This article provides an overview of the second interview in a three-part interview series that explores how digitalization is reshaping environmental governance. I spoke with Oane Visser, an Associate Professor in Agrarian Studies at the International Institute of Social Studies. Visser earned his Ph.D. in anthropology from Radboud University, Nijmegen, in the Netherlands. His research focuses on the intersection of digitalization and climate change, environmental degradation, and the future of food production.

His current project explores precision agriculture in the Netherlands, the United States, Canada, and the United Kingdom. Visser argues that precision agriculture has been promoted as a means of addressing the problems with conventional agriculture. When practicing conventional agriculture, a farmer will typically apply the same amount of fertilizer and pesticides across their entire field. With precision agriculture, each plant and animal ideally receive exactly the inputs it needs, thereby reducing water, energy, fertilizer, and pesticide use. This precise application of inputs is achieved through an assemblage of technologies including crop, animal, and soil sensors, satellites and remote sensing devices, geographic information systems (GIS), global positioning systems (GPS), variable rate technologies (VRT), and artificial intelligence, among others. Precision agriculture goes by several other names including, “smart farming,” “agriculture 4.0,” and “digital agriculture.”

Advocates of precision agriculture often frame technology as a seamless solution to the problems that ecological crisis and climate change pose to food systems. Approaching these technologies with an ethnographic perspective, Visser complicates that narrative and argues that these digitalized agricultural technologies are not, in fact, seamless, and instead remain dependent on human action. At its worst, precision agriculture may even extend or intensify the vulnerabilities that farmers experience and produce power dynamics that can be exploitative.

Precision agriculture originated on large farms in the Midwestern United States in the 1990s, where the focus was on staple crops like corn, soy, and wheat. Precision agriculture remains most prevalent in developed countries like the Netherlands, Germany, the United Kingdom, France, Australia, and Canada, but has spread around the globe. Much of the investment in, and deployment of, precision agriculture remains targeted at large- and mid-sized farms.

Interest in precision agriculture has increased within California over the last few years. In 2020, the University of California, Merced joined the University of Pennsylvania, Purdue University, and the University of Florida in forming a research center on the Internet of Things for precision agriculture. Additionally, the University of California, Davis now offers a minor in precision agriculture. According to the program’s website, “the minor prepares

students for challenging positions in site-specific crop management as we enter the 'information age' in agriculture."

Visser sees this shift toward the "information age" of agriculture as being driven by three sets of actors. First, there's the AgTech manufacturing industry — large, traditional manufacturers of agricultural equipment, like John Deere and AGCO — which is interested in branching out into software and cloud-based services. Second, precision agriculture is being promoted by the agribusiness sector — i.e. major chemical, pesticide, herbicide, and fertilizer companies, like Bayer-Monsanto and Syngenta — which seeks to control data about farming practices and develop the dominant digital platforms used by farmers. Finally, Big Tech firms like IBM, Google, and Microsoft are also boosters of precision agriculture. Through digitalization, all three sets of actors profit from, and extend their control over, the management of farms in what Visser describes as an "off-farm choreography."

Some environmental advocates see precision agriculture as a valuable tool for addressing climate change. They legitimately fear the unprecedented, unpredictable, and fast-moving environmental and economic disturbances that climate change will bring, and believe that farmers will struggle to adapt in time. They argue that digital tools could provide farmers with the precise, accurate, and reliable data necessary to adapt to climate change.

While there may be some merit to this argument, Visser's ethnographic research — which includes interviews with farmers — brings some much-needed nuance to this story. Visser believes the argument presents an overly optimistic view of technology's capabilities. In fact, some of the farmers he's spoken with don't see the promises of digital technologies materialize in practice. The AI-powered algorithms that drive precision agriculture require historical datasets to function accurately. Visser notes that when the datasets are too small or the baselines are constantly shifting due to climate change, the algorithms can perform poorly. He argues that, in some cases, the lived experience and knowledge of a farmer who's been in business for decades is more useful for adapting to climate change.

Visser also highlights some of the ways that nature and the environment can affect technological systems and diminish their efficacy. Animals can destroy sensors on or around them, and environmental conditions, such as wind, water, sunlight, and dirt, can degrade sensors. Sensors can also change the behavior of animals or make them ill, which affects the quality of the data that are collected. Visser provides the specific example of a farmer who invests in a barn floor that has valves that open and close to separate urine from cow manure. In theory, this can dramatically reduce nitrogen emissions. However, if the floor isn't meticulously maintained, dirt and other matter can accumulate and cause the

machinery to malfunction. This, Visser says, is why it's important to actually study technologies "in the wild." Unfortunately, many technology developers tend to treat the farm like a laboratory.

Visser pushes back against the narrative that a farmer's knowledge is no longer adequate to meet contemporary environmental crises by highlighting the many ways farmers have successfully and skillfully adapted to major disturbances throughout history. This history includes changing climates, population growth, droughts, and other disasters. And, he argues, in those instances where farmers *have* had difficulty adapting, it's often because of investments in earlier technologies. The large capital outlays for new systems, machines, and equipment, can send farmers into debt and leave them *less* flexible and nimble in the face of unforeseen challenges. Instead of these tools being a path toward farmer empowerment, as they're sometimes described, Visser argues they can result in vulnerabilities, dependencies, and constraints upon the farmer.

Finally, Visser argues that, in those cases where digital farm technologies *do* perform accurately and precisely, it's often the farmer, through his or her labor, who *makes* the technology work as it should. Visser explains that the farmer plays a pivotal role in calibrating, corroborating, and interpreting the data produced by digital technologies. They have to constantly assess whether or not the data that's generated is logical and fix any errors. This reality stands in stark contrast to what the president of the European Agricultural Machinery Association said when he referred to farmers as "one of the weakest components" of digital agriculture (Visser et al., 2021, p. 629). Rather than understanding precision agriculture as an interplay between humans and technology, the technology is glorified as continually moving toward perfection, limited only by human fallibility.

What is the consequence of this tendency to overestimate the accuracy of digital tools? In his paper, "Imprecision farming? Examining the (in)accuracy and risks of digital agriculture," Visser argues that it can lead to a "precision trap." A precision trap is the "exaggerated belief in the precision of big data that over time leads to an erosion of checks and balances," such as analog means of quality assurance and direct farmer observation (Visser et al., 2021, p. 623). He writes that three conditions can lead to a precision trap: (1) the opacity of algorithms, (2) the increasing focus on forecasting and prediction, and (3) the growing distance between farmers and the daily field operations on their farms (Visser et al., 2021, p. 624). It's not that digital farming technologies must be hyper-accurate to have value, he says. Instead, the problem is the lack of scrutiny around the *inaccuracies* of these tools. These oversights can lead to costly and environmentally harmful outcomes.

The speed with which digital technologies operate can compound the risk and impacts of a

precision trap, Visser claims. While fast-paced, real-time, algorithmically-driven, decision-making carries a certain appeal, it also makes it difficult for farmers to assess, intervene, and correct a process gone awry. Visser interviewed a farmer who said that digital tools generate and transmit data *and* errors with lightning speed. If a farm operates as an Internet of Things — where digital devices are interconnected — then it's possible to have interactions between devices that produce cascading failures.

If and when precision agriculture produces costly operational failures, Visser argues that it's often the farmer who's blamed. For example, he asks us to consider the fate of a farmer who invests a significant amount of money in a robotic milking system for their cows. Visser says that the milk robots work well for about 98% of farmers. In each barn, there will inevitably be some cows that cannot adapt to the robots, so they are slaughtered. This level of attrition is deemed acceptable. However, there can be cases where the whole herd doesn't adapt to the robots, or they adapt in the beginning only to become intolerant some months later. When the cows don't enter the milk robots, diseases and infections can quickly spread throughout the herd.

Then the question becomes: who's responsible for the financial losses incurred by the farmer? The farmer would likely seek compensation from the manufacturer of the equipment. However, when purchasing the equipment, the farmer has to sign a dense, lengthy contract. These contracts typically stipulate that the farmer will be compensated only if they can prove the issue wasn't due to the weather, animals, farming or management style, buildings, etc. With so many factors at play, this can be an onerous burden of proof. This example illustrates the power dynamics that exist between multinational corporations and farmers and the repercussions of that disparity. Digitalization within agriculture pressures farmers to invest in large, mechanized and digitalized systems, which shift greater control of farm management to corporations, yet leave the farmers responsible when issues arise.

Visser also raises the issue of a "precision divide." In an agricultural context, the precision divide arises when there are differences inherent to the technology itself — on the level of the hardware or software (i.e. the algorithm) — that privileges certain crops over others. AI-driven algorithms are only as good as the datasets they've been trained on. Given that precision agriculture originated in the Midwestern U.S., early algorithms were trained on the staple crops grown in that region. These commodity crops continue to be the main focus. Therefore, the algorithms that drive precision agriculture produce higher-quality data for staple crops and privilege the farmers who grow those crops. Visser says that a farmer who attempts to grow a less common crop will likely receive lower-quality data and poorer outcomes.

A precision divide can also form between farming styles. For example, Visser explains that algorithms tend to have a much easier time capturing and analyzing data from a farmer who's monocropping. In contrast, a farmer who engages in complex rotation schemes, regenerative agriculture, permaculture, or integrated crop and livestock farming will typically find the algorithms to be less accurate (Visser et al., 2021, p. 630). Sometimes the data collected for one crop can be corrupted by nearby crops. Or, the farmer may need multiple software packages to collect data on each crop. Visser argues that, at present, precision agriculture focuses on and reinforces monocropping at the expense of more experimental and sustainable forms of farming.

Precision agriculture can produce precision traps and precision divides that expose farmers to risk, for which they are often liable. Nevertheless, Visser sees opportunities for more just and equitable approaches to precision agriculture. Farmer-led movements and coalitions are developing open-source technologies, in partnership with engineers, software designers, and software developers. They're producing tools adapted to farming styles largely ignored by profit-maximizing transnational corporations. This bottom-up, innovative approach is happening in places like the U.S., especially New England. There's also the Gathering for Open Agriculture Technologies (GOAT) and L'atelier Paysan — the Workshop of the Peasant — two collectives located in France. Then there are global hubs of collaboration like Farm Hack. These are encouraging developments in terms of promoting equity for farmers and more sustainable farming styles, says Visser. He hopes his research will help inform these movements and alert farmers to the risks and possibilities of precision agriculture.

In terms of his future work, Visser now turns his attention to greenhouse-based horticulture. He points out that greenhouses and indoor farms are increasingly seen as a way to grow food on a planet made less hospitable by climate change. The idea is to "shut agriculture off from the environment," he says. He sees a danger in "this idea of total controllability of agriculture." Despite our greatest efforts, the farm resists algorithmic thinking.

References:

Visser, O., Sippel S.R., Thiemann, L. (2021). Imprecision farming? Examining the (in)accuracy and risks of digital agriculture. *Journal of Rural Studies,* 86, 623-632. https://doi.org/10.1016/j.jrurstud.2021.07.024

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