
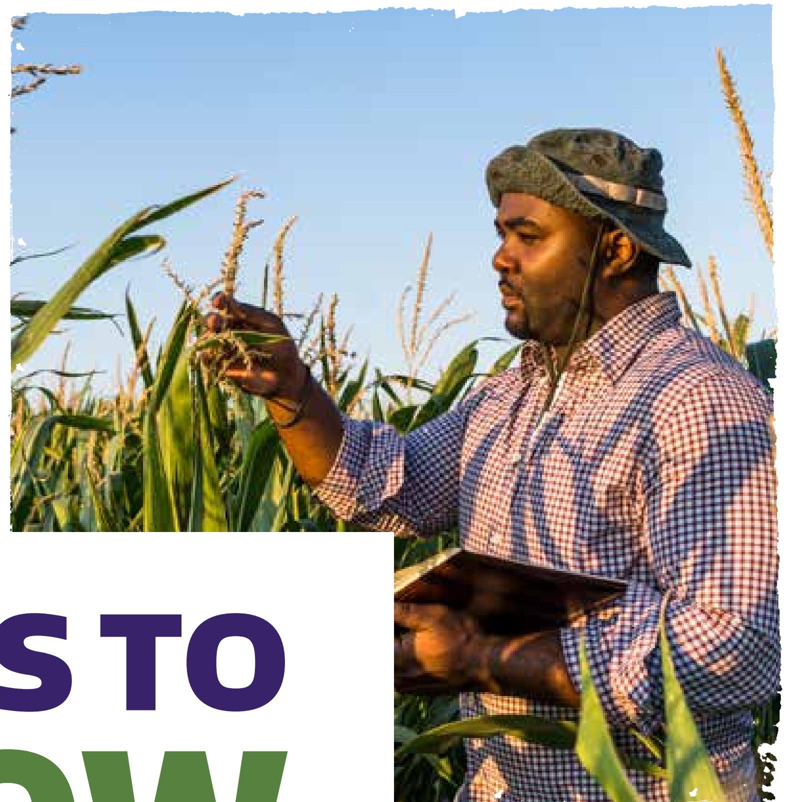

WAYS TO GROW

New Directions for Agricultural Technology Policy


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INTRODUCTION

Farming is in the midst of a technological revolution. Many associate rapid, technological change with urban environments. But agrarian landscapes may be undergoing the deeper transformation. Tractors run complex software. Drones patrol rows of corn for weeds. Sensors monitor irrigation and livestock. Such is the reality of precision agriculture, a $6 billion industry that promises to deliver a new era of productivity and efficiency through the deployment of sensors, automation, and data analytics.

Farming is also in the midst of a crisis. Disruptions to the food chain throughout the COVID-19 pandemic have called into question assumptions about the security of the American food system, revealing a system unable to absorb shocks reliably in a time of crisis. In 2020, farmers destroyed crops and culled cattle while grocery store aisles went empty. Worse, the burden of this frailty has been borne disproportionately by those on the periphery of the agriculture industry: small farmers, food workers, and consumers.[i] As the pandemic continues—and as new challenges such as climate change loom large—we can anticipate even greater fallout from the brittleness of America's agricultural system.

This whitepaper, which grows out of interdisciplinary research at the University of Washington Tech Policy Lab, argues for a widening of the aperture with respect to contemporary technology policy in agriculture. Emerging technology could, as advertised, reduce costs and increase food production. But the industrial model of agriculture that technology currently supports—focused on faster, more, and cheaper—has its tradeoffs. Precision agriculture remakes the land to serve technology, introduces new sources of instability into agriculture, and contributes to the destabilization and vulnerability of the American food system. Greater resources should be allocated to "civic" agricultural[ii] approaches that transition away from a reliance on hydrocarbons and foreground goals such as soil restoration, regional supply-chain resiliency, and strong local economies.

The whitepaper makes the following specific recommendations:

1. Efforts to reform agricultural policy should attend to the role of technology. Agricultural policy is technology policy, and increasingly so.
2. All stakeholders should fully acknowledge the externalities of precision agriculture alongside its benefits, including the exacerbation of trends that undermine the stated environmental goals of precision agriculture and deepen inequity.
3. The introduction of automation and digital technology to farming, coupled with extractive legal and financial strategies by firms, is introducing new vulnerabilities for farmers—from unrepairable equipment to cybersecurity concerns—that undermine food resilience. Policymakers should work to address these vulnerabilities and the forces behind them.
4. Research and development dollars are flowing into technologies that focus on ramping up production, often at the expense of addressing existing challenges to food resilience such as storage and soil management. Policymakers should rebalance investment in agricultural technology, funding innovation that supports civic agriculture in parallel with larger-scale food production.

The current farming crisis presents a challenge, but also an opportunity. Policymakers at the federal and state levels are already exploring ways to address various facets of the problem, such as concentration, subsidies, regulatory thickets, agency capture, historic and present-day discrimination, labor rights, and safety. These are important areas for reform. Yet policymakers cannot afford to ignore the increasing role of technology in agriculture, nor fail to nurture alternate agricultural models focused on locality and resilience.

GETTING PRECISE

Farming, like most human endeavors, is intertwined with technological advancement. In recent years, there has been significant investment in a set of technologies and techniques known collectively as precision agriculture. These are technologies that leverage sensors, artificial intelligence, and robotics to fine-tune and automate many agricultural functions, including planting, harvesting, pest control, crop inspection, fertilization, and irrigation. The goal of these technologies is to produce more food with less labor and fewer chemical or energy resources. Precision agriculture also aims to increase knowledge about crop yield and timing at local, regional, and system-wide scales.

To help foster this revolution, farmers are expected to harvest not just food, but information. American agricultural producers are now generating tens of millions of gigabytes of data per year. This information will ostensibly help the individual farmer make better informed choices. But in practice, farmers have little meaningful access to the knowledge and insights they generate, let alone visibility into the farming information ecosystem as a whole. Individual farmers may glean local insights that incrementally improve production, but service providers gain global information that positions them and corporate partners to shape the food market to their advantage.[iii]

Precision agriculture is often heralded as a "greener" method of farming in that it relies upon less water or pesticides and produces less waste. While this is true, proponents often fail to account for the full set of externalities of technology for the environment.[iv] From the use of water to cool servers in the "cloud," to the training of resource-intensive AI/ML models, to the fossil-fueled non-biodegradable machines, precision agriculture takes a material toll on the environment even as it helps conserve water and chemicals on the farm.[v]

Precision agriculture is capable of increasing yield while reducing inputs such as pesticide and water under ideal circumstances. But the technologies behind precision, as they exist today, struggle wherever agricultural conditions are varied or unpredictable. The "see and spray" system that purports to use machine learning to identify weeds and then spray them, for instance, does not function well in an uncontrolled environment.[vi] To be effective, artificial intelligence models must be fed consistent, clear, precise, and "clean" data that are seldom available on a working farm. This has resulted in a suite of technologies which can sometimes help farmers plant, weed, irrigate, and seed, but only on farms that are flat, symmetrical, and have bare dirt rows of genetically identical plants. [vii]

Finally, farmers must also rearrange and reprioritize the farm to suit the needs of technology, rather than use technology to support their farming operation. This comes at a price: scientists warn that this type of farming undermines soil nutrients to the point of requiring costly interventions.[viii] Precision agriculture reinforces monocropping, aggressive tilling, and other techniques that, ironically, farmers steered away from in the past due to their capacity to undermine production in the long run. Just as the modern tomato has been bred to withstand mechanical picking at a cost to taste and nutritional content, the contemporary farm is being rearranged and reprioritized to maximize the productivity gains from precision architecture at the cost of sustainability.

IF THE FARM MACHINE STOPS

There is a short story by E.M. Forster written in 1909, *The Machine Stops*, where people who over-rely on technology risk much when technology fails. As much is true for contemporary farms. The vision of precision agriculture depends on agricultural technology in good working order. Reliance upon automation, digitization, and other hallmarks of precision agriculture places farmers at the mercy of complex equipment that may be unreliable, easier to break and harder to repair. Take, for example, the widespread reliance upon global position systems (GPS) in tractors, robots, and other farm logistics. Everything from solar storms to routine military exercises hold the potential to disrupt GPS, throwing off carefully calibrated equipment, leading to crop damage, and even shutting a farm down entirely.[ix]

To leverage connected equipment or tools, farmers must have easy access to steady broadband, but this is not always the case in the countryside (or anywhere). A USDA census in 2019 indicated that only 75% of farmers have access to the internet, and only 38% are using broadband – a *decrease* of six percent since 2017.[x] Climate change and other factors may contribute to the interruption of broadband even where access is available in the usual course of events.

There are increasing reports of digital networks and equipment being purposively targeted for cyberattack. The Department of Homeland Security has repeatedly warned that agricultural infrastructure is a target for foreign adversaries and domestic criminals, including through the manipulation and falsification of sensor data.[xi] There have been multiple incursions already, including a ransomware attack against the world's largest meat supplier, which was forced to halt operations.

Quickly restoring equipment to use is critical to farming given narrow sowing and harvesting windows. When analog farm equipment breaks down, farmers may be able to diagnose the problem and conduct their own repairs, or at least access a secondary repair market. But precision agriculture equipment involves complex cyber-physical systems requiring highly specific diagnostic equipment and parts. Corporations increasingly posit that while farmers own the hardware they purchase, they have no right to access or alter the underlying software that makes it run. These forces delay repair. Farmers in states like North Dakota and Nebraska have waited days or weeks for specialized parts or available technicians.[xii]

These problems are not purely technical. Law and sanctions can reduce the prospect of cyberattacks on agricultural infrastructure, for instance, and a "right to repair" bill for agriculture would furnish farmers with more flexibility in addressing equipment malfunction. Digital technology is far from the only source of disruption to food production. There can be no denying, however, that precision agriculture introduces vulnerabilities that detract from resilience even as they augment productivity under *ideal* conditions.

TAKING RESILIENCE SERIOUSLY

The guiding star of contemporary industrial food production is not greater resilience—in the sense of a food system that is equitable, healthy, and robust—but simply more food cheaper.[xiii] The technology presently in use and under development in farming has the same orientation. The American food system leverages technology in the service of productivity—even as food is wasted, destroyed, or possesses a lower nutritional value. This push toward maximizing returns on food production while depending on hydrocarbons and externalizing costs deepens rather than reverses dangerous farming trends and introduces additional challenges and vulnerabilities. Meanwhile, the potential of technology to support alternative models of civic agriculture, which privilege locality and resilience, is largely overlooked.

One technological obstacle to resilience is the absence of local storage. Crops need to be stored and transported at very specific temperatures to preserve nutrients and avoid rot. The withdrawal of U.S. maintained national grain reserves and food storage warehouses, coupled with industry consolidation, have dramatically reduced the availability of storage at or near farms. At the same time, the warming planet has taken natural storage of staples such as tomatoes off the table. These forces and others, such as just-in-time inventory, contribute to massive food waste. While less flashy than drones or digital dashboards, an investment in root cellars and the development of adjustable, self-contained storage systems would improve food resilience. [xiv]

Another undeveloped area is soil nutrient recycling. New methods should be developed that transition away from reliance on hydrocarbons, and the efficacy of existing methods and processes such as anaerobic digesters and biochar merit greater research and investment. Meanwhile, the answer to reducing nitrogen is not always adding machines: many in the farming community have noted specific farming practices (such as rotational grazing and crop diversification) can have a carbon neutral impact on the environment, restore topsoil, improve biodiversity, and reduce fertilizer inputs.[xv] Investment in tools which assist in such processes is gravely needed.

A third and final example is information communications technology that supports the ability of networks of local farmers to compete with larger-scale modes of agriculture. The past few years have seen a proliferation of platforms constructed to connect consumers directly to agricultural producers. Yet many of the solutions generated out of Silicon Valley have fallen flat; the offerings only served affluent areas or large cities, and the developers failed to understand the needs of vendors. With COVID-19, individual growers scrambled to put their offerings online, but struggled with the many logistical elements: creating and running their own websites, handling payments and distribution, adhering to federal and state safety regulations, and finding processing space.

Platforms that streamline processes—helping farmers accept alternative payments such as SNAP or EBT, find refrigerated delivery services to various locations, scout processing availability—are likely to be a welcome addition to the civic agricultural community. As would investment in new and existing tools for small farmers to collaborate and plan together. Some states and municipalities have already developed Food Hubs, which connect producers and buyers, aggregate, distribute, and store product, and host online sales platforms.[xvi] Such infrastructure also helps diminish food waste by becoming a distributor of production surplus. The co-development of ICTs for small farmers is worthy of far greater investment and could help protect against increasingly precarious supply chains.

CONCLUSION

Agricultural policy is technology policy. Important considerations such as farm industry consolidation, subsidies, regulatory thickets, discrimination, and labor remain hotly debated. Amidst such pressing concerns, policymakers must also confront the myriad ways technology and technology policy contribute to or undermine a resilient food system.

Investment in agricultural technology to date aims largely to increase the volume of food production, with hidden costs to the environment, the farmer, and the public. Governments should acknowledge these costs and incentivize innovations that center locality, resilience, and long-term environmental sustainability. Policymakers must work to protect farmers from digital disruptions which threaten harvest, storage, and transportation and provide farmers with the legal and technical means to repair critical equipment. And research dollars should flow into the development of technologies to tackle pressing issues such as soil degradation and dependencies upon hydrocarbons.

Recent events have highlighted the vulnerabilities in the American food system and demonstrated the necessity of preparing for future disruptions. A resilient food system requires more than investing in precision and volume. It requires engaging with multiple approaches to farming supported by a wide variety of techniques and tools. This whitepaper has argued for a broader conception of the role of technology and technology policy in agriculture, one that centers resilience and supports civic agricultural approaches alongside existing models. Only by mitigating the impacts of technology and nurturing resilient alternatives can the American food system hope to grow into the challenges to come.

ENDNOTES

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[xv] Mingxin Guo, “Soil Health Assessment and Management: Recent Development in Science and Practices,” Soil Systems 5, no. 4 (2021), https://www.mdpi.com/1298660.

[xvi] Nicole Motzer, “‘Broad but not deep’: regional food hubs and rural development in the United States,” Social & Cultural Geography 20, no. 8 (2019).

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