Challenging the digitalization of the agrifood chain

TROJAN HORSES ON THE FARM

Six critical questions

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Contents

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Six key questions

The implementation of digitalization technologies across a wide range of agriculture and food sectors risks being deeply disruptive, as many farmers and food producers are faced with making difficult decisions about whether or not to adopt new technologies and at what cost. Food workers and food vendors are also likely to find themselves unexpectedly impacted by the introduction of automation and digitalization technologies. This discussion paper is offered as a resource, providing information and perspectives to help foster exploration of these complex issues.

In general, giving data away to companies enriches them and makes them more powerful, further skewing the balance of power in the Industrial Food Chain, with unknown consequences in the future. This does not mean that digitalization should always be avoided, but it does mean that careful consideration is required. This paper is offered as a contribution to inform emerging inter-regional and inter-movement civil society gatherings and processes, offering six initial key questions that we might collectively explore and build on over time.

- What is the nature of the underlying Big Agritech business model and where is it heading?
- Why is the ownership of digital infrastructure and data so critical?
- What roles do governments play in terms of facilitating the digitalization of food and agriculture?
- What are the hidden environmental and social impacts of the digitalization of food and agriculture?
- Who should decide whether digital technologies are beneficial to or important for smallholder and peasant farmers and communities, local food producers and traders etc?
- Is there a place for digital technologies in food and agriculture at all?

Overall, the key concern that we want to highlight is that the corporate strategy or 'business model' that is being ushered in along with agrifood digitalization privileges those who have developed and control these technologies and processes and their interests, over the knowledge systems of the indigenous and peasant communities that have nurtured crops and breeds across generations.

Summary of concerns

The glittering promise being made by the promoters of the digitalization of food and agriculture is that it will significantly increase production at minimal cost, in nature-friendly ways that restore or even improve the environment and the climate, while maximizing profits. If that sounds too good to be true, that's because it is. There are many pitfalls and risks which need to be considered.

To be clear, the issue is not with the pros and cons of individual technologies or the use of peer-to-peer digital communications platforms, or digital devices that might be used in food production such as temperature or humidity sensors, or cattle trackers. It is the extractive business model within which they are being deployed that is the issue: this 'Big Data' model is a very different beast.

While digital communication and information storage have already changed the nature of how some people organize and relate to each other in the 21st century, including in agriculture-related sectors, this is just a small part of what is actually being envisioned by Big Ag and the Tech Titans for the digital transformation of the agrifood system. These new digital tools are being used to usher in a new business model that will expand corporate control and industrial agriculture even further. It is data itself that is the central product being farmed and extracted in this model, which is characterized by deep data surveillance, data-mining and data-trading. Take away this data extraction, control and manipulation and the entire model falls apart. It is not about the production of food, stopping climate change or protecting biodiversity.

The landscape of corporate involvement is also changing as a result: Big Ag is creating digital platforms, designing automated farm machinery, partnering with drone companies, and using Big Tech's cloud services to store and analyze valuable farm and food-related data. At the same time, Big Tech is investing in food and agriculture as well; and companies from both sectors are also partnering with each other. The two sectors combined are effectively running the 'digitalization in food and ag' show, and clearly anticipate significant gains from their investments down the line.

For now, however, these investments are also being accompanied by a loud and insistent drumbeat: corporations demanding that governments and international institutions should finance this transformation, channelling billions of dollars – annually – towards the proponents of this new agribusiness model.

To make this demand as palatable as possible, Big Ag and Big Tech are relentlessly projecting and reinforcing assumptions and premises that may be untrue or only partially true. In particular, their underlying narrative is based on promoting the current food system as being 'not fit for purpose', requiring an 'efficiency' that only digitalization can supposedly bring. [1]

A deeper analysis also reveals that this looks a lot like the same old colonialism, the same old capitalism, coming from existing Big Ag and Big Tech companies looking for new markets and power bases. The companies amass data, acquired in exchange for services that they may often present as being 'free', using digital technologies. But these technologies have been designed and developed by humans, overwhelmingly from well-resourced and powerful elites, and are embedded in their political biases, reinforcing oppressive power structures. The companies in question then aggregate, trade and exploit this captured data as a valuable and strategic commodity, even selling it back in a processed form to

those from whom the data was originally obtained.

There is also a concern that algorithms are likely to be trained on data from industrial monocultures, which is not publicly available and cannot be interrogated. Transferring on-farm decision-making from farmers to proprietary algorithms designed by corporations in this way would seem to be a remarkably effective way of massively expanding industrial agriculture at the expense of other food production systems.

Another corporate narrative being used extensively is that data reflects objective truth and is therefore neutral, that it is weightless like a cloud, and 'immaculate', with no physical impacts. Yet nothing could be further from the truth. Data isn't green, clean or neutral. There is growing alarm about 'digital discrimination' falling disproportionately on racial and gender minorities, including through the use of already-biased data sets for training algorithms. It is also increasingly recognized that digital technologies have a heavy environmental 'footprint' in terms of the vast quantities of minerals, energy, land and water required for digital infrastructure and operations around the clock.

There are also risks that the digitalization of agriculture could disadvantage farmers, food workers and food vendors directly. This could include locking farmers into contracts which dictate their agricultural practices, potentially affecting their creditworthiness and future access to finance and markets if they do not comply with recommendations. In some countries, farmers may also be forbidden from repairing the proprietary equipment on their farms. There is also a risk that land rents and prices may increase as data companies identify and micro-target the most productive land and buy it up.

Food workers can find their jobs being replaced by machines such as robots and drones, and even if not, they may be expected to work at the same pace as a robot, perhaps by wearing robotic devices which surveil them – even though this has already been leading to more accidents in manufacturing and warehouse settings. Food vendors are beginning to find that giant data platforms are seeking to skew food distribution routes, inserting themselves as middlemen between farmers and consumers, thereby excluding food vendors.

Finally, the inclusion of agricultural soils in carbon markets as a purported means of sequestering carbon dioxide – a current flash point in climate change negotiations – also poses a significant risk to territories and food production, which is linked to the digitalization of agriculture.

Big Ag companies are seeking to use digital technologies to measure carbon dioxide supposedly sequestered in soils so that 'carbon credits' can be sold to polluting companies (who can then continue to pollute). Again, this is not as beneficial for farmers as it may sound, even though it claims to create a "new revenue stream" for them.[2] It requires them to conform to all recommendations from the corporations in question and to share all their agricultural data. The farmers get paid a small amount for having sequestered carbon for selling on for offsets, including to Big Ag (although the potential of agricultural soils to sequester carbon has been said to be overestimated and exaggerated). This could also exacerbate land disputes and speculation, as companies acquire yet more granular data concerning which land is more profitable and where yields are highest.

Introduction

Powerful corporate players are endeavouring to encroach even further on 'global food systems' with data and digital tools. Like Odysseus and his soldiers hiding inside a wooden horse in Ancient Greece, the Tech Titans wrap themselves in fun and user-friendly apps, presenting themselves as altruistic geeks who simply want to feed the hungry and fix the climate, but they are in reality seeking to increase their influence over global food systems.

Click on various websites depicting future food system scenarios[3] and they may show computers using artificial intelligence (A.I.) to design seeds, breeds, and even foods; or digital platforms using algorithms to 'precisely' determine the amount and type of input to use while an automated tractor delivers it; or drones surveilling billions of productive acres on the farm or in the ocean; or blockchains automatically trading the world's grain; or digitally-designed microbes being transformed into food; and data-driven robots managing the distribution of food.

The most common version of the 'digitalization of food and ag' story, circulating in the North and in cities and urban areas in developing countries, is that more and more people are already ordering food and other products using online apps, and that drones and other autonomous vehicles will increasingly deliver directly into our hands at our home and office doors. We may be told that the food we order is designed to satisfy us, and possibly even heal us, but this is likely to be based on apps that only offer a selection of what they consider to be the most 'relevant' options based on our individual tastes and health status, as determined by personal data that we have knowingly (or unknowingly) shared with the platform.

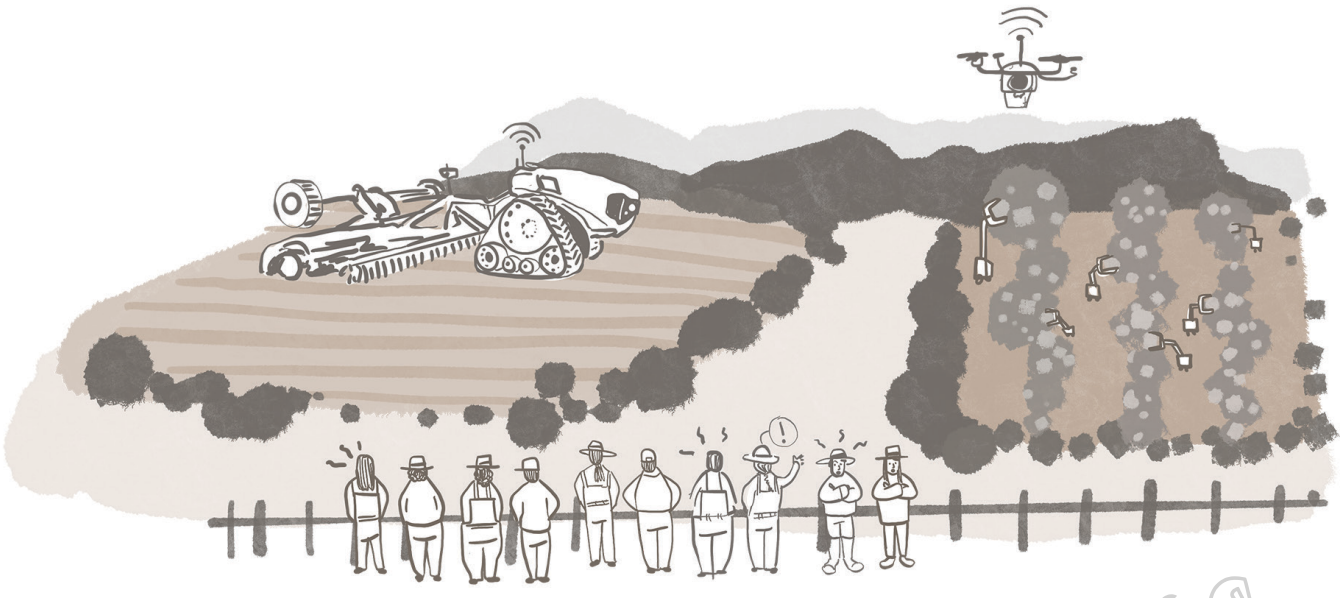
Whether we are food producers or consumers, the data we are generating whenever we use these various technologies is often the main product the company is interested in; it is used to profile us and then maximise the profit that can subsequently be extracted from us, by the company in question and/or others it may sell our data on to. As is the norm with neoliberal capitalism, the corporations driving these attempts to digitalize the food system are attempting to create extensive new sources of profit via digital technologies, in ways that are almost entirely hidden from the users of

those technologies.
An ideological imperialism is also at work here, through the way the future is being framed. Silicon Valley is driving a cultural shift whereby it creates a desire and a perceived need for companies and others, including institutions and governments, to rapidly incorporate emerging technologies, Artificial Intelligence (A.I.), systems operated on Big Data, and hence digitalization, if they are to remain competitive.

This digital 'utopia' is additionally problematic in that there are not enough material resources on the planet to deploy it in all parts of the world. Furthermore, as with other technological waves, digitalization creates opportunities for some to design, sell and enjoy the comfort of 'total' automation, while other regions are likely to be condemned to continue being the suppliers of raw materials and cheap labour (for example, people employed to label large language training models for AI systems to learn from[4]), while also serving as end-users of digital tools and technologies primarily produced in the North.

Overall, this envisioned transformation – in the way we grow, make, distribute, choose and consume food as well as govern food systems – is part of a wider paradigm shift towards a digitalized, virtual world, affecting almost all aspects of our economies, not just the way we communicate with each other.

Those of us in civil society who are involved in food systems, in a multitude of ways – including farmers themselves, those supporting or directly working with farmers, consumers and workers, and people working in the areas of food sovereignty, human and animal health, and environmental, economic and climate justice and more – urgently need to understand and assess digitalization's full range of impacts and implications. Then we need to engage in the necessary dialogue, reflection, organising and common action to address the concerns that arise.



The Trojan Horse and its hidden secret

According to the narrative currently being pushed by the World Bank, the World Economic Forum, the UN's Food and Agriculture Organization (FAO), and Big Ag and Big Tech, our 'global agrifood system' is 'not fit for purpose', for a number of reasons, including its impact on climate change.[5] However, this assessment isn't accompanied by a call to create or lift up different and already existing alternatives, such as peasant agriculture and agroecology. Instead, the argument being made is that what's lacking in the current food system is 'efficiency' and that the only way forward is 'agrifood digitalization'.

But first it's important to reflect on the fact that 'digitalizing the agrifood system' can mean different things to different people, including in relation to different sectors along the food chain.[6]

Many people around the world, mainly in the global North and in cities and urban areas in developing countries, are already familiar and comfortable with using digital technologies, meaning that the idea of digitalizing food and agriculture can be and is being pushed with a strong narrative about being modern, tech-savvy and convenient for both producers and consumers.

For example, there is a growing trend for consumers, mainly in cities and urban areas in developing countries, to use smartphone apps for online grocery shopping and food delivery (at least amongst some of the two-thirds of the global population connected to the internet[7]). Similarly, some farmers and farm workers may already use email, chat or text messaging to share information with their neighbours about weather or emerging pests; and they may post text and photos to social media platforms to let customers know about the food they are growing, or use smartphone cameras to document unhealthy plants in their fields. They may also use app-based spreadsheets to track farm equipment maintenance or how much their animals are eating and to check environmental conditions. These digital tools, in turn, may rely on digital infrastructure, like networks (to transmit data between devices).

But this is just a part of what is actually being envisioned by Big Ag and the Tech Titans for the digital transformation of the agrifood system.

New digital tools are being used to usher in new business models that consolidate corporate control and industrial agriculture even further. It is data that is the central product being farmed and extracted, including in systems ostensibly about food production and consumption. This business model implies the design, building, provision and control of data infrastructures and digital processes by large off-farm corporations; and is fundamentally based on the idea of deep data surveillance, data-mining and data-trading. Take away data extraction, control and manipulation and the entire model falls apart. It is not about the production of food, stopping climate change or protecting biodiversity.

To summarise, the key concern is not about the practical use of data, but about who controls the 'Big Data' business model. An Excel file used by a farmer to record their sales is not 'Big Data', but a 'data lake' of real-time, raw information flowing in from sensors on hundreds of farms, to be accessed and aggregated behind the scenes *is* Big Data. In a digitalized food and agriculture system, this may involve 'machine learning' to design plant or animal genomes, algorithmic-based decision-making to grow crops,

using blockchains to automate contracts or execute grain trades, or customer profiling in relation to online food delivery and grocery shopping – they all rely on data.

By design, agrifood digitalization turns data into an agricultural input of its own – aiming to make it as fundamental to farming as seed or fertiliser. The World Bank estimates that by 2050 every farm could produce around 4.1 million data points ***daily***.[8] The Big Tech companies also rely on their ownership of cloud services for most of their profits, meaning that the ownership of hard infrastructure like data centres, satellites and undersea cables is key to their business model.

Focusing too narrowly on digital technologies obscures or glosses over the fact that the key problem is actually about who designs, develops and controls these technologies.

Box 1: China, the USA and India: real life examples of the hidden dangers of agrifood digitalization

Technologies are the products of deeply political processes, knowledge and systems and, as ETC Group has argued for decades, any technology introduced into an unjust society will tend to exacerbate existing inequalities.

What we can usefully do is think collectively about the implications of agrifood digitalization generally and what actions are necessary to address potential negative impacts. These three real life examples illustrate the complexities:

1) China: China-based **Pinduoduo** is a wildly successful social media platform, incorporating gaming to attract users (it's "both Costco and Disneyland" says its founder[9]). Pinduoduo gets almost all of its revenue from advertising as sellers on the platform must buy ads to attract buyers. According to FAO, 16 million farmers in rural China use the platform to sell their produce directly to consumers, bypassing wholesalers and other traders and 'middlemen' who would otherwise cut into their earnings.

The company received FAO's Innovation Award in 2022 "for developing a unique platform to connect smallholders with the market while improving lives and livelihoods of millions of farmers".[10] To make selling on Pinduoduo profitable, however, farmers must become skilled social media self-promoters, or as one analyst says, they have to "work for it" – using livestreams and ads "to catch eyeballs".[11] Some farmers have left the platform because their already slim profit margins were further reduced by spending money on ads, or because the e-commerce algorithms favour only a few types of top-selling crops.

As with other social media platforms, Pinduoduo captures data on users (both buyers and sellers), but in early 2023 Pinduoduo was found to have "innovated" to achieve "next level" privacy violations: the company exploited device security flaws to install malware along with its app "to monitor [users'] activities on other apps, check notifications, read private messages and change settings"; the goal was to improve its machine learning model to more effectively personalize push notifications and ads, according to sources.[12]

2) USA: By design, and in the name of 'efficiency', there is a tendency for digitalized agrifood systems to privilege uniformity, including monocultures – just as we have seen for all technologies promoted by industrial agriculture, including the Green Revolution technologies and genetic engineering through to digitalization. A stark example can be seen in the

commercial apple and pear orchards at the heart of the US fruit tree industry. According to a presentation in 2022 by scholar and farmworker advocate Erik Nicholson, one third to one half of all orchards in the US Pacific Northwest – both large and small – were up for sale due to the impending 'transformation' toward digitalization; more specifically, due to the need to transform traditional 'three-dimensional' orchards into 'two-dimensional' orchards to accommodate robotic harvesting and 'precision' technology that uses AI to identify fruit that is ready for harvesting.

Whereas orchard trees have canopies that extend in all directions (3D), a fully 'digitalized' orchard needs trees to grow in flat rows along trellises and without canopies (2D). The cost of replanting is untenable for most orchardists. Nicholson estimates the cost at US$60,000-80,000 per acre and that it takes three to five years to establish a '2D' orchard.[13]

What is playing out with the 'flattening' of US orchards may occur across other agricultural landscapes. In global South contexts, such as sub-Saharan Africa, the traditional peasant agroecological production that feeds most people is mixed, multifunctional and biodiverse. While entities such as the Gates Foundation and AGRA are keen to push digitalization into African agriculture, any adoption of digital tools is likely to require a similarly reductive approach to accommodate technical limitations.

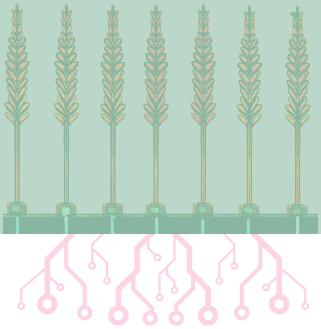
3) **India:** In Andhra Pradesh, Big Agritech is moving into the territories of Indigenous people illegally, without their knowledge or consent (but with state support). Adivasi farmers are unknowingly being incorporated into global digital agriculture value chains, linking them to the world's biggest food and agriculture companies, via multi-stakeholder 'compacts' formed locally. A key agribusiness goal is to be seen to be resourcing sustainably by linking directly to the well-known Zero Budget Natural Farming (ZBNF) program, and similar agroecology projects. (ZBNF has been funded by the state of Andhra Pradesh and championed globally as one of the world's success stories in terms of upscaling agroecology.)[14]

This digitalization drive involves new data platforms and technologies being tested out in Adivasi territories. For example, digital platforms include SourceUp, which describes itself as a "collaboration platform for supply chain sustainability at scale". SourceUp uses digital mapping technologies, Google Cloud and track and tracing technologies, and its 'participating buyers' include companies such as Bayer, Carrefour, Cargill, JBS, Marfrig, Nestlé, Pepsico and Unilever.[15]

These companies are all investing heavily in digital technologies as well, nominally for responsible sourcing, but more likely to wrest control of entire production value chains from end to end. In the case of Unilever, for example, the company is reported to be, amongst other things, digitally crowdsourcing and mapping photographs of small 'illegal' traders with a view to eliminating 'leakage' from the company's supply chains.[16]

Platforms such as SourceUp and their backers are also gaining control of setting sustainability indicators – what is and isn't considered to be sustainable – as well as gaining access to data treasure troves which they can then utilize to further their own business objectives.[17, 18]

Who's behind the agrifood digitalization agenda?



Box 2: Agrifood digitalization provides fertile ground for Big Data cloud companies

Big Data firms have already beefed up their involvement in providing 'cloud' data storage services for digital agriculture. Gartner, a technology-focused consultancy, calculated that spending on cloud services was nearly 10% of all corporate spending on information technology in 2021. The proliferation of digital ag companies is thus a gold mine for Big Tech, which is developing cloud services to enable massive volumes of agriculture-related data to be stored and processed.

The biggest players in industrial agriculture (Bayer, BASF, Syngenta, Corteva Agriscience) use Amazon Web Services (AWS), Microsoft Azure or Google Cloud services to process and analyze data on their digital platforms. The cloud services market is tightly consolidated: Recent data indicates that Amazon, Microsoft and Google accounted for 66% of the cloud services market at the start of 2023; and that AWS alone accounted for half of that (ie. a third of the total market).[19]

As the 'digitalization in food and agriculture' agenda is rolled out, the landscape of corporate involvement is changing: Big Ag is creating its own digital platforms, designing automated farm machinery, partnering with drone companies, and using Big Tech's cloud services to store and analyze valuable farm and food-related data. At the same time, Big Tech is investing in food and agriculture as well; and companies from both sectors are partnering with each other.

For example, Chinese state-owned Syngenta now has a digital platform, Cropwise Grower, focusing on selling services including agronomic advice, weather forecasting, and pest and disease identification to small farmers.[20] A company such as Syngenta, that is already selling agrochemicals and commercial seeds to farmers can benefit hugely from digitalization by acquiring insight into valuable data relating to the agricultural practices of farmers, and soil and weather data, which it can then use to influence farmers to buy its products and practice agriculture the way the company wants them to. This comes back to farmers in the guise of "technical advice" provided through the Cropwise platform, with the purported aim of obtaining better yields, or sequestering carbon in soils, or similar advice.

Bayer has similarly developed a platform called FieldView. FieldView has partnerships with about 60 companies which cover a range of services like satellite or drone imagery collection and analysis, and soil health analysis. Bayer uses the data collected from its digital platform to develop tailor-made seeds and tell farmers how to carry out their agricultural practices.[21] As an example of its corporate relationships Bayer has entered into a partnership with XAG, which is one of the world's largest drone manufacturers, in order to promote digital agriculture in South-

east Asia and Pakistan (SEAP), focusing on spraying agrochemicals via drones, and targeting use by small farmers in particular.

At the other end of the Big Ag-Big Tech spectrum we have some of the largest Big Tech companies such as Microsoft and Alphabet (Google's parent company) piling into the food and agriculture sectors.

For example in 2021, Microsoft signed agreements with the governments of India and Indonesia to promote digital technologies among smallholder farmers, using Microsoft's FarmBeats. Its platform collects and analyzes data from multiple sources like drones, sensors and satellites, and tells farmers how to practise agriculture based on that data.[22] While this may sound helpful to many, it seriously undermines farmers' autonomy and knowledge, transforming them into mere implementers of these companies' directives. Microsoft will get access to a large farmer base and farmers' data, both of which will help them promote and sell their platform back to farmers and significantly influence smallholder farming practices in those countries.

Similarly in 2023, Google's parent company Alphabet launched an agritech firm, Mineral, as a 'stand-alone' Alphabet company[23] developed from its Moonshot projects. Mineral is using proprietary technology to collect and analyze valuable on-farm data by combining satellite data, data from farm machinery and public databases.[24] By collecting and analyzing this valuable data, Alphabet will have insight into where the most valuable land is located, the details of how farmers are practising agriculture, and the crops that are being grown in a region. It will be able to use this information to expand its business into farm advisory, and likely sell this valuable data to other companies which are vying to develop tailor made commercial seeds and agrochemicals.

There is also a trend of Big Ag and smaller technology companies partnering with each other. For example, DJI, the Chinese corporation which is the largest drone manufacturer in the world, has partnered with Syngenta Japan to promote agriculture drones in Japan.[25] Corteva, one of the largest agrochemical and commercial seed companies in the world, also owns a fleet of 400 DJI drones.[26]

These investments in and the rapid rollout of agrifood digitalization have been accompanied by a loud and insistent drumbeat: corporations demanding that governments should finance this transformation. Perhaps the loudest calls come from the World Economic Forum with its Food Systems Initiative and the closely aligned industry think tank FOLU (the Food and Land Use Coalition), as well as the constellation of 'sustainability' enterprises and advisors that cluster around them. The influential UK self-styled 'systems change company' Systemiq hosts FOLU. FOLU lists 'harnessing the digital revolution' in the food system as one of the ten critical transitions that will support progress toward the SDGs and it advocates for 15 billion dollars in investment *annually* toward that end to 2030. At the 2021 UN Food Systems Summit (captained by the same agribusiness trade groups and shaped by Systemiq), a Global Coalition for Data and Digital Food Systems Innovation[27] was established by the World Economic Forum to press the case for government investment in data and digital tools. A sister initiative also stemming from the 2021 Summit was the AIM4C or AIM for Climate (Agricultural Innovation Mission for Climate) coalition co-founded by the US and UAE, which advocates for investment in high-tech agricultural technologies that are 'climate-smart', with agrifood digitalization squarely in the centre of the frame.[28]

Challenging Big Ag and the Tech Titans' Problematic Promises

In order to make the whole concept of digital transformation palatable and enticing to policymakers, investors, farmers and the public, Big Ag and Big Tech are relentlessly projecting and reinforcing assumptions and premises that may be untrue or only partially true.

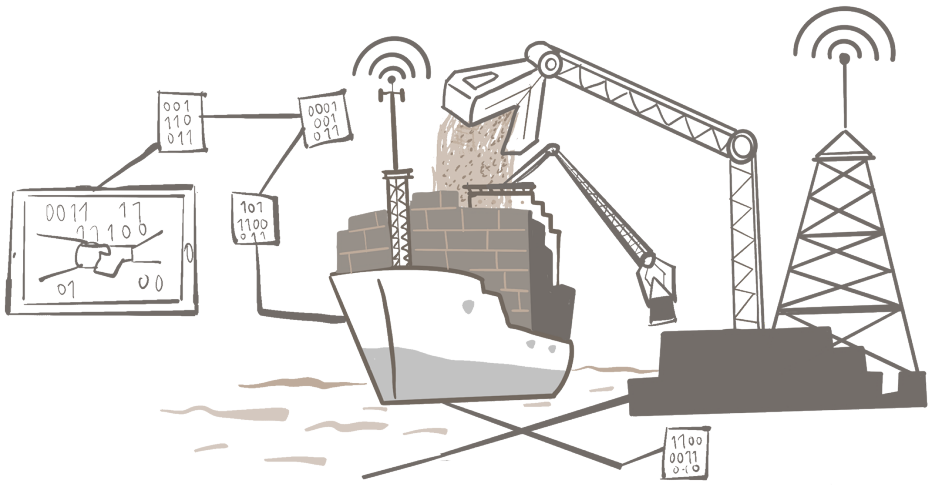
Some of the deeper (and more specious) assumptions necessary to attain and sustain high levels of investment apply to industrial agriculture more broadly – for example, the claim that we must drastically increase food production so that we can feed a growing population.

Other assumptions are common across commercial technologies, including the heavily promoted idea that 'high' technology is politically neutral, innovative and a sign of social progress. These include narrative assumptions specifically relating to agrifood digitalization which are also helpful to name and should be interrogated. We challenge five of these normally unquestioned corporate narratives below.

1 Digitalization is not transformative, it is based on yet more colonialism

Big Ag and Big Tech's underlying narrative or promise is that agrifood digitalization is transforming sectors and business models and will bring 'efficiency' to a food system that is currently labelled, by them, as being 'not fit for purpose'. But this depends on what the purpose is: feeding profits or people? Look more deeply and this looks a lot like the same old colonialism, the same old capitalism, coming from existing Big Ag and Big Tech companies looking for new markets and power bases.

Tech evangelists like to point to the innovative nature of new, 'disruptive' hi-tech tools, and we are frequently told that the internet has revolutionized all areas of the economy.



Yet if we look back to the steam engine, the internal combustion engine and the production of synthetic chemicals, we can see that all of these fundamentally changed our economies, societies and environment – but not necessarily in equitable ways, and with very different impacts in the Global North compared to its global colonies/ex-colonies in the Global South.

While the disruptive force of these technologies is irrefutable, history shows that it's not the emergence of a new tool or technique by itself that drives these various changes, but the accompanying application of new business models that industrialists usher in under cover of these tools in order to profit from the technologies in question.

For example, in the 18th century, the steam engine's real disruptive power was felt when the technology was integrated into the new factory system – a business model that forced labour to serve automated production, de-skilling production and creating a new 'working class' under the rule of 'factory bosses'.

Similarly, genetic engineering began to transform agriculture when agrochemical companies secured enforceable patent monopolies on engineered seeds and then leveraged those legal rights – along with corporate consolidation and enabled by government policies that advanced corporate interests – to force farmers to buy their seeds and herbicides as a proprietary package.[29] Those legal mechanisms also prevented farmers from saving seed under threat of prosecution for violating the terms of licensing agreements.[30]

2 Digital technologies are not neutral, unbiased or 'immaculate'

The corporate narrative here is that data reflects objective truth and is therefore neutral; and that it is weightless (like a cloud), 'immaculate', with no physical impacts.

Nothing could be farther from the truth however. 'Big' data is amassed and interrogated using digital technologies constructed by humans – overwhelmingly from well-resourced and powerful elites – and is subject to geopolitical, corporate and other manipulations. Even more importantly, algorithms are likely to be trained on data from industrial monocultures,. Transferring on-farm decision-making to such algorithms would seem to be a remarkably effective way of massively expanding industrial agriculture at the expense of other food systems in particular, indigenous and traditional systems.

Data isn't green or clean, nor is it 'weightless' and 'neutral'. In her book "The Immaculate Conception of Data: Agribusiness, Activists, and Their Shared Politics of the Future", Canadian scholar Kelly Bronson undertakes an ethnographic study of the digitalization of agriculture. She observes that not only digital farming advocates, but also policymakers and media, blithely accept and promote the notion that so-called 'raw' data streaming off of digital devices and sensors, stored and processed in cloud servers and used by 'data-driven' farming, is unsullied and represents a kind of authoritative, unimpeachable, rational truth about the world.[31] (This mirrors assumptions about the 'objectivity' of science and its superiority to other systems of knowledge and ways of knowing.)

In reality, as Bronson points out, data is not 'found' as a resource in nature but is 'made' or 'generated' and, as human actors make and construct data, they introduce biases, place limitations, impose perspectives and choices, and skew outcomes. In the case of automated decision-making for digital farming, Bronson points out that humans have, for example, chosen the 'inputs' (the multitude of data points on variables like soil and seed). And if the system 'learns', then a human has decided which data will be used to 'train' it. Biases will further be introduced by the assumptions built into the design of software and hardware, use of language, and socio-economic factors like who gets to use and benefit from computational resources.

Box 3: There's no such thing as a free lunch: digital colonialism

In their book "The Costs of Connection: How Data Is Colonizing Human Life and Appropriating It for Capitalism", scholars Nick Couldry and Ulises A. Mejias push back on the idea of digital capitalism as a 'new' business model and show how it is essentially a (re)manifestation of much older patterns of colonial exploitation. Previous waves of colonists grabbed and aggregated land, natural resources and human labour into empires of control. They did this by downplaying those assets as worthless or basically free, trading trinkets for them or using violence to acquire them. They then used new technologies of transportation and processing/production to make those assets much more valuable in their home marketplace.

In the same way, Big Data companies amass data in exchange for (often 'free') services and then aggregate, trade and exploit the captured data as a valuable and strategic commodity (or sell it in processed form back to those from whom it was originally obtained). Couldry and Mejias describe how the colonial drive towards data extraction creates a new 'cloud empire' of data-processing power brokers whose emperors are the tech billionaires that are now household names. To sustain their empires, the data colonists need to find new data sources—to move beyond datafying our social lives (through social media) to datafication of other aspects of life—including food and agriculture, health and the natural world.

Movements and people rooted in resistance to colonialism have been quick to understand data colonialism as an extension of previous colonial waves. Ethiopian A.I. scholar Abeba Birhane has written on algorithmic colonization of Africa in a way that is particularly relevant in the context of agrifood digitalization for 'sustainable development'. She writes:

"The discourse around 'data mining', 'abundance of data', and 'data rich continent' shows the extent to which the individual behind each data point is disregarded. This muting of the individual…is symptomatic of how little attention is given to matters such as people's well-being and consent, which should be the primary concerns if the goal indeed is to 'help' those in need. Furthermore, this discourse of 'mining' people for data is reminiscent of the coloniser attitude that declares humans as raw material free for the taking." [32]

This accords with Abeba Birhane's research into Algorithmic Colonisation (see Box 3). She finds that much of this digital discrimination falls disproportionately on minorities, including racial and gender minorities, and is very clear that "Anybody who doesn't satisfy the status quo is often seen as an outlier and those are the people that suffer the most."[33] In just this way, Bronson recalls one of the leading data scientists behind Microsoft's digital farming platform expressing the power of digital platforms to transform peasant farming from something "primitive" to something "innovative". [34] Such condescending judgements of existing peasant agriculture are likely coded into the software platforms and invisibly structure the data and its end uses.

3 Digital technologies have a heavy environmental 'footprint'

Notions of data being an ephemeral thing stored in 'the cloud' – or the decades-long promises of limitless data processing and storage on Google, AWS or other servers – hide the true energy costs and intensely physical nature of data extraction, transmission, storage and processing. (And, by the way, clouds are heavy, too – a 'typical' cumulus cloud weighs about 1.5 billion pounds.[35])

Electronic data is fundamentally energy – the movement of electrons as signals along circuitry. It uses infrastructure based on minerals: those signals are stored in physical media such as silicon or cobalt on glass, aluminium and ceram-

ic substrate. The land needed to house the servers and data centres that power the 'cloud' for data and machine learning databases, the massive amount of energy required to manufacture and run these machines, and the immense amount of water needed to cool down servers to keep them running around the clock, all involve indelible carbon footprints and could compete directly with the resources needed for food production.

Microchip-grade silicon production involves the transformation of particularly high-quality quartz sand, of which 30,000 tonnes is mined annually from dwindling stores in China, Mongolia and the U.S., using extremely high heat, toxic gases, hazardous chemicals and water. According to New Scientist, "a typical data centre, which may house several thousand servers, can use between 11 million and 19 million litres of water per day, equivalent to what a city of 30,000 to 50,000 people uses." [36]

Box 4: Data as an asset: is data the new oil (or new soil?)

For a few decades now, data has been (favourably) compared to petroleum because of its flexibility: data can be processed, analyzed and packaged to be relevant in various ways for multiple markets, just as petroleum can be 'cracked', using heat and pressure, to create various products such as fuel, plastics or pesticides. Like oil, data too can be extracted on a massive scale.

Raw data can be analyzed and made relevant to various areas of commerce using machine learning tools to find relevant patterns, relations or 'signals.' For example, the same genomic data gathered to monitor one's health may also be used to sell dating services (www.dnaromance.com/), family history research (through companies such as AncestryDNA and 23andme), create musical playlists to reflect 'genetic ancestry' (Spotify), and even potentially to market 'ethnic' foods.[37] Weather data can be used simultaneously to inform crop-planting decisions, insurance policies, hedge fund strategies and land investments. Data gathered for agriculture may also be used for environmental monitoring or 'homeland security'.

The accumulation and sale of this data can be the primary objective of a company as the following example, also from the genomic data gathering sector, shows:

"*Patrick Chung, a 23andMe board member, noted in an interview that "the long game here is not to make money selling [gene testing] kits, although the kits are essential to get the base level data" (Murphy 2013). In line with this notion, 23andMe has already accredited access to its data to the pharmaceutical company GlaxoSmithKline in a $300 million deal (Brodwin 2018).*" [38]

This is partly because data differs from oil in that its value increases as you amass more of it. While scarcity increases petroleum's value, the more data you have to interrogate the more marketable 'insights' you can derive, because that's how machine learning works. Thus the most powerful players are those who can grab the most unstructured data and feed it into their machine-learning models.

This is one reason the food chain is particularly attractive as a target to Big Data firms: food systems produce data continuously end-to-end (e.g., seeds, inputs, weather, prices, ecosystems data, genomic data, consumer behaviour, etc.). If Big Data is the new oil, then Big Agrifood looks something like Saudi Arabia.

4 The digitalization of agriculture could disadvantage farmers, food workers and food vendors directly

Digital agriculture, as being proposed by Big Ag, should come with a warning for farmers, farm workers and food vendors, about potential lock-ins and other traps.

In particular, signing up with a digital ag company could lock farmers and other food producers into a contract that will force them to buy the products the company promotes and sells on credit (at high prices), follow chatbot advice to qualify for insurance (which they must pay for), and receive payment via a digital money app (for which there may be a fee). If farmers deviate from the technical advisory or do not comply, it could potentially affect their credit worthiness and future access to finance and markets.[39]

Even if a company declares it will share some of the risk with them, farmers may still find themselves locked into selling their farm products to just one company at a price determined by an algorithm (potentially on the basis of opaque criteria). Farmers may be forbidden from repairing proprietary equipment on their farm. And land rents and prices may also increase as data companies identify and micro-target the most productive land and buy it up.

Furthermore, the inclusion of agricultural soils in carbon markets as a supposed means of sequestering carbon dioxide poses a significant risk to territories and food production, which is linked to the digitalization of agriculture. Big Ag companies are seeking to use digital technologies to measure carbon dioxide supposedly sequestered in soils so that 'carbon credits' can be sold to polluting companies (who can then continue to pollute).

This is not as beneficial for farmers as it might seem. Simply put, carbon programs like Bayer Carbon or Cargill's RegenConnect, currently being rolled out, tell farmers that they will be remunerated if they practise agriculture exactly the way those companies want them to, and only if they share all their agricultural data with the proponent companies. Big polluter companies, including Big Ag companies with carbon farming programmes, like Cargill and Bayer, can then buy the carbon offsets to set against their own polluting activities.[40] This could lead to increased land disputes and speculation, as companies will have granular data on which land is more profitable and where yields are highest, likely leading to more dispossession and displacement of peasants. It would also lead to the submission of farmers to yet more forms of management imposed by so-called experts as they are again expected to resort to practices prescribed by corporations.

Food workers such as warehouse workers are also threatened. They may find their jobs replaced by machines such as robots and drones, and even if not, they may be expected to work at the same pace as a robot, even though this has already been leading to increasing numbers of accidents in manufacturing and warehouse settings.

Food vendors may find that giant data platforms skew food distribution routes, inserting themselves as middlemen between farmers and consumers, and excluding food vendors (as has already happened around Nairobi, for example).[41]

In general giving data away to large companies enriches them and makes them more powerful, further skewing the balance of power in the Industrial Food Chain, with further unknown consequences in the future. This does not mean that digitalization should always be avoided, but it does mean that careful and critical consideration is required, along the lines of the questions we outline below.

5 The industrial agrifood value chain is not the best or only possible food system, digitalized or otherwise

Big Ag has been at pains, at every possible opportunity, to drive home the idea that the

industrial agrifood value chain is the only possible food system that can be imagined. This is not the case. The industrial food system is destructive for the environment, humans and the climate, and this narrative is deliberately structured to make the peasant food web invisible.

The metaphor of the industrial food value chain – a series of linear steps that are consistently and precisely adhered to in order to attain desired results or finished products – so dominates decision-making about food that many policymakers barely recognize the traditional webs of peasant food-provisioning that exist (and pre-existed) alongside it.

Over the past 80 years, agribusiness has successfully built up a story in the popular imagination that the majority of the world's people get their food from the industrial food chain. However, the story that the industrial food chain provides global nutrition is wrong. In fact, the peasant food web still feeds most of the world's people — particularly outside of the industrial North. If policymakers fully grasped the importance of the peasant web of food provisioning, they *should* have troubling second thoughts about the (mostly blind) faith they are putting into agrifood digitalization.

Food, in the agroecological world view, is valued not according to scarcity or price, but more as an infrastructure of social and cultural systems to be maintained in abundance: food webs focus on building relationships between seed, soil, story and community, strengthening resilience and respecting experiential human-centred knowledge (e.g., farmer expertise and knowledge, consumer-farmer relationships, etc.).

The agroecological approach clashes with the productivist approach to food systems and, to date, very little digital technology in the food and agriculture space has been about maintaining agroecological webs, relationships or infrastructure in the absence of large-scale commercial exploitation.

Agrifood digitalization is not an inevitable or even logical process of evolution of the food system 'transformation'. Rather, it is a deliberate, costly and resource-intensive endeavour driven by industrial agrifood and big data corporations, with a very different end goal, profit, in mind.

Conclusions

Questions for exploring digitalized agriculture's (false) promises and (harsh) realities

The hundreds of billions of dollars flowing into the digitalization of agrifood systems is buoyed by a bevy of promises that it will: make farming more 'productive'; provide more nutritious food at a lower price; help agriculture become 'climate smart'; reduce farmers' pesticide use through precision agriculture; and promote and quantify carbon sequestration in soils and maybe seas. We, as civil society and social movements, need to scrutinise each of these claims, and this paper is intended as a contribution to that scrutiny.

To be clear, the issue is not with the pros and cons of individual technologies or the use of peer-to-peer digital communications platforms. The problem is that agrifood digitalization – as an overall trend and within the context of the specific corporate business model that is being applied to it – privileges digital information, and the ownership of that information, over the knowledge systems of the Indigenous and peasant communities that have nurtured crops and breeds across generations.

If we step even further back, we can see the ongoing development of yet another extractive neo-colonial business model that is deliberately designed to expand corporate access to and control over data in all sectors of the food system.

This Big Ag/Big Tech model is expanding rapidly. Although the industrial digitalization of food and agriculture is currently more advanced in regions such as North America, we can already see that smallholder farmers, peasants and others, in countries and regions around the world, are now being targeted directly, often with state involvement and support. We also see examples of the Big Ag/Big Tech business model being used to squeeze out small food retailers, with further negative impacts for cohesive local food economies that sustain local populations.

Overall, ETC Group views the ongoing corporate-driven digitalization of food and agriculture as a deliberate and aggressive move to expand industrial agriculture at the expense of the peasant food web. This is why we view it as a Trojan Horse. Behind the superficial convenience promised by these digital technologies lie the:

- Potential disempowerment, de-skilling and increasing invisibility of peasants and the rich cultures, practices and knowledge systems that underpin diverse agricultures around the world.
- Progressive erosion of farmers' autonomy.
- A dematerialization deception or 'con trick' (because the environmental costs of digitalization are actually so high).
- Further privatization of the biological and genetic resources that are the foundation of our food system.

When assessing the digitalization of food and agriculture we propose collectively considering the following questions in more depth:

• What is the nature of the underlying Big Ag/Big Tech business model and where is it heading?

This new digital phase in agrifood is more than just a technological change, because it opens new frontiers of control, surveil-

lance and ways of extracting resources and profits from the work of farmers, even in family and peasant agriculture.

These schemes are being promoted as a means of making food production more efficient, but this 'productivist' approach ignores the fact that the ongoing digitalization of food and agriculture threatens to crowd out traditional and efficient agroecological knowledge, as used by current generations, and terminate inter-generational knowledge transfer if new generations of farmers become entirely dependent on Big Ag/Big Tech platforms and apps.

• Why is the ownership of digital infrastructure and data so critical?

By far the largest share of the gains to be had from the adoption of digital agricultural platforms – in terms of finance and power – goes to the corporations driving this trend. Big Agritech's platforms and associated digital infrastructure are central to the whole process, enabling the massive extraction of data; the onward selling of that data in valuable aggregated form; and the guaranteed sale of proprietary inputs and equipment in accordance with contracts that farmers have to sign, locking them into these corporate systems for a given period of time.

Given the dominance of the current Big Ag/Big Tech model, it seems that the possibility of communities or public collectives being able to control data mining, data reconfiguration and data storage may be near to zero. If that is the case what are the implications for the development of locally-designed and locally-based digital apps and other tools? Is it possible for data to be uploaded onto clouds and infrastructure controlled by local communities?

On another note, how can Full, Prior and Informed Consent (FPIC) concerning the use of the data of anyone involved in the food system – as a producer, consumer or intermediary – be ensured? Is it possible to ensure that private corporations are banned from having proprietary rights to that data? And how can we ensure that users also have the rights and capacity to repair their digital equipment?

• What role do governments play in terms of facilitating the digitalization of food and agriculture?

Although most of the digital transformation currently underway is being driven by and developed in the interests of large companies, especially Big Ag/Big Tech, it is important to explore and understand the role that states are increasingly playing, both as developers, facilitators and potential regulators of aspects of digitalization. This can include the provision of digital infrastructure and access to public databases, paid for with public money, for private/commercial use and profit.

• What are the hidden environmental and social impacts of the digitalization of food and agriculture?

The corporate narrative that digital technology is progressive, apolitical and immaterial has been used extremely successfully to divert attention away from the very real environmental and social impacts of digitalization. These include its high demand for energy, mineral resources and water for cooling, and the impacts that all of those have on communities and the environments they depend on; and because farm, food and retail workers around the world are increasingly being replaced by automation and robotization.

At the same time digital technologies, including 'precision agriculture', are being heavily promoted as supposed solutions to environmental and social crises, including climate change, biodiversity collapse, climate crisis and unequal access to food. Digitally-based 'techno-fix' approaches are highly profitable for the companies selling the technologies, and easily marketed as 'solutions' to governments looking for quick and cheap 'fixes' so that they can be seen to be green. But they are 'false solutions' and

dangerous distractions from what really needs to be done. This techno-fix 'bubble' needs to be burst, to make way for real solutions.

• Who should decide whether digital technologies are useful to or important for smallholder and peasant farmers and communities, local food producers and traders?

Since 70% of the world is fed by small-scale farmers and peasants, who use just 30% of the world's resources to do so, it is clearly critical that these food systems are promoted and protected at all costs. This includes protecting small-scale farming, family farming, urban farming, and local and indigenous livelihoods from encroachment based on the corporate interests. The profit-motivated and wasteful industrial food chain feeds just 30% of the world using 70% of its resources.

Any technologies and processes, high- or low-tech, digital or otherwise, need to be assessed, chosen, developed and implemented by small-scale farmers and peasants themselves, along with the communities and constituencies they feed. This has not so far been the case with respect to the digitalization tsunami spreading across the world from Silicon Valley.

• Is there a place for digitalization in food and agriculture at all?

On a practical level, it cannot be simply assumed that digital technologies based solely on the 'productivist' approach, and designed with large-scale farmers in mind, will benefit small-scale and agroecological food production systems. Digital technologies usually require uniformity at scale, for example in terms of accessible landscapes and suitable monocrop plant varieties.

Big Agritech's insistence that digitalization is the only way forward also negates all the different technologies and local knowledge that already exist within the peasant food web, which are highly effective, able to address local challenges and nuances, people-centred and entirely workable on a small-scale basis.

On a more conceptual level, the idea that 'high-technology' is the only kind of technology that exists or matters is another false corporate narrative. Technology can and should be much more broadly defined, including in terms of incorporating all the 'low-tech' or 'wide-tech' solutions that already exist and are in use outside the industrial food chain.

Furthermore, the supposedly sophisticated advice sold to farmers by digital platforms is in many cases knowledge that those working on the plots already had or could have obtained through community or associative relationships with peers, and through public advisory and research institutions.

So even at the level of specific technologies we need to consider: Who controls the technologies? Who designed them and why? Who defined the problems they are supposedly going to solve? What are the materials and processes being used to develop them? And who are the beneficiaries and who are the losers?

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To conclude, further in-depth discussion of this extractive digitalization model is essential. Powerful digital technologies are being promoted and used to extract valuable data from farmers, consumers and the environment, storing it in proprietary databases and using it to generate further economic benefits for the data 'owners'. This drives further corporate control and concentration, undermining farmers' autonomy, and is a direct threat to peasant and small-holder farming. It is therefore in complete opposition to the concept of food sovereignty, which is entirely based on communities controlling the way their food is produced, traded and consumed.

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- 'Algorithmic Colonisation', ETC Group with Abeba Birhane, 18 September 2020, https://www.etcgroup.org/content/5-algorithmic-colonisation-abeba-birhane
- 'Big Tech Jumping on the Bandwagon', ETC Group, 29 June 2023, www.etcgroup.org/content/who-will-control-food-system
- 'The "Immaculate Conception of Data" and why it's a problem', ETC Group with Kelly Bronson, 1 September 2023, https://www.etcgroup.org/content/episode-2-our-new-podcast-mini-series
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- 'Growing carbon is not like growing watermelons: the seductive trap of carbon farming and digital tech', ETC Group with Camila Moreno, www.etcgroup.org/content/growing-carbon-not-growing-watermelons-seductive-trap-carbon-farming-and-digital-tech

Blog:

- 'Did you know that the digitalization of agriculture could affect farmers' rights?', ETC Group, 9 December 2021, www.etcgroup.org/content/did-you-know-digitalization-agriculture-could-affect-farmers-rights

Animation:

- 'Big Brother is Coming to the Farm: the digitalization of food', ETC Group, link to YouTube playlist with animation available in multiple languages: www.youtube.com/playlist?list=PLs1KEir4Q9vSOeSCDQGizuSgIl_93Tb5o

Website:

- The assess.technology website is a resource for local and international movements working together to evaluate new and emerging technologies, with links to regional technology assessment platforms.

Glossary

A short dictionary of terms commonly used in the digitalization debate

Here we include a brief description of key terms used in this discussion paper and elsewhere. For more detailed information about these and other terms please see 'Further Information.'

Algorithms: In the simplest terms, an 'algorithm' refers to a series of steps that are consistently taken to reach a conclusion. For example, if you want to count by odd numbers beginning from the number 1, you add 2 (that is, 1 + 2) to reach 3. To reach the next odd number, you add 2 again (that is, 3 + 2), to reach 5, and so on. 'Adding 2 to an odd number' is the algorithm for reaching the next larger odd number. That algorithm will always succeed in getting the 'right answer.' But not all algorithms are as dependable.

For example, 'predictive policing' is a concept that describes the use of biased algorithms in police data systems, well documented by Black Lives Matters and other human rights movements and organizations. A number of studies have shown that these tools perpetuate systemic racism.

For example, some algorithms used in policing draw on data about people, such as their age, gender, marital status, history of substance abuse, and criminal record, to predict who has a high chance of being involved in future criminal activity. These person-based tools can be used either by police, to intervene before a crime takes place, or by courts, to determine during pretrial hearings or sentencing whether someone who has been arrested is likely to reoffend. The problem lies with the data the algorithms feed upon. For one thing, predictive algorithms are easily skewed by arrest rates. For example, it has been calculated that a Black person in the US is five times as likely to be stopped without just cause as a white person.[42]

Artificial Intelligence is designed to mimic the way people understand data, undertake tasks and make decisions – at speed. 'Machine learning' by computers is based on the use of algorithms (see above) that analyse data sets and apply what they learn from patterns they find to make one or more 'automated' decisions, gradually improving over time. 'Deep learning' is a subset of machine learning that creates more complex, layered 'artificial neural networks' of algorithms (the idea is modelled on the human brain's neural networks), resulting in processes that can learn and make decisions independently – including about the accuracy of its own predictions.

Risks associated with these complex digital processes, especially deep learning, include: the need to train AI on very large data sets (which may be scraped randomly from the internet or lifted from public databases); the inclusion of biases and discrimination already built into those initial data sets; the 'black box' dilemma, where it is not possible for humans to interrogate how an AI process has reached a particular decision; and the lack of regulation of AI development and processes.

Biodigital convergence: Two classes of technologies – agrichemicals and genetics – are today most commonly associated with either crop production (through pesticides and genetically modified crops respectively) or with synthetic foodstuffs brewed in factory vats (including artificial flavours and essences). However, it is possible that the convergence of these two

technologies with the digital realm (bio-digital convergence) will have the farthest ranging impacts on food systems and the environment.

Blockchain is commonly defined as a 'transparent, distributed ledger system'. Conceptually, it's a bit like a shared Google Doc, where everyone with edit-power can make additions (but not changes) to the document, and everyone with access to the document can see those edits happening in real time. That's the basis for describing blockchain as 'transparent', although who actually has access in the first place is of course critical. A blockchain is hosted by a network of computers instead of a single server (that's the 'distributed' aspect). Making changes to data on a blockchain requires enormous computing power, because there is an extra 'mining' step. This involves supercomputers competing to solve complex equations in relation to each transaction as a way to validate the changes to that chain. This makes current blockchain technology extraordinarily energy-intensive, e-wasteful and "terrible for the environment".[43] Another concern is the way in which blockchain can be used as undisputed 'proof of ownership', just as computer systems may be used by someone in power to illegally 'assign' land tenure, facilitating land grabbing. Blockchain underpins cryptocurrencies such as Bitcoin.

Bots are automated software programs that can interact with systems and users in relation to predefined tasks. Examples include: chatbots that can answer a range of questions from a website user; bots that scan websites' digital content for keywords; and bots that criminals might install on your computer, for example to access private information.

Data, at least when it's digital data, refers to information in a particular digital or 'computer-readable' format. For example, human speech is not data – even if someone writes down the words spoken. Human speech, music, Indigenous knowledge and artworks might become data when they are converted to a coded format for storing and processing as files on computers.

Digital refers to the format that enables a device to process and send data along electrical circuits. All digital data (whether in the form of text, image or sound) can be expressed as a numerical value in binary code – that is, as 1's and/or 0's (sometimes other binary language is used: on/off, true/false or yes/no). Tiny electronic sensors ('bits', which are grouped together in 'bytes' of 8) are switched on or off (ie 1 or 0) to represent that data. For a further explanation of binary code, see https://www.youtube.com/watch?v=Xpk67YzOn5w.

Data-driven refers to digital technologies that use algorithms and computer 'intelligence' to 'act upon' the data that has been gathered/entered. The algorithmic-dependent action is the feature that distinguishes data-driven automation from other kinds of automation. For example, a traditional tractor might use automation (its seed drill can be set to automatically sow seeds at a specific soil depth and with uniform spacing), but that isn't enough to qualify as 'data driven'. A tractor that uses Global Positioning System (GPS) coordinates (sourced from satellites orbiting the Earth) for autonomous steering, and/or sensors for computer-based soil analysis to plant seeds at a variable depth depending on soil composition, could be described as data-driven agriculture.

Digital tools can refer to various technologies that generate, store or process data. These may be either hardware (for example, an electronic device such as a smartphone) or software (for example, blockchains, artificial intelligence agents or 'bots' or apps). Other examples of digital tools include drones and robots, data-driven farming advice platforms, blockchain-based transactions, app-based food delivery and online grocery shopping. These digital tools, in turn, may rely on other digital tools, like sensors and networks (that transmit data between devices).

Facial recognition is a technology that is already widely used to monitor people's behaviour, often without their consent, and it is now being used with pigs, cows and other livestock in order to reduce labour costs and increase the scale of factory farming, contrary to industry claims that it would benefit the welfare of animals. This increase in intensification would cause severe negative environmental and biodiversity effects.

Hyperspectral Imaging: Hyperspectral imaging technologies are used to allow the surveying and analysis of land, vegetation and crops. They use information from the electromagnetic spectrum for each pixel in the image of a scene in order to find objects, identify materials or detect processes. They are key enablers of highly intensive industrialized 'precision' agriculture. Corporations can be expected to measure what makes profit with little regard for the environment or biodiversity.

The Internet of Things or 'IoT' refers to the way in which objects are embedded in a network of sensors, data processing software, and other technologies, that connect and exchange data with other devices and systems over the internet. It is central to the processes of digital automation that lie at the heart of the industrial intensification of agriculture. The network is generally designed by a corporation to maximize its profits by maximizing the amount of patterns from which its AI can guide profitable short-term investments, without regard to the long-term impact on the environment or on biodiversity.

Robots are designed on the basis of data extracted from the existing human workforce, who they will replace. They are normally tied to an intensive system of industrial monocultures, carrying out tasks more cheaply than humans and without the need to rest or eat. By contributing to the increased industrialization of food systems they would be helping to exacerbate overall damage to the environment and biodiversity.

Sensors: Automated sensors measure numerous aspects of the environment creating data to be processed, which is of significant financial interest to corporations and will help them to maximize profit. This risks both de-skilling farmers and overlooking important aspects of the environment and biodiversity, causing ecosystems to be at greater risk of harm.