate sites can help us to identify new empirical questions and build analytical frames and political movements capable of crossing the Global South and Global North (Katz 2001; Sidaway 2013; Koch 2015). As we think beyond remote sensing, apps and AMS towards other agrarian technologies, we highlight the need both to locate and to disaggregate digital agriculture whilst being open to unexpected engagements.

Doing so strengthens both Critical Agrarian Studies and Feminist Political Ecology. Continuing the longstanding cross-pollination between these critical traditions also provides opportunities to build a more vibrant community – one that includes scholars, but also practitioners, designers, programmers, and activists – to understand and innovate more equitable agrarian technologies. Our exploration here is intended to open pathways forward. In this spirit, we offer a set of questions to inspire and provoke future feminist political ecologies of digital agrarian technologies:

- How does technology operate at the scale of the field, the farm, the body? How does it rework the relations of people, animals, plants and places?
- Who builds and benefits from these technologies? In their design and deployment, whose knowledge counts?
- Whose labor is replaced, transformed or validated? More fundamentally, how is work itself, its physicality, temporalities, affective politics and social value, transformed?
- How do different and contested farmer subjectivities emerge through the adoption, alteration or rejection, of particular technologies?
- How do gender, race, class and other intersectional dimensions of difference shift the politics and material effects of new digital technologies in agriculture?
- How do similar technologies roll out differently in various agrarian settings? How are different technologies embraced, adapted or rejected within and across particular geographies?
- What methods for research and communication, including through collaborations with designers, agronomists, and activists, can we use to understand and re-purpose digital tools for a more equitable and sustainable agriculture?

## Conclusion

This article has begun to explore how the analytical tools of FPE enable thinking technology differently in agrarian studies. With its long tradition of problematizing the assumed relationships between technology, environment and modernity, FPE offers analytics and methodologies that can contribute to growing work on digital technologies within critical agrarian studies. Applying conceptual tools from the FPE repertoire such as situated knowledges, gendered and social reproductive labor, and affective embodiment enables new types of analysis, deepening existing conversations on production and expertise in digital agriculture. Awareness of and dialogue about our own distinct positionalities, training, and field experiences shape what we see and how we narrate. These foci bring us new stories of technological intervention in global agriculture, while clarifying the stakes of such inventions for agrarian relations and identities. By highlighting remote sensing, farming advice apps and AMS, we hope to inspire FPE

engagements with different types of technologies. We invite new approaches within a growing body of scholarship on technologies in agrarian studies, building on and complementing scholarship that draws on STS by suggesting that FPE, too, offers conceptual and methodological tools for engaging the rapidly changing world of agri-tech. An FPE approach that remains skeptical, creative, collaborative and committed to equity is essential for not only resisting, but also reprogramming, agrarian technologies.

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