Dear Colleagues,

 Thank you for reading and responding to our work-in-progress on the “data revolution for agriculture.” A few quick notes. This is a preliminary working draft that we plan to shorten and tighten into article length for submission at *Antipode* later this fall. The final section on assembling digital infrastructures and subjects is incomplete; while we’ve included our empirical examples, those subsections still require a little additional framing. We particularly welcome feedback to help us strengthen the section on assembling farmer-subjects within the digital agriculture economy. The conclusion is also at present undeveloped.

 Overall, we are trying to develop a critique of the global digitization of agriculture that is in deeper conversation with the racial capitalism literature, but as you will see, this effort needs further development to cohere across the paper. We welcome your suggestions for continuing to pursue this critique.

Our goal for this paper is to propose a research agenda for ICT4Ag, an emerging digital economy that has seen little academic engagement so far. We hope to lay out important questions and areas for further investigation, and feel that each section could be expanded into its own article-length investigation (pending further fieldwork).

 We ask that you please do not circulate this paper or reference it without getting in touch with us first.

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*Draft – Not for Circulation*

**Data farming: Seeding a “data revolution” in African agriculture**

In a recent publication by the Global Open Data for Agriculture and Nutrition (GODAN) initiative, the authors assert that we live in unprecedented times. Soon, the world’s population will have more than tripled in a century and, they note, we will need a more than 60% increase in food production in the coming decades to keep pace. “The industrial revolution is long gone,” they contend, and “even the Internet revolution and its extraordinary benefits seem to level off” (Laperrière 2). To attain “the next level of global efficiency,” what is needed is an open data revolution to align “government, private sector and civil society for the first time to work together in a truly participative manner,” particularly in light of the fact that nearly “the totality of data generation is digital.” A new model of agricultural development—one that collects, analyzes, and disseminates mass amounts of data across the entire agricultural value chain—is envisioned as necessary for securing the future of global food production. As one industry commentator articulates it, “data is one of the most valuable things farmers harvest” (Tatge 2016).

While GODAN is at the forefront of advancing the "data revolution" for agriculture in developing countries, the agricultural sector in the Global North is already being reorganized by “smart” and “precision” data-intensive technologies, which are poised to become the next frontier of agribusiness accumulation. In 2013 Monsanto paid almost a billion dollars to purchase Climate Corporation, which processes fifty terabytes of weather data per day to support its business of selling weather insurance and highly location-specific weather data to farmers. Monsanto now has agreements with the three largest agricultural equipment manufacturers allowing its FieldView app to sync with their farm equipment. And Monsanto isn’t alone, DuPont—another agro-chemical/biotech giant—has also gotten in on the ag data business. Collecting farm-level data allows these big ag companies to offer “prescriptive planting” services—detailed recommendations about how deep seeds should be planted and which parts of the field require additional fertilizer. Against this backdrop, the datafication of agriculture is being explored as the most effective means for smallholder farmers to achieve development targets—and for multinational agribusinesses to increase their footprint—across the Global South.

While the implications of these transformations for Northern agriculture is the subject of growing scholarly scrutiny, and Northern farmers have begun to find ways to resist the creep of data collection and commodification from their farm equipment, little critical or activist attention has been paid to the impact of datafication on small farmers in the Global South. Instead, efforts to extend the benefits of digital data to small farmers in developing countries—which generally fall under the umbrella term of information and communication technologies for agriculture (ICT4Ag)—are lauded for their potential to bridge the "digital divide." What is rarely examined in such accounts, however, is how ICT development projects tend to result in further embedding capitalist imperatives in the expansion of these technologies. The divide, argues Pieterse (2010), is not so much digital as socioeconomic, but this widespread misrepresentation of technology gaps suggests that technical solutions will solve the divide. Within policy and academic debates about transcending the digital divide, the solutions typically focus on increasing Internet connectivity for the poor as a means to diminish economic inequality.

This is not merely a question of technology or socioeconomic gaps, however. We argue that the "digital divide" debates mask how this divide is also a global racializing technology. Search the indices of the myriad books published on the digital divide, and race rarely appears. It is either assumed to be self-evident if one discusses "development" or "Africa" and hardly worth mentioning, or else it is not considered to be an important category of analysis.[[1]](#footnote-1) Despite the prominence of critical race frameworks for digital surveillance and critical data studies focused on the US (see for example Browne 2015, Chun 2009, and Sweeney 2013), the focus on international digital inequality as an object of "development" calls for more sustained critiques of the racial dimensions of global digital economies. As Chun (2009: 8) suggests, such an approach to communicative and networked systems benefits not only from an examination of how "race and technology impact each other's logic and development," but also from considering how race functions *as* technology, shifting focus "from the *what* of race to the *how* of race."

 As these data-driven technologies and strategies remake who grows our food and how they do it, we wish to offer a series of "provocations"—in the spirit of boyd and Crawford (2012)—about these transformations and their implications for small farmers in Africa and other parts of the Global South. First, we urge reflection on how data-intensive farming changes the nature of agricultural knowledge. This takes place through a devaluation of traditional farmer knowledge, while also restructuring what farmers and agribusinesses (can) know by legitimizing some forms of knowing and obliterating others. Second, we problematize the maxim among proponents of ICT4Ag that greater market penetration of smallholder agriculture is always better. While greater availability and transparency of market-related agricultural data can be useful for farmers, forging new agricultural markets in developing contexts has historically often been a route to increased agricultural consolidation and agribusiness colonization. Third, we hone in on data ethics, arguing that privacy, consent, and data ownership are issues that should be at the forefront of these discussions, particularly because poor, typically racialized farmers themselves are often denied any stake in them. And finally, we draw attention to the need for greater understanding of the assemblage of data both at the level of remaking farmers as data-producing subjects whose identity, knowledge, and labor is transformed; and at the level of constructing data-enabling farm environments through new material infrastructures.

Initiated in September 2016, our research is based on 34 interviews with people working in a range of organizations focused on bringing digital solutions to farmers in the Global South, including private companies, nonprofits, international development agencies, civil society actors, and the public sector. The practitioners we interviewed were working in Asia, Africa, and Latin America, though African initiatives were most heavily represented. We also conducted participant observation at three important conferences in this emerging field: the Global Open Data on Agriculture and Nutrition (GODAN) 2016 summit in New York City; the ICTforAg 2017 conference in Washington, D.C.; and the 2017 Africa Open Data Conference held in Accra, Ghana. Our interviews and conference observation are complemented by analysis of industry reports and publicly available webinars, which are important supplementary sites to study how claims-making and debates emerge across the field.

Because the speed and scale at which these information technologies roll out far exceeds the capacity of policymakers, civil society actors, and farmers to adequately track and regulate them, it is urgent for researchers to raise questions about the politics through which data-centric solutions become inscribed as the future of smallholder agriculture in the Global South. Following Ruppert et al.’s (2017) call for renewed attention to what we mean by "data politics," we explore the conditions of possibility of the datafication of agriculture, and question how it alters racialized knowledge politics, the public/private divide, the meaning of privacy among vulnerable farmer populations, and the subjective and material assemblage of data.

**The Changing Nature of Agricultural Knowledge**

Data is widely used to denote the basic units or “raw material” from which information and knowledge are formed (Kitchin 2014: 1). This can include representative measurements, categories, and objects that are commonly understood to exist “prior to argument or interpretation that converts them to facts, evidence and information” (Rosenberg 2013 qtd in Kitchin 2014: 3). As Gitelman and Jackson (2013) note, however, there is no such thing as “raw data”—the appearance of their existence “before the fact” (2) belies how “data need to be imagined as data to exist and function as such” (3). Data are not unmediated and self-evident truths of the world, even if that is how they tend to be treated. Rather, as Ruppert et al. (2017) observe, data bring their subjects and objects into being through actions such as collection, storage, retrieval, analysis, and aggregation. This ontological process is also a political one: data subjects and objects arise through struggles over their content, meaning, analysis, circulation, and audiences. How data are produced as information and knowledge, then, is at the heart of data politics (Ruppert et al. 2017): what kinds of data are desired? how are data selected and used? how are data rendered valuable? Because agricultural knowledge production is vested with significant biopolitical consequences, carries deep cultural significance, and is central to the livelihoods and subsistence of a majority of people in the Global South, recent moves to foster a “data revolution for agriculture” draw attention to the ways in which control over agricultural knowledge has long been a site of political struggle.

Smallholder and peasant farmer knowledge have frequently been targets for control, erasure, and reengineering. As Scott (1998) shows, various state-led agricultural modernization initiatives, from the Soviet Union’s collectivization drive to socialist Tanzania’s village relocation scheme, were coercive attempts to extinguish traditional forms of farmer knowledge. Similarly, the Green Revolution was spawned as a U.S. foreign policy program that identified south Asian peasant populations as resistant to global market integration. The solutions to this problem were sourced among predominantly American knowledge centers that Cullather (2010: 30) calls “racial laboratories”—particularly university agronomy labs—and knowledge brokers—especially philanthropies—who developed and promoted not only new high-yield hybrid seeds and other farm inputs, but also new modes of understanding the farming process and gathering data valuable to agribusinesses from it.[[2]](#footnote-2) These development projects extended earlier imperial pursuit of subject populations reimagined as customers for western industries (31).

Recently developed ICT and data-intensive technologies for agriculture extend this history into the digital age, drawing on many of the same tropes of technophilic modernization and “leapfrogging” that have characterized previous iterations of development ideology. In the 1950s and 60s, communication scientists argued that the transfer of western media technologies to countries in the South, including newspapers, radio, and television, would “give an enormous and enduring burst to development” by leading “southern countries onto a pathway to industrialization and modernization” (Nulens 2003: 255). Similar rhetoric of the transformative power of data technologies prevail today. The *Africa Data Revolution Report* published in 2016 by a number of development partners enumerates how they envision data serving as the foundation for sustainable and inclusive growth in all sectors for the continent:

…the potential of data goes beyond reporting of development progress. Empirical evidence is mounting that data enables citizens to make more effective decisions in their daily lives, entrepreneurs to create new business opportunities, and institutions to make the governing process more efficient, responsive, inclusive and transparent. (v)

In the following subsections, we explore the main knowledge claims being made about data-intensive technologies for agricultural development and consider what struggles are emerging over how agricultural data is legitimized within global information networks, the changing value of farmer knowledge within these sociotechnical assemblages, and the distribution of authority within networks of agricultural expertise.

***Ontology as Power***

Agriculture and nutrition have long been realms of mass data production, but the drive to digitize these types of data changes the nature of how data is understood to be meaningful and usable. The newly imagined global agricultural data networks aim to make forms of information like weather, crop yield, water usage, and consumption of fertilizer transparent to any user, anywhere. However, in order to be input, stored, analyzed, and communicated—in short, to be used—raw data need to be made legible within some shared organizational system. In computer and data sciences, *ontologies* serve as formal systems for naming and defining the types of entities and objects that exist within a particular domain, and also serve to delineate the hierarchies and types of relationships that pertain among them. More than naming systems, ontologies are devised within data environments as a means to structure and codify the reality of a domain, rendering data recognizable, meaningful, and legible as they travel between different information systems (Kishore and Sharman 2004). Ontology, therefore, is the conceptual architecture through which data become *interoperable*—the end goal of proponents of the data revolution for agriculture. Interoperability is imagined to be what Paul Edwards calls a “lubricant” for information systems, reducing the forms of friction that hinder the free flow of agricultural data and constituting a central process in the project of “*making data global*” (2010: 251).[[3]](#footnote-3)

Several research participants explained to us that a lack of shared ontologies in the field of agricultural development is currently holding back development professionals and, by extension, farmers. A European environmental researcher told us that this is a major block to his organization’s progress on developing knowledge systems for the sector: “In agriculture and nutrition, because the meaning of things—and this sounds a bit philosophical—is so all over the place that it takes quite a lot of effort to make a database application.” The Chief Technology Officer (CTO) of an AgTech startup in the UK concurred:

it is challenging because you have different currencies, different time spans…and because we are cross-country, different terms mean different things to different people. So, for example a “cow shed” in the UK—literally that is a shed. But in New Zealand that means milking parlor. So, you know, there are regional variations.

Regional syntactical differences are accompanied by conceptual differences between users as well as between operating systems. The CTO provided another example of a conceptual ontological problem for agricultural data systems to illustrate this point. When data is collected about fuel, it must be ontologically classified—but how? The CTO first pointed out that you could categorize fuel according to whether it will be used to drive your tractor, or your car, or heat your building. You would also want to know whether it is diesel, oil, or petrol. “So where do you do the division? Do you divide into where it is going first, or do you divide into the types first?” And this, he continued, doesn’t even touch on different grades of diesel, which are classed in some places and not in others.

For data scientists, these differences are rooted in the reality of the things being categorized. This invests power in the individuals and agencies that design ontologies, as they schematize what counts as reality and how to map raw data into its categories of legibility (Iliadis 2017). In the global domain of agriculture and nutrition, several ontologies are currently in development and will determine the rules of engagement for these rapidly proliferating information networks. These include the GODAN-spearheaded Global Agricultural Concept Scheme (GACS) and the UN Food and Agriculture Organization’s AGROVOC, which consists of over 32,000 concepts spanning 23 different languages.[[4]](#footnote-4) As the CTO quoted above explained, “these are big, big, big challenges and big conceptual problems and it is going to take a while.” He likened this movement to the medical field. “The equivalent within medicine is something called Snowmed CT,” he explained, “and that was originally conceived in the 60s and that is still not stabilized.” “Agriculture,” he continued, “is quite big and I think that all the companies out there are just trying to get on and, you know, make progress in their domains. And as these things start to merge together – you know over the next four to ten years – standards will emerge.”

The creation of a global agricultural data infrastructure will arise out of the ontologies devised for this domain; ontologies provide the framework that render heterogeneous forms of data comparable and mutually intelligible via controlled vocabularies. As these standardizing semantic systems are constructed, it is crucial to observe which values are embedded within them and how they organize global relations across spaces of uneven development. Ontologies, which set the threshold of what count as data and serve as primary sites for the production of categories of meaning, have the potential to prioritize the epistemes of technocrats located in the US and Europe. This raises the risk of both reproducing race and gender-based algorithmic discrimination already widespread in the US, and potentially producing new forms of social exclusion through the selective legitimization—and delegitimization—of different forms of knowledge. When we asked the CTO mentioned above about the extent to which his AgTech firm consulted with farmers themselves about what types of knowledge categories, relationships, and hierarchies they need, he responded, “I do not know how interested farmers are in the whole technicalities of this. They are kind of, pretty busy with what they are doing on the ground—we are trying to provide the information services, but farmers tend to be very farm-centric.”

This quote speaks to the knowledge politics embedded within the emerging global information infrastructure for agriculture. Using geospatial data as a reference point, Elwood (2010, 352) defines knowledge politics as the leveraging of digital data and technologies “in negotiating social, political, and economic processes, often doing so in ways that rely upon the differential influence and authority that is granted to particular forms of knowledge or representations.” As we show below, the exclusion of farmers from most spaces of knowledge creation for the emerging data economy not only passively reproduces structural exclusions that have long characterized institutional—and commercial—agricultural expertise along geographical and racial lines, but actively motivates many emerging knowledge brokers in this sphere.

***Devaluing Farmer Knowledge***

At a 2014 conference on big data and agricultural production whose funders included agribusiness giants Monsanto, Syngenta, Dow, and DuPont, Jeff Raikes, former CEO of the Gates Foundation, touted the importance of fomenting a data revolution for agriculture. Addressing an audience of science, technology, and policy experts from around the world, Raikes argued that this revolution is necessary to secure food security in the Global South, and vividly set the scene for this transformation. He explained that Africa is home to the most depleted soils in the world, and yet many soil maps across the continent date back to colonial times. “The result” of existing information gaps, he explained, “is bad agricultural policy and ineffective agronomy across developing countries.” African countries, he expounded, subsidize the wrong kinds of fertilizer due to a lack of regard to soil nutrient needs. As a result, farmers don’t properly use fertilizer or avoid it altogether because they don’t see it helping them. Raikes contends that farmers, local agro-dealers, and extension agents simply “don’t have the information—they don’t *know* what to plant, when to plant, or how to manage a soil to get the most out of it.”

In spaces of concentrated agricultural capital and techno-expertise such as the conference where Raikes spoke, the agricultural data revolution is received as *the* solution for unproductive smallholder farmers imagined to know nothing about their environments and how to grow food there. From this point of view, soil quality is largely inscrutable until western precision agriculture technologies arrive to reveal the true nature of such resource limitations, offering both accurate, up-to-date information and liberation from lingering remnants of colonial knowledge strictures such as old maps. Raikes makes clear for the audience what is at stake:

It’s easy to imagine the ‘before’ and the ‘after’ picture, and it’s stark. Now, smallholder farmers are planting whatever seed they happen to have based on roughly no information about how to conserve resources or maximize yields. In the future, based on projects that are already underway, they will plant seeds specifically adapted to the soil and water and the weather conditions they face. They will have access to inputs optimized for those conditions.

By telling agrarian communities in Africa and elsewhere what, when, and how much to plant, he advocates for new technologically-anchored “precise” knowledge assemblages that will teach farmers how to recognize and maximize the productive potential of their specific environments.

This vision updates modernization narratives that invest proprietary new technologies with the power to create new futures for a seemingly helpless peasant population, who for Raikes, have “roughly no information” on how to do what they have been doing for a very long time.

This ambivalent connection to real, “on the ground” farmers and the work they do betrays the widespread exclusion of farmers from the construction of these data networks in practice. According to a data scientist who works in the field, “I think it has been a top-down process. […] I think there needs to be more voice, change, so [the] Global South has to have more representation at these events,” she commented with regard to the first GODAN summit in New York in 2016. She continued that real inclusion would not just mean physical presence, but representation at the highest levels of policy formation. “We are so disconnected from it, like, geographically and mentally,” she continued. “I am not a farmer, […] I do not have the ag expertise either but I am here as an Open Data connector. My agenda is still representing the marginalized population somehow.”

The exclusion of farmers and devaluation of their knowledge is evident among international donors and development organizations, but also emerges locally among communities of tech entrepreneurs in African capitals. In Accra, Ghana, the Ghanaian-born and UK-educated founder of a tech incubator spoke about the new Internet of Things (IoT) startups he was nurturing. IoT applications for agriculture, from soil moisture sensors to infrared plant health monitors tracking crop growth, comprise a fast-growing subsector that promises to reinvent farms as networked spaces producing constantly updated streams of data on all aspects of farm operations. The founder of the tech incubator explained why such information technologies are necessary for agriculture to remain relevant to the generation of young farmers coming up:

Here the old lady or the old man is like 99 who’d sit and say, "Oh your cattle is pregnant." The young guys go, "Well how do you know?" Yeah, that's how my dad taught me. Those days are over. This data now is going to tell these people when the right time to feed that cattle and what kind of food that they're eating, their health and everything else. That would then inform or guide the business decisions that you make to take loans to buy more land, to do whatever, because you will know the life expectancy of your cows, the deliveries and all the money that you're making. […] That would also increase productivity in itself, because then we would know what we produce, how much we sold it for, who were the people that bought it, and in what regions and everything else.

For this young tech advocate, the capabilities of these data-streaming technologies reinforce the notion that the very nature of agricultural knowledge is in need of change: farmers’ intimate knowledge of their land and agricultural practices, gained over generations, is invalid or out of date. Traditional farmer knowledge is inadequate for negotiating modern markets. As one program coordinator at a development research center in Kenya depicted it, “we are now moving from the drum to the Internet, from the African drum to the latest technology” (qtd in Opala, n.d.).

***Legitimizing Digital Knowledge***

The central claim that farmers require new forms of technologically-mediated knowledge production and sharing in order to meet global food security needs rests on a number of presumptions about what kinds of data count, and to whom. Agricultural data encompasses a wide range of meteorological data, geospatial data (such as property boundaries, demographics mapping, crop growth monitoring, etc.), market data (especially local and regional market prices), and data quantifying physical conditions on farms (such as soil quality, water consumption, crop growth, etc.). Not all data gets digitized within these domains, however, and decisions about what to include and exclude from the agricultural data economy are made using various technological and political justifications. What is significant about these emerging digital domains is not so much their newness but, as Elwood and Leszczynski (2013, 552) argue, “their role in advancing different epistemological strategies for establishing the legitimacy and authority of knowledge claims.”

In part, the particular knowledge politics of digitizing small-scale farming mirrors similar tendencies in other domains of digitization: as Elwood (2010, 352) observes of geospatial data broadly, the “differential influence and authority” granted to such data is partly due to factors including the “pervasive numeracy of many state institutions and policy regimes” and the “truth power” often imputed to cartographic rationalities. Additional factors are at play among diverse agricultural data forms, including features Burns (2015) identifies with the big data “epistemology” common to digital humanitarian initiatives. These include the representation of agricultural data as categorizable, modifiable, and abstractable, and the framing of “locally-situated knowledges as best understood by those working remotely” (485)—i.e. people other than local farmers themselves. Encapsulated in such commonplace productivist talking points as the assessment that small farmers in Africa typically yield only one-seventh the amount of tonnage per hectare compared with “developed countries” (Manyika et al 2013), development actors continue to frame smallholder and landless farmer knowledges as lacking or retrograde. In short, their knowledge practices are seen as impediments to progress, and by extension, future food security.

As Brock et al (2010) argue, such framings of the digital divide reproduce racial difference through deficit models of knowledge production and technological affinity. In contrast to the lack of traditional knowledges, the particular characteristics of digital knowledge production come to stand for everything that is desirable for the future of the sector. In particular, data that are standardizable, mobile, inter-operable (i.e. are formatted for use across different platforms), and fungible are valuable because they can travel through the global knowledge economy with reduced friction and can be easily transferred to other actors in the value chain (Wolff and Buttel 1996). This transferability makes smallholder farmers more legible to multinational agribusinesses as potential customers for capital-intensive farm inputs and to financial organizations looking to enroll them as debtors. Similar to the Green Revolution, once data leaves the domain of peasant and smallholder agriculture, it takes on new meanings and becomes accessible—and monetizable—on new scales.

The restructuring of agricultural knowledge in these ways is justified through a number of ascendant narratives that reinforce the necessity of depoliticized data-based solutions to secure the future of global food security. One such narrative that we heard repeatedly in interviews posits that, while farmer knowledge about their land and crops might have been sufficient in the past, the increased environmental volatility introduced by climate change creates the need for more responsive, "real-time" digital data. This narrative dismisses farmer knowledge as backward or resistant to change, and valorizes new, often capital-intensive inputs as more resilient. Another dominant narrative (common to ICT-driven development initiatives) invests data-intensive technologies with an almost magical power to trigger new waves of economic growth (Pieterse 2010). In the case of ICT4Ag, the narrative goes, digital technologies will foster a new generation of flexible, data-savvy farmers. The Silicon Valley-driven model of economic growth rooted in the tech sector is alluring in the development sphere because it offers romantic images of lean innovative startups that can help to entrepreneurialize populations out of poverty with little investment. However, as Juma (2017) observes, the recent promise of the mobile phone revolution to act as a catalyst for broader industrial development in Africa has failed to materialize, and prompts skepticism about the capacity for the data revolution to spark any significant “leaps” in the absence of other structural changes.

Although datafied agricultural knowledge systems are in the early stages of formation, they are quickly becoming infused with new developmentalist dreams of technological "leapfrogging" and are being used to construct new economic scaffolding for the sector. Emerging ontologies solidify the syntax and hierarchy of agricultural concepts into global constants, increasing their intelligibility across platforms and borders. Farmer knowledge is revalued according to market and climate adaptability imperatives, which leads to threat of collective forgetting and the growing dependency on data- and capital-intensive inputs it entails (Kitchin and Dodge 2011). By studying the conditions of production of agricultural data, we suggest the importance of being attentive to how such knowledge is created, structured, and made real in the sector, as well as who is included and excluded from those processes. These uses of data are neither objective nor pre-political. We need to remain vigilant about how knowledge is created, disciplined, and legitimized in the sector, and who is included and excluded from those processes. This is not a simple call for greater visibility of farmers at high-level policymaking venues, which is important but insufficient. Rather, this means engaging on another level with questions concerning what kinds of data farmers ask for, and how they are made meaningful as knowledge for them.

**Data as a Means to Increase Market Penetration**

Taking seriously the knowledge politics behind data-driven agricultural interventions means interrogating the power relations that are embodied in the ICT solutions promoted to farmers. While some organizations intentionally grapple with the knowledge politics of digital data through, for instance, community mapping projects that aim to empower vulnerable populations by validating their knowledge claims, many companies and organizations working in ICT for Ag show little reflexivity about how their collection, dissemination, and valorization of digital data might reproduce certain types of social relationship.

This lack of critical awareness about the possible social implications of data intensification in agriculture is problematic because technology has historically been one of the main drivers of agricultural consolidation. The advent of gas-powered tractors, synthetic inputs, and genetically modified seed varieties put North American farmers on a “technological treadmill”: each new technology led to increased production, which in turn caused crop prices to fall, which meant that farmers faced no choice but to adopt the new technology or go out of business. This contributed to a steep decline in farm numbers over the twentieth century (Cochrane 1993). The subsequent transfer of these technologies to Asia and Latin America during the Green Revolution also had unintended social consequences. In replacing saved seeds with purchased hybrids and animal manure with purchased fertilizer, it contributed to farmer indebtedness and increased their economic vulnerability (Cullather 2013). Like these prior technological revolutions, the precision agriculture technologies permeating Northern agriculture come at a cost to farmers to the extent that they replacing another free agricultural input (farmer knowledge) with a purchased input (agricultural data), which farmers often must pay a subscription fee to receive (Wolf and Wood 1997). They thus contribute to the ongoing trend of agriculture becoming more capital-intensive, raising the barriers to participation for small farmers.[[5]](#footnote-5)

Yet despite this history, many ICT for Ag interventions encourage farmers onto a trajectory toward more input- and capital-intensive production processes, uncritically adopting a productivist vision for global agriculture in which increasing farmer yields is the undisputed goal. This vision is on full display in the World Bank’s (2017) definitive report, *ICT in Agriculture: Connecting smallholders to knowledge, networks, and institutions*. Declaring that “Increasing smallholder productivity is one of the greatest tasks of this century” (p.104), this report emphasizes the compatibility between yield-enhancing technologies—such as pesticides, fertilizers, and biotech seeds—and the ICTs which can teach farmers how to use them (see Figure 1).

ICT provides an incredible opportunity to reach farmers with the technical information they require to increase yields… When farmers have access to biophysical and other yield-enhancing technologies, frequently they do not know how to use them effectively to address their productivity challenges (for example, they may have fertilizer but not know the optimal amount to apply). ICT can fill this gap in knowledge…. (for example, nitrogen sensors can help to determine the correct fertilizer dose). (p.102)

Data collection and analysis methods such as wireless sensor networks and digital soil mapping are touted as potentially bridging the smallholder “knowledge gap” about how to effectively apply inputs.

Crucially, data-driven agriculture is promoted for its ability to *optimize* input usage. This input optimization, the World Bank report suggests, will be essential to the “sustainable intensification” of agriculture worldwide. This argument mirrors one of the main points made in favor of precision agriculture in the Global North: that once in possession of detailed data on every corner of their fields, farmers will apply only as much nutrient or herbicide as is strictly warranted, thereby saving money and helping the environment. While there is research to suggest that this may be true for large-scale, industrial agricultural production (see Bongiovanni and Lowenberg-Deboer 2004), whether these findings hold for smallholders in developing countries, whose input use is much lower in the first place, is questionable. When asked what the biggest problem was with farmer fertilizer use in Africa at the moment, a researcher at a CGIAR institution explained: “Number one, the farmers are not applying enough for the most part. That’s been established in the literature. As I say, not enough fertilizer has been used for farm production in Africa. That’s number one.” The second point he listed was that farmers apply the fertilizer inappropriately, putting it on the surface of the soil so that it gets burnt up by the sun or washed away by rain. Thirdly, he said, the standard fertilizer blends available in the market weren’t right for all soils: “There are places that have more critical requirements for Nitrogen versus Phosphorous versus Potassium. There are some places where you need to apply extra micronutrient to be able to bring the best out of a plant.” His response is largely in line with the optimization narrative—many farmers need to use more fertilizer, some might be able to use less if they weren’t wasting so much, and some simply need to use different mixtures—and like other purveyors of this narrative, he does not question the centrality of purchased inputs to productive agriculture. Like the (vast) majority of the practitioners we interviewed, his project takes the need to increase smallholder yields through purchased inputs as the starting place for their data collection and dissemination efforts, thereby reinforcing the hegemony of a productivist agricultural vision.

The datafication of agriculture also frequently goes hand-in-hand with efforts to increase financial penetration of agriculture. The most prominent example of this is index-based agricultural insurance. Unlike traditional crop insurance, which makes indemnity payments to farmers based on their demonstrable crop losses, index insurance payouts are based on environmental indices (e.g., rainfall, temperature) that are expected to correlate with crop loss (Isakson 2015). Because of this unusual model, index insurance is quite cheap and development organizations, including the World Bank and UN International Fund for Agricultural Development (IFAD), have begun touting index insurance as a promising agricultural development tool. However, its unusual model also means that index insurance is essentially just another type of weather derivative. Johnson (2013) observes that, by marketing index insurance to small farmers as a means to reduce agricultural risk, development institutions encourage them to take on financial risk, thereby transforming agricultural producers into financial consumers. Remotely sensed weather data, as an independent consultant we interviewed underscored, is *not* an infallible proxy for crop performance. Even if satellite data could infallibly determine rainfall in a given region (which it can’t), crop performance will also depend on other variables such as soil type, farmer skill, and topography. For farmers, therefore, buying index insurance means speculating on the accuracy of remotely sensed data and their derived indices.

Many ag-data projects also aim to increase farmer access to credit. Several of the agricultural data practitioners we interviewed mentioned alternative credit scoring as something that they were currently working on or considering broaching in the future. Since many small farmers do not have the financial track record needed for an official credit score, these companies see their collection of farm data as potentially giving lenders an alternative route to assess the riskiness of lending to a particular farmer. Farm data such as yield predictions, field size, sales records, and land ownership, can be used as a basis of alternative credit scoring. In Ghana alone, several companies—Syecomp, Esoko, and BigData Ghana—are working on some kind of alternative credit scoring initiative. Nairobi-based startup FarmDrive, for instance, combines farmer-provided data (including demographic information, farm location, soil type, as well as farm economic data on expenses, revenues, and yields) with remotely sensed data on weather and soils, then algorithmically transform these data into farmer credit profiles (Onyeji-Nwogu 2017). The Grameen Foundation, which pioneered micro-lending for the poor, is one of the major donor organizations working at the intersection of farm data and farm financing; Grameen-backed projects in Uganda (Opportunity Bank Partnership) and Colombia (Agricultural Risk Evaluation Tool—ARET) collect digital data on farmers as a basis for establishing credit worthiness (Grameen Foundation n.d.). Some initiatives also work to bring farmers into formal financial channels via digital finance, encouraging them to pay for inputs or accept payments for their crops via their mobile phones using m-PESA or similar platforms.

Ag-data initiatives also sometimes increase smallholder integration into formal markets by helping to make farmers more visible to agribusiness. The company 6th Grain, for instance, combines remotely sensed and farmer-supplied data to provide farmers with a free farm management platform that allows them to visualize their fields and manage production. To make money, they also have a contract with a major international agribusiness to map cropped area of wheat and corn across parts of Africa in order to improve the agribusiness’ “filed force effectiveness”—its ability to sell inputs directly to farmers. Agribusinesses are also developing their own tools to gather data on smallholders. Syngenta’s Farmforce, for instance, is a software tool designed to help contract farming and outgrower schemes manage their small farmer workforce. It is advertised as helping smallholders access formal markets by increasing the traceability of their crops and monitoring their compliance with food safety and other standards (FarmForce n.d.). As discussed above, the ag data revolution privileges data that is visible to and transferable between a broad range of parties. Here we see one reason why: it allows for monitoring, which can be used to enforce compliance with the demands of formal markets.

Many NGOs and donors see strategic partnerships with agribusiness or other corporate parties as the best (or only) route to ensuring the long-term success of their digital extension services. One approach, therefore, is to “bundle” ag-data services for farmers with corporate products, such as the cell phone services offered by a mobile network operator (MNO), or the inputs supplied by an agribusiness. Out of this arrangement, the corporate actor gets increased market penetration by having their services promoted to farmers directly by trusted non-profit or government organizations, while the non-profit or government organization gets the assurance that their extension approach will have longevity beyond the length of its initial grant funding because it is integrated into a corporate business model.

While promoted as a neutral means to give smallholders a leg up in competitive markets, digital agricultural data is also deeply implicated in the ongoing capitalist penetration of agriculture. Under “digital capitalism” (Schiller 2000) ICT infrastructure becomes a central means of both extending and “deepening” markets into previously uncommercialized realms of life. The technologies are thus inseparable from the political economic context of neoliberal globalization. Pieterse (2010: 313) argues that ICT for Development (ICT4D) is just “digital capitalism looking South.” Cloaked in cyber utopian discourses, ICT4D projects make extravagant promises about bridging the digital divide without critically examining how the vaunted technologies may perpetuate vastly unequal power relations or create new situations of technological dependency. There is so much hype around ICT4D projects, Pieterse (2010) argues, precisely because they promise to open up new frontiers of accumulation for industry actors while also allowing non-profit development actors to attract coveted private partners. There are such great profits to be made in bringing digital technologies to consumers at the “bottom of the pyramid,” that few remember to ask whether such technologies—created originally for middle class, Northern consumers—are actually the most appropriate for their new context.

Agriculture in the Global South presents twice the untapped market potential. The capitalist transformation of agriculture has been notoriously slow compared to other industries, hampered as it is by a production process that depends so greatly on nature (Mann and Dickinson 1978). However, while the act of farming—with all the risk it entails—is still dominated by millions of small farmers globally, technological advances have allowed capitalist actors to take over more and more of the upstream and downstream aspects of agricultural production (e.g., input provision, financing, processing) (Goodman et al. 1987). Like each technological revolution before it, the proliferation of digital data promises to generate a new wave of capital accumulation from agriculture, but—if history is anything to go by—the farmers will not be the greatest beneficiaries. While greater access to fertilizer or credit may indeed be a boon to farmers in many cases, to assume that greater market penetration is a development good in its own right is to be willfully blind to the history of agricultural development. Before naively embracing the transformative potential of agricultural data, development practitioners should ask themselves why it is that agribusinesses, banks, or mobile network operators are so willing to collaborate with them and what relations of dependency they may be helping to foster within rural communities.

**Digital privacy and consent matter, even to poor farmers**

The aggregation of enormous farm datasets in the hands of Monsanto and other purveyors of precision agriculture software has raised concerns among American farmers about privacy and data ownership (Bunge 2014). A survey conducted by the American Farm Bureau Federation (AFBF) in 2016 found that 77% of farmers were concerned that their data could be used “for regulatory purposes” and 61% that it could be used by companies to influence market decisions (AFBF 2016). One major concern among North American farmers is that companies like Monsanto and DuPont, which already exercise oligopolistic control over farm input markets, would use this data to justify increases to the price of seed. Another is that they might sell the data to third parties, such as commodities traders, with negative effects for farmers. The draconian methods these agribusinesses have used to prevent farmers from saving genetically modified seed—hotlines encouraging farmers to report on one another, compliance monitoring teams comprised of ex-law enforcement officials, and law suits whose expense alone can ruin a farmer—have given farmers an idea of the length these companies will go to control data. Given that patented seeds—themselves just tiny packages of genetic data—have so tightened the corporate grip on North American farms, it is no surprise that farmers worry about those same companies receiving an endless digital report on their on-farm activities.

In North America, concern about corporate control of farm data is further stoked by legal restrictions on farmer use of machinery. John Deere, for instance, one of the major equipment manufacturers for precision agriculture, insists that farmers own the hardware to their tractor, but not the software or data upon which it runs. According to its 2016 Embedded Software License Agreement, the “Licensed Materials” whose use by farmers is severely restricted include: “any Software, data files, documentation, engine calibration tables, proprietary data messages, and controller area network (CAN) data messages that are in or communicated to or from any [Licensed Product] (e.g., to monitor, diagnose, or operate the Authorized Equipment)” (John Deere 2016). In practice, this means that farmers cannot fix their broken tractors. They are forbidden from looking at raw data files, altering the software code, or even accessing the service manuals and diagnostic equipment that would allow them to identify a problem (Fitzpatrick 2017, Wiens 2015). These legal restrictions have contributed to the introduction of “Right to Repair” and “Fair Repair” bills in eleven states since 2016. These bills would expand the rights of farmers and local repair shops to mend farm equipment, but they are being vigorously contested by a corporate coalition of equipment and software giants (Sessa-Hawkins 2017).[[6]](#footnote-6) Resistance to the various digital and legal “locks” placed on farm equipment also takes the forms of grassroots groups like Farm Hack, a community of farmers who share tips for modifying farm machinery through online and in-person forums (Carolan 2016, 2017).

In North America, concern about farmer privacy and control of data has led to several types of initiative to ensure that farmers maintain control over their own data. In November 2014, the AFBF brought together a group of farm organizations and agricultural technology providers to come up with recommendations on best practices for farm data. The resulting statement, “Privacy and Security Principles for Farm Data,” was signed by major agribusinesses, including Dow AgroSciences, DuPont Pioneer, John Deere, the Climate Corporation (now owned by Monsanto), and Syngenta (AFBF 2014). This statement affirms, among other things, that farmers retain ownership over the data generated on their farms, and that “access and use of farm data should be granted only with the affirmative and explicit consent of the farmer” (AFBF 2014), although, as Carbonell (2016) observes, this doesn’t preclude companies from claiming ownership over the “generated data” produced by their analytical software. The AFBF also created the Ag Data Transparent label to certify companies that are particularly open about their use of data. To be certified, companies must answer ten questions based on the principles about their data collection, usage, data consent processes etc. and then submit to having their answers independently evaluated (Ag Data Transparent 2017).

Agri-tech startups have also sprung up which promise to give farmers greater data control. Farm management software companies like Conservis, FarmLogs, and Granular (acquired by DuPont in August, 2017) collect data on farm operations and put them in farmer hands, literally, via mobile applications with accessible user interfaces. Like the precision agriculture companies, they generally charge an annual subscription fee based on acreage. Other companies seek to help farmers monetize their data. Farmobile, for instance, provides a device which (for $1,250 a year) collects the sensor data generated by a piece of farm machinery and sends it wirelessly into cloud storage. The farmer owns these “Electronic Field Records” and can share them or sell them to third parties via the Farmobile “Data Store,” in which case the revenue is split 50-50 between the farmer and Farmobile (Farmobile 2017). Farmobile fashions itself as a leading a data revolution among farmers: “It's time to protect your data like the significant asset it really is. Own your data. Own your relationships. Own your margins. We exist to believe in **#FarmerPower.**” proclaims the Farmobile website (Tatge 2017, original emphasis). A similar—though more grassroots—initiative is underway at Grower Information Services Cooperative (GISC), which aims to maintain farmer control over data by giving them access to a free ag data collection platform. GISC has 1,300 members and is governed by a co-op board of growers diversified by crop type and geography (Borst 2016). GISC recently entered into a partnership with Farmobile, allowing them to monetize the data they have collected.

In short, the “datafication” of North American agriculture has been accompanied by anxious debates about data privacy and control. Legislative efforts, voluntary corporate principles, agri-tech startups, and farmer-led efforts have all been deployed in an effort to keep data control firmly in the hands of farmers and to be sure that their informed consent is obtained before farm data is shared with third parties. The ag-data protections provided by industry are still pretty unsatisfactory, but corporations seem to have gotten the message that this is a sensitive subject for farmers, one in which they must tread carefully.

Unfortunately, these lessons appear not to have been transferred to efforts to create more data-intensive agriculture in the Global South. Some companies and organizations do take farmer privacy seriously and have policies in place to protect it; many aggregate data before sharing it with third parties with the goal of rendering individual farmers and farms unidentifiable, while others intentionally introduce a small amount of error into their datasets. However, our interviews reveal that many working in the field give only perfunctory consideration to privacy considerations. For instance, we interviewed executives at three of the biggest funders of ICT for Ag projects and, while all acknowledged the importance of informed consent and privacy protection measures, none had particular policies in place to ensure the data rights of farmers involved in the projects they fund. When asked if he had any privacy concerns about collecting farmer data, one responded honestly: “that's a great question, and it's an important question. It just hasn't been something I've engaged on just yet. But it needs to be a part of how we engage in this space, in the future. That is for sure.” Many non-profit organizations seemed to share this perspective that the ethical implications of collecting and using farmer data was important but something to be addressed down the road.

Some working with farmer data see privacy concerns as an obstacle to their work improving the lives of smallholders. An executive at agtech startup was blunt on the subject. Saying that her company needs a minimum amount of farmer data for the services they provide, she said: “the thing will not work if we protect the guy's privacy, essentially… So yes, [it] sucks. But there you have it.” She went on to point out the prevalence of companies like Facebook and Amazon, which collect user data and are nonetheless widely accepted by the public, concluding:

So I'm not really very worried about privacy because we are in 2017. If it was 1955… I would be worried about privacy. But [we are] in 2017 where you have targeted political ads and all sorts of stuff. So, privacy is such a naughty thing and you as a sociologist can write about it and it'll be lovely. But from my perspective, I would much rather make them more money, give them more control, give them more options, connect them to better offtake contracts, and better input options than to protect their privacy.

Though she put a finer point on it than most of our interview participants, it was clear that many shared her perspective that privacy was not—nor should it be—a major priority in the face of rural poverty and hunger.

One possible explanation for this attitude toward privacy is that practitioners are consulting their own, relatively cavalier relationship to data privacy. That the woman quoted above compared collection of farmer data to digital data collection by Amazon and Facebook was not at all unusual. Several people we interviewed spontaneously drew parallels between Northern consumers choosing to share their internet search and purchasing data with online companies and Southern farmers being asked to give up data about their farm locations, crop types, yields, etc. An executive at a private company that supplies remotely sensed weather and agronomic data to many ICT4Ag initiatives, for instance, explained:

In the case of sharing with Google what we're interested in searching for, the value is we get access to this amazing search engine. The value to Google is they know what we're looking for and they can sell to advertisers based on that. That's an exchange, right there. Anytime anybody types into Google, that's a value exchange that's happening. I think, in the case of smallholder farmers and these sorts of information services, you've really just gotta demonstrate okay, these are valuable enough that you're okay with providing any sort of personal information about what I'm growing, where I'm growing it, what stage of growth I'm in, and how much my production is likely to be or if I have any pest or disease issues, that type of thing.

This type of comparison is problematic because it implies a parallel level of digital literacy between the habitual Google user and the smallholder farmer whose primary digital interactions are likely to consist of SMS text messages. In fact, farmers may have little ability to conceive of the implications of sharing their data and may not know the right kind of questions to ask to find out what will be done with it. The comparison also implies that the stakes are somehow similar between a company knowing your browsing history and a company knowing the details of how you earn your livelihood. This casual comparison is only possible because it is assumed that the value of the services is greater than the value of the privacy—again, there is an appeal to an implicit hierarchy of needs.

Yet, in reality the stakes for farmers sharing their data may be much higher than for a person looking up good weekend brunch spots on the internet. Some organizations and companies (a minority among our interview participants) were keenly aware of this fact. A big data researcher at the International Center for Tropical Agriculture (CIAT) in Colombia, for instance, identified two very concrete risks that could affect farmers if their data were not adequately protected. First, he pointed out that many taxes and fees paid by farmers are based on their yields or incomes, and so sharing any data, including farm locations, that could be extrapolated to determine their production will potentially inflect economic damage on them. Second, he pointed out that in some Latin American countries, farmer income data getting into the wrong hands could also put them at risk of kidnapping or other forms of violence. His conclusion was that: “So that is a big concern. So you should present it aggregated or just don't present it.” As Scott (1998) observes, increased legibility to the state and corporate actors can be a negative, or even a dangerous thing for rural people.

This relative unconcern with farmer data rights also stems in part from a view of privacy as a luxury that only the wealthy can afford: a higher-order need than growing enough food to eat or earning enough money to send your children to school. Research on the emerging field of “digital humanitarianism” has found that, during emergencies, concerns about data consent, privacy, and even legality are often disregarded in favor of a rapid response to disaster. Both the 2010 Haitian earthquake (Crawford and Finn 2015) and the 2014 Ebola outbreak in West Africa (McDonald 2016) saw mass data collection and sloppy privacy protections in the name of saving lives. Crawford and Finn (2015) argue that this negligent treatment of crisis data is justified by the “emergency imaginary” (Calhoun 2004), in which disasters are framed as unpredictable, short-term disruptions to the norm, generally caused by nature rather than humans. The crisis is too urgent and the need too great, it is implied, to worry about trifling issues of consent. Unlike an earthquake or disease outbreak, the problems that agricultural data projects are trying to solve—rural poverty and hunger—have no clear temporal boundaries. They constitute a constant and on-going humanitarian crisis, making it possible to brush aside concerns about the ethics of farmer data collection ad infinitum.

What this perspective misses is that the problems facing poor farmers are very much man-made. Farmers in Africa are not just poor because they lack good information about a changing climate or about crop diseases; they are poor because of their place in extant social and economic systems. It is therefore crucial that efforts to bring “smart farming” to smallholders consider how these technologies may exacerbate that vulnerability by, for instance, fostering dependence on agricultural inputs of external financing. Even measures such as data aggregation, which satisfy Western ideals of privacy protection, may still increase farmer visibility to government and corporate actors and therefore increase their vulnerability to taxation or fees. A recent report on *Responsible Data in Agriculture,* commissioned by GODAN, explained that there is a need for particular care in handling agricultural data in the case of vulnerable communities such as indigenous populations, landless farmers, and women farmers. For indigenous groups and those with communal or informal resource tenure, it argued, the push to open agricultural data may be a path to dispossession (Ferris and Rahman 2016).

**Assembling Digital Farms**

The commodification of data takes place unevenly amidst geopolitical and economic struggles for dominance in these emerging markets. Describing this commodification as neither a smooth trend nor governed by consensus, Schiller (2015) asks, “Who – which companies, headquartered in which countries – will appropriate the fruits of what pundits call ‘the digital economy’?” This question is open-ended because the digitization of domains like agriculture on a global scale is difficult to enact due to many different kinds of challenges. Data-intensive technologies and strategies for agriculture need to cultivate particular kinds of environments in which to operate, and simultaneously work to remake those very environments. In this section, we examine two particular areas of both expansion and challenge for digital agriculture: the assemblage of material infrastructures and farmer-subjects. We consider how these transformations help to construct new spaces and modes for accumulation across agricultural value chains, but also present stubborn forms of friction that interrupt any smooth rollout of precision agriculture in spaces targeted for development.

***Emergent Infrastructures***

The datafication of agriculture transforms farms into communicative networks that absorb and emit data between various types of actors, who may or may not include farmers themselves. The normalization of these data networks takes place partly by materially altering agricultural processes in dramatic ways by renovating existing infrastructures (and installing new ones), changing farmers’ relationships with their land and crops, and reorganizing the social relationships embedded within agricultural environments. These communicative infrastructures come into being through what Gabrys (2016) describes as “concretizing technological arrangements as well as distinct ways of inhabiting these infrastructures” that “becom[e] environmental” (241-2). As such, they connect people and objects in ways that vary across geographies and never completely fulfill users’ needs and desires (Edwards 2010: 11) – they strive to become stable but are subject to various limitations and unpredictabilities.

These transformations take place at various scales. Daniel Jimenez from CIAT in Colombia explained a years-long process of trying to get the federal government to make their national, publicly-funded meteorological data available to organizations such as his in order to increase accessibility for farmers. The government resisted publicizing this data for decades, but finally a few years ago offered to share data from meteorological stations across the country with CIAT. This represented a large breakthrough for farmer advocacy groups—“that is a huge step”—but that the data was only made available in pdf form, which is cumbersome to access because the data is not machine readable and has to be manually entered into analytics applications. “My team,” he explained, “they always say that 80% of the time they spend on cleaning the data and merging databases and just 20% of the time having fun with the data.” The seemingly small material fact that the data arrived in pdf form fundamentally shapes what can be done with the data and how much labor is required to render it usable. “In that sense, we are not very good." The data "is available but we still need to work a lot on that.”

At another scale, Internet of Things (IoT) sensors are being embedded into all corners of farms and agricultural supply chains to render them transparent, controllable, and more easily acted upon. This includes soil quality and water level sensors, infrared cameras, phones and their various applications, drones, and other means of surveilling and dominating the environment. It is not only humans and physical environments enrolled into these networks; farm stock are increasingly incorporated into them through instruments of hyper-surveillance and control over their life cycles. Vital Herd exemplifies this approach with their “smart e-pill” which is designed to be ingested by cattle and electronically transmit “continuous check-ups” on each individual animal’s vitals to your computer or mobile phone, including details on their core temperature, heart rate, respiration rate, stomach contraction rate, and monitoring of their volatile fatty acid and lactic acid levels. This vision of “fundamentally better, data-driven, individual animal management” (VitalHerd) disarticulates the animal into a set of constituent data streams that are available to be manipulated from a distance.

***Digital Farmers***

The normalization of digital farming also requires farmers-as-subjects to be interpellated in new ways because the networked, IoT-embedded farm can only be productive to the extent that farmers know how—and choose—to interact with these technologies in appropriate ways. Farmers are reframed as data workers who desire ever more fine-grained information about every aspect of their farm, and are adept at working with proliferating types of data being offered. This farmer is remade through ICT4Ag paradigms as both a producer and consumer of ever-growing datasets and data services, which become primary sources of agricultural value because these data are of interest to so many potential actors, from government agencies to agribusinesses and fintech (financial technologies used to provide insurance, loans, banking services, etc.) companies.

The farmer is reimagined through these technologies in various ways. The farmer becomes a subject of discipline: they must learn to value this data and become literate in its manipulation. If they don’t, there is the danger they may be left behind as others “leap” into the future offered by precision ag. A Ghanaian ag tech company that offers data collection and analysis services for rural agrarian communities actively negotiates the training of farmers into new modes of participation in data collection and communication that alter their relationship with their work and resources. The company offers various kinds of agricultural information for small rural farmers concerning what and when to plant, how to deal with pests, and so forth via text and voice message. The communications manager for the company explained to me that farmers need phones and network reception to access this information once they start to depend on it, but this makes for complex rearrangements of their daily lives. In some rural areas in the north of the country, where a lot of their customers are located, there might be a single phone for an entire household, or shared among multiple households, and the micro-politics of access and information sharing get mapped along pre-existing power hierarchies. Further, reception in many of these areas is "really poor, really really poor," and so farmers find themselves walking perhaps a mile away to a tree where they can reliably connect to the network and download updated information. They may do this "twice or three times in a day." To become better, data-networked farmers, new investments in energy, inputs, and mobility are required.

The farmer also becomes a digitally quantified subject, put under surveillance and urged to micro-manage and be accountable for every detail of their farm operations. This heightened visibility of the small farmer and their operations makes them legible to outside actors according to their productivity, and potential to become new customers for agro-inputs or financial services. For instance, when asked why agribusinesses would be interested in partnering with development organizations to promote digital services to farmers, one executive at a major donor organization explained that it can reduce their costs. As an example, he said that enrolling contract farmers in digital payments can reduce farmer side-selling of contracted goods[[7]](#footnote-7):

… when farmers feel like they are receiving their payment on their phone, they feel like they're connected to the buyer, right? They feel like they're no longer invisible. One reason why they do side-selling is because they feel like they're off-grid. They feel like they're invisible. And they can go ahead and sell, not to who they contracted to sell to, you know, when they got their advance payment, or they got their input supplies, or whatever. And they can go ahead and sell instead to somebody else. And for them, it's all the same. They don't care. Because they don't think the buyer really cares after all, right? Because they're invisible to the buyer.

Here, as in Syngenta’s FarmForce platform, digital data is used to heighten farmer visibility as a mechanism of social control. In most ways, the power within contract grower arrangements is deeply skewed toward the corporate buyer; it is a form of flexible accumulation which leaves farmers with an appearance of autonomy while in fact subordinating them to the buyer’s indirect control through such mechanisms as quality control standards and non-negotiable prices (Watts 1994). Side-selling to other buyers who offer a higher price is one of the few forms of “everyday resistance” (Scott 1987) available to contracted farmers. Heightened digital visibility serves to narrow this already slender space for disobedience.

Farmers' control over data, however, is a site of struggle with uncertain outcomes. Ag tech companies attempt to attract farmers with the promise of increased freedom over their work and schedules. IBM’s EZ Farm IoT pilot projects in Kenya, for instance, offer web-enabled remote sensors on their farms linked to mobile apps, which allow tech-savvy youth to become weekend “telephone farmers”: living in the city during the week, they are able to water their crops remotely and watch them grow from a distance (Mungai). Farmers, however, also see avenues to use their data for their own ends. As the program manager at an agricultural development NGO in Ghana explained to me (Kish), the more data is desired from farmers, the more they see its value and the power it gives them. Farmers ask of the ag tech companies, "but what are you taking from us?" Rural agricultural communities recognize that their data is a "source of, if you like, power" and they use it to bargain "quite a lot for something that they think will benefit them." He stressed, "that's all they have" but is a valuable bargaining chip with development agencies.

These examples illustrate how deeply embedded agriculture is into environments and social structures, and the challenges involved in attempting to coordinate these complex assemblages of humans, seeds, soil, water, climate, animals, communication infrastructure, and markets through new data-intensive technologies. The complexity of these assemblages is the source of their potential profitability for agribusinesses and other private sector actors seeking to control more of the agricultural value chain; but possibilities for subversion and redirected power also lie within these manifold connections and their interruption.

**Conclusion**

Offering these starting points for research and debate, we propose that the issues raised by data-intensive technologies in agricultural contexts in Africa and other areas of the Global South are not straightforward derivatives of the concerns of farmers in the U.S., and require a research agenda that is attuned to both the continuities and differences of digital agricultural technologies across these geographies. While the development actors we interviewed tend to present their vision of ICT4Ag as an unquestioned social good, little research has been conducted into how farmers perceive this development agenda. Early research in this area and anecdotal evidence we collected suggest that farmers are often leery of sharing their data, have significant reservations about data ownership and privacy protections, and express varying levels of “participation fatigue” as yet another techno-utopian idea ripples across the development policy world (see for instance Wyche and Steinfeld 2015). These unresolved questions call for further investigation into the tech dreams being planted in small farms across the Global South.

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1. For a provocative discussion of the surprising evacuation of race from analyses of Africa, see Pierre (2013). She writes: "Africa could not represent a more racialized location—and yet the continent and its peoples are left out of our current discussions and theorizations of race. In other words, while Africa—as trope and geopolitical space—is clearly understood as the site of racial otherness, it is this very assumption (and all that it entails) that obstructs sustained analyses of race and its continuous and active processes on the continent" (xii). [↑](#footnote-ref-1)
2. Cullather writes that development was imagined and performed during the Green Revolution through three main expository conventions: projects were designed to “display” statistical victories such as higher yields; to offer models that could be replicated; and to produce narratives about development (2010: 5). [↑](#footnote-ref-2)
3. Edwards discusses standards around data collection and communication as lubricants, which diminish friction “by reducing variation, and hence complexity, in sociotechnical processes.” Ontologies work like standards in this respect and, similarly, are “typically negotiated by central bodies and mandated from above” (251) as a means to contain disagreement. [↑](#footnote-ref-3)
4. The FAO website explains the range of uses for their semantic system: “You can use AGROVOC to look up the common name of a plant in a language that you do not master, or to find relations between a commodity and the crop from which it is produced. Your library can use AGROVOC to index its documents, or you can use it from inside your content management system (e.g., Drupal) to organize your documents or web site” (AGROVOC Multilingual Agricultural Thesaurus, n.d.) [↑](#footnote-ref-4)
5. Like the earlier technological revolutions to transform agriculture, the data revolution also represents a solution in search of a problem. Intensive fertilizer use in agriculture stemmed from a repurposing of bomb-making factories after World War II, while agro-chemicals like DDT and glyphosate have their roots in war (CITE). Likewise, the global positioning system (GPS) technology essential to almost all precision agriculture technology is a product of the military-industrial complex (Wolf and Buttel 1996), as are drones, which are coming into increasing use for agriculture (CITE). Given that each agricultural revolution represented an industry search for new ways to use and market existing technology, its little wonder that the prime beneficiaries were companies. [↑](#footnote-ref-5)
6. The states where Right to Repair bill have been introduced include: Illinois, Iowa, Kansas, Massachusetts, Minnesota, Missouri, Nebraska, New York, North Carolina, Tennessee, and Wyoming. They are being opposed by farm equipment manufacturers like John Deere and Case IH, car manufacturers like General Motors, communication and technology giants like Apple and Verizon, and conservative groups like the American Legislative Exchange Council (ALEC) (Sessa-Hawkins 2017). [↑](#footnote-ref-6)
7. Side-selling describes the act of farmers selling their product to a buyer or buyers other than the one they initially contracted with for a set price, usually in the case that they can get a better price elsewhere. [↑](#footnote-ref-7)