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AI in Agriculture: Transforming the Food System from Data to Decisions to Action

A policy brief on artificial intelligence across the U.S. food system

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Agriculture combines biological variability, weather uncertainty, and real-time production pressure at scales from a single plant to a global supply chain — making it one of AI's most demanding and consequential application environments. The policy choices made now will determine how quickly the capabilities of AI to improve agriculture advance, who benefits, and whether AI strengthens the resilience of the U.S. food system.

FIVE KEY MESSAGES

1. AI is becoming a foundational capability across agriculture.
It is no longer limited to research labs or isolated software applications. It is increasingly embedded in agricultural equipment, production systems, food processing, logistics, and natural resource management.

2. AI is changing the role of computing in agriculture.
It is moving beyond analyzing information to enabling intelligent systems that can perceive, reason, and increasingly act in the physical world.

3. Data quality, human expertise, and trust remain essential.
AI systems depend on accurate, representative data and effective human oversight. Successful adoption requires attention to validation, transparency, cybersecurity, interoperability, and responsible governance.

4. AI is transforming the entire agricultural value chain.
Applications extend beyond crop production to include livestock management, food processing, supply chains, natural resource stewardship, and scientific research.

5. The future of AI in agriculture depends partially on policy.
The benefits of AI in agriculture depend not only on advances in AI itself, but also on the computing infrastructure needed to develop and operate increasingly capable models and services. Policies affecting data centers, connectivity, interoperability, producer choice, workforce development, and responsible governance will therefore influence how rapidly agricultural AI develops and how broadly its benefits are realized.

WHERE AI IS CREATING VALUE

- **Crop Production:** AI shifts crop management from field-scale decisions to individual-plant precision — enabling equipment to distinguish crops from weeds, detect disease before symptoms are visible, and apply inputs only where and when needed.
- **Animal Production:** Continuous behavioral monitoring through acoustic sensors, video analysis, and wearables detects health, stress, and reproductive events days before clinical signs appear, enabling earlier and more targeted intervention.
- **Food & Postharvest Systems:** Optical AI shifts food safety and quality inspection from statistical sampling to real-time, per-unit assessment — evaluating size, color, and defects in milliseconds across an entire production stream and strengthening traceability.
- **Natural Resource Management:** By integrating satellite imagery, weather data, soil sensors, and hydrology monitoring, AI enables predictive assessment of drought, wildfire risk, harmful algal blooms, and invasive species — supporting proactive rather than reactive management.

FROM DATA TO DECISIONS TO ACTION

- **From collecting to acting.** Earlier digital tools collected and displayed information for human review. AI now analyzes that information — identifying patterns, predicting outcomes, and directing physical operations through autonomous equipment.
- **Agriculture as a proving ground for physical AI.** Physical AI — systems that perceive, reason, and act — faces an unusually demanding test in agriculture, where dynamic biological environments require real-time integration of perception and action under uncertainty. Harvesting a marketable peach, for example, requires estimating ripeness, planning a collision-free path, and adjusting grip in response to unexpected branch movement, all without direct human intervention.
- **Generative AI is lowering the barrier to advanced analytics.** Producers and advisors increasingly interact with sophisticated analytical tools through natural language rather than specialized software, making advanced decision support accessible to agricultural professionals without specialized technical expertise.

KEY POLICY CONSIDERATIONS

- **Agricultural data as national research infrastructure.** High-quality datasets are to AI innovation what experimental farms, weather networks, and genomic databases are to traditional agricultural science. Federal investment in benchmark datasets, standardized evaluation protocols, and shared evaluation frameworks should be treated as research infrastructure — reducing duplication and lowering barriers to entry across the innovation ecosystem.
- **AI infrastructure as agricultural infrastructure.** Rural broadband, edge computing, and positioning systems enable AI to operate in agricultural environments — where connectivity is intermittent and decisions cannot wait for a remote data center. At the same time, data centers proposed for rural areas carry real tradeoffs in electricity, water, land, and transmission capacity that bear directly on agricultural competitiveness and conservation. Both connectivity investment and data-center siting deserve consideration alongside agricultural and environmental planning.
- **Competition, interoperability, and producer choice.** AI in agriculture is increasingly delivered through integrated platforms bundling machinery, software, and agronomic services. Open data standards, interoperable formats, and transparent interfaces can help preserve competition, limit vendor lock-in, and ensure that producers retain the ability to combine tools from different providers.
- **Workforce preparation at every level.** Future agricultural professionals will need the ability to supervise intelligent systems, interpret AI-generated recommendations, and integrate digital tools into practice — different skills than today's, not fewer. Land-grant universities, Extension, and community colleges will play central roles in that preparation; continuing education pathways matter equally for experienced professionals adapting to rapidly evolving technologies.
- **Validation, standards, and cybersecurity for autonomous systems.** As AI assumes greater responsibility for controlling physical equipment, policy must address machines that operate under human supervision rather than direct human control. Existing regulatory frameworks were developed for human-operated equipment. Independent validation, rigorous field testing, cybersecurity, and evolving safety and performance standards will be increasingly important for trustworthy deployment.

AI ACROSS THE VALUE CHAIN: WHERE ARE WE TODAY?

AI applications across agriculture increasingly extend from interpreting data, to supporting decisions, to directing physical action. The maturity of these capabilities varies substantially by sector and application.

Sector	Perception & Analysis	Decision Support	Physical Action
Crop Production	Commercially deployed	Commercially deployed	Commercially deployed/emerging
Animal Production	Commercially deployed	Commercially deployed	Emerging
Food & Postharvest	Commercially deployed	Commercially deployed	Commercially deployed
Natural Resources	Commercially deployed	Commercially deployed/emerging	Early/emerging

Commercially deployed = available and in operational use. **Emerging** = limited operational deployment or advanced development. **Early** = primarily research and development.

THE RESEARCH FOUNDATIONS OF AGRICULTURAL AI

Many of the advances in agricultural AI described in this brief are built upon decades of research. AI systems for agriculture rely on scientific discoveries, high-quality datasets, field-based validation, and practical expertise developed through research and education programs. Research institutions, Extension programs, government agencies, producers, and industry all play important roles in generating the knowledge and evidence needed to develop, evaluate, and responsibly deploy AI technologies across the food system.

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