AI in Agriculture: From Data to Decisions to Action

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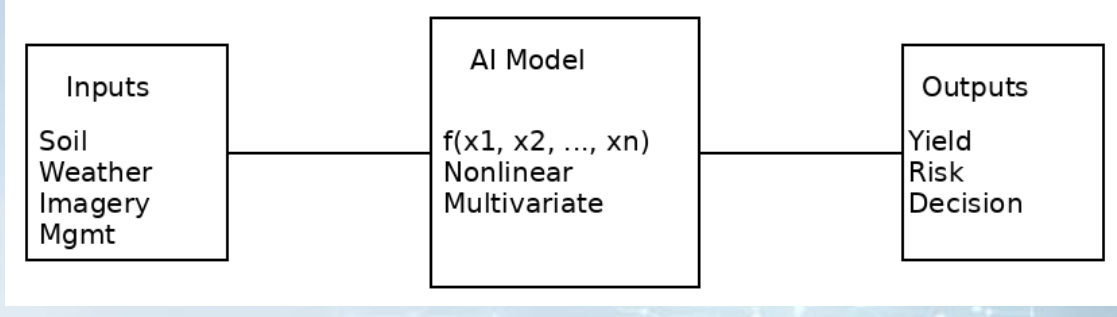
What this brief is intended to do

- CAST's Role: to convene experts, to translate science, to inform the public (particularly policymakers)
- Show where AI is used across agriculture and the food system
- Identify where AI creates value now and where capabilities are emerging
- Explain how AI is moving from data analysis to decision support to physical action
- Highlight infrastructure, standards, workforce, and other policy issues that will influence adoption and direction

What Do We Mean by AI?



- The field of computing focused on simulating human intelligence (as in perception, learning, problem-solving, and decision-making)
  - Involves highly nonlinear, multivariate, statistics implemented at very large scale
  - Based on vast datasets
  - Used to generate content, classify and detect, predict, support decisions, and ultimately automate actions
  - It is advancing with amazing speed

From Data to Decisions to Action

- Digital agriculture (e.g., precision agriculture) has been used to collect, store, display, and communicate information
- AI now interprets information, identifies patterns, predicts outcomes, and recommends actions
- When combined with autonomous machines, AI can carry out physical tasks

https://climate.com/en-us/solutions/scout-fields.html

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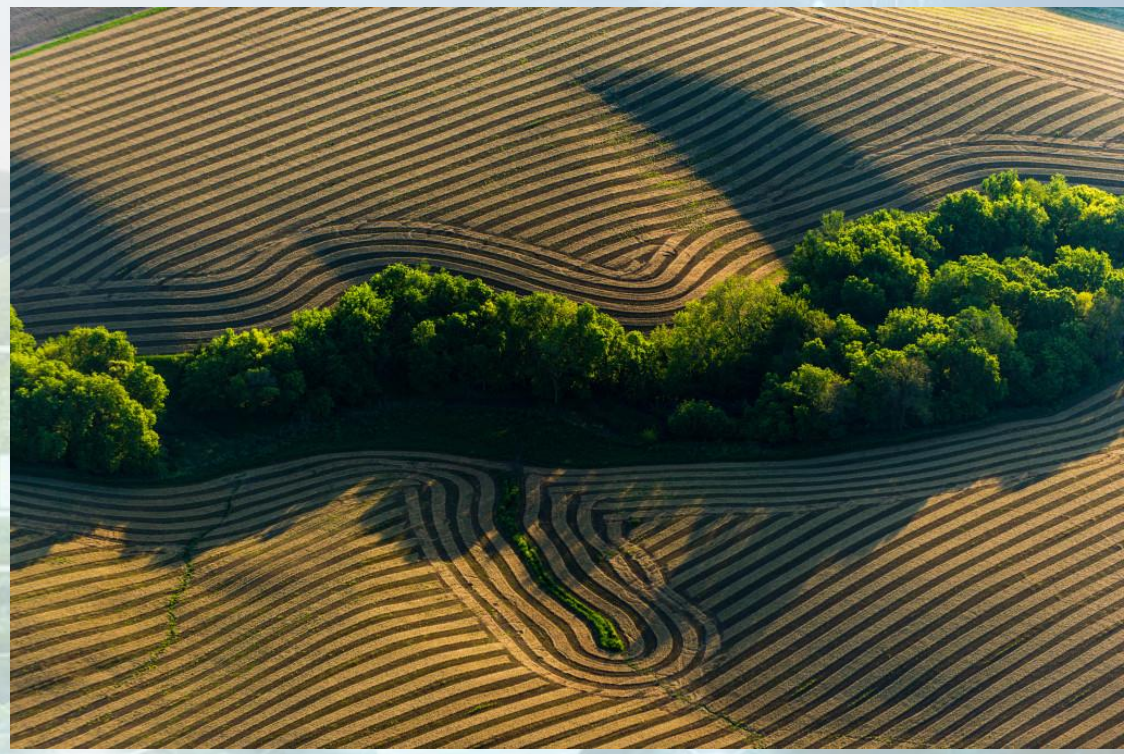
Agriculture is a demanding environment for AI

- Agriculture is extremely variable
  - Biological systems inherently variable
  - Weather changes continuously
  - Pests are unpredictable
  - Soil conditions vary across and within fields
- Decisions often must be made in real time, under uncertainty
- Systems must be safe, reliable, and economically practical

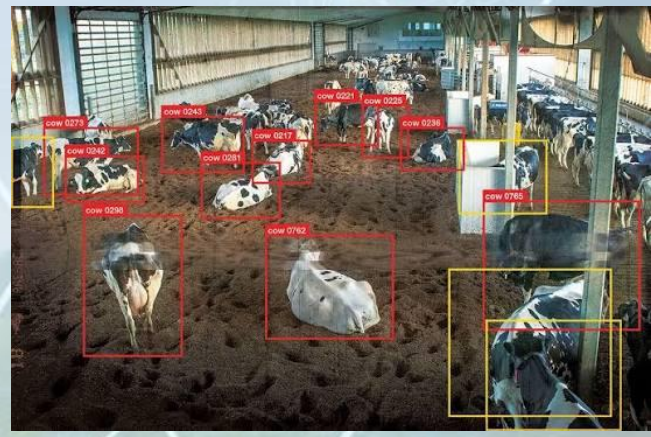


https://magazine.outdoornebraska.gov/stories/photography/patterns-from-above/

AI is creating value across agriculture and the food system

- Crop Production
  - Plant-level detection and management
  - Targeted inputs
  - Autonomous field operations
- Animal Production
  - Continuous health and behavior monitoring
  - Early detection of disease, stress, and reproduction events
- Food and Postharvest
  - Per-unit inspection and grading
  - Food safety, traceability, inventory, and cold-chain management
- Natural Resource Management
  - Drought, wildfire, algal bloom, and invasive-species prediction
  - Irrigation, watershed, and conservation decision support

https://www.futurefarming.com/smart-farming/tools-data/smart-cameras-see-the-way-to-better-weed-control/



https://www.agproud.com/articles/60592-ai-enables-cameras-to-put-new-eyes-on-your-cows

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AI can increase precision in **plant** production

- AI-based computer vision can distinguish individual small weeds at field speed
- Spraying can thus be done on individual weeds rather than spraying uniformly
- University of Arkansas soybean trial suggested See & Spray reduced herbicide use by 50%
- Similar plant-level approaches are emerging for laser weeding, pruning, thinning, and harvesting

https://www.agriculture.com/news/technology/john-deere-launches-see-spray-select

AI can enable continuous **animal** observation

- Computer vision, wearables, acoustic sensors, and automated feeding systems provide data for AI
- AI can detect subtle changes associated with growth, disease, lameness, heat stress, estrus, and parturition
- Acoustic monitoring in swine can identify respiratory changes before obvious clinical symptoms
- Early detection can support targeted intervention and reduce unnecessary treatment

https://animalscience.unl.edu/research/research-areas/animal-health-welfare-and-precision-management-research/nutrack-livestock/

AI can enable comprehensive **food** product inspection

- Optical systems can produce data on individual products in milliseconds
- AI can assess size, color, bruising, defects, even internal quality
- High-quality products can be routed to high-value markets while defective products are diverted
- AI can also support traceability, inventory optimization, predictive maintenance, etc.

https://visionplatform.ai/ai-for-traceability-and-visual-inspection-in-meat-production/

AI can help identify **natural resources** risks early

https://www.linkedin.com/pulse/ai-enhanced-environmental-monitoring-harnessing-power-guru-pavan-vyzgc

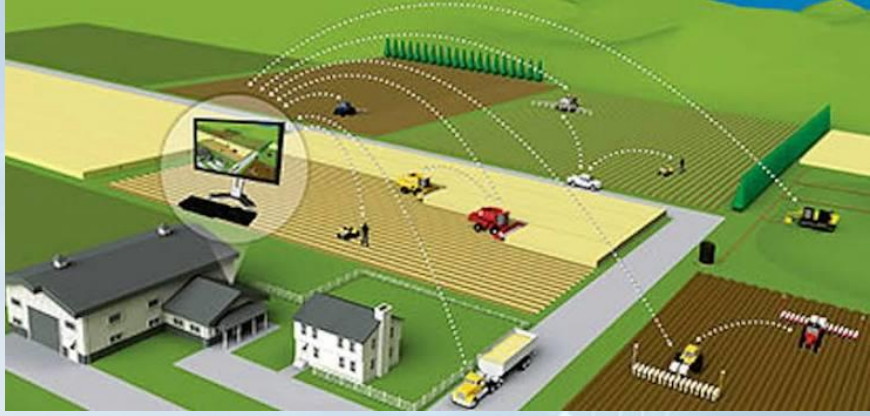
- Integrating information from satellites, weather networks, stream gauges, and other monitoring systems
- Supporting drought assessment, wildfire-risk prediction, harmful algal bloom prediction, and invasive-species detection
- Helping managers consider responses using more information than traditional approaches can integrate
- Many applications depend on long-term public environmental data infrastructure

Physical AI connects perception, reasoning, and action

- Systems must
  - Understand what they see
  - Decide on appropriate action
  - Execute that action safely in a changing environment
  - Adjust when conditions do not match expectations
- Example: robotic apple harvesting
  - Identify a marketable fruit
  - Estimate ripeness and reachability
  - Plan a collision-free path
  - Adjust grip as fruit and branches move

https://www.mlive.com/news/2024/09/watch-robotic-apple-picker-use-suction-arms-and-ai-to-harvest-michigan-orchard.html

AI does not succeed simply because algorithms get better



https://www.farmprogress.com/farm-operations/buyer-s-checklist-telematics-for-late-model-vehicles

- Reliable agricultural AI depends on…
  - High-quality data: accurate, representative, scientifically credible
  - Digital infrastructure: broadband, positioning, large-scale computing (with some edge computing)
  - Interoperability: equipment and software that can exchange and correctly interpret information
  - Validation and trust: rigorous field testing, cybersecurity, and human oversight
  - Workforce capability: people who can evaluate, supervise, maintain, and use AI systems effectively

Agricultural AI only as good as data and validation behind it

- Agricultural data are expensive to collect, fragmented, and vary between crops, regions, and production systems
- Data often require expert annotation before they are useful for AI
- Common benchmark datasets and evaluation methods reduce duplication and improve scientific credibility
- Independent field validation is important as AI takes on greater decision-making responsibility

https://blog.onesoil.ai/en/how-onesoil-collects-data-1

AI depends on infrastructure that affects agriculture

- Agricultural AI depends on broadband, positioning systems, cloud services, and large-scale computing (and some edge computing)
- Agricultural operations typically occur where connectivity is limited
- Data centers are creating new demand for electricity, water, land, and transmission capacity
- Those demands can compete with agricultural and community needs
- Site selection, utility investment, permitting, and water-use decisions have agricultural consequences

https://www.continental.com/en/press/press-releases/20240318-agriculture-transition/

https://www.agriculture.com/partners-rural-americans-are-concerned-about-the-impact-of-data-centers-12007246

Beneficial AI should expand capability without unnecessarily reducing producer choice

- Agricultural AI is often delivered through integrated machinery, software, cloud, and data platforms
- Interoperability and open standards reduce technology lock-in, allowing growers to use tools from different providers
- Data ownership, portability, privacy, and cybersecurity will affect producer confidence
- Workforce needs new skills to supervise, evaluate, maintain, and repair AI-based systems
- Land-grant universities, Extension, community colleges, and industry have roles in preparing workforce

https://agriculture.papemachinery.com/blog/top-tech-trends-in-agriculture-equipment-for-2026-how-precision-ag-is-transforming-the-field/

ISO 11783, commonly known as ISOBUS, is a standard communication protocol used in ag to allow seamless data transfer between tractors, tools, and farm software.

AI will become increasingly important part of agriculture

https://www.equipmenttrader.com/blog/2025/02/11/top-5-heavy-equipment-machines-revolutionizing-modern-farming-operations/

- AI will continue moving from information to decisions to action
- Adoption will be uneven
  - Some applications are a good fit for AI, while some are not
  - Areas with connectivity have an advantage
  - Areas with technical support have an advantage
- Human expertise and oversight will remain important
- Policy will influence infrastructure, standards, competition, workforce preparation, and trust
- We want to capture AI's benefits while recognizing and managing its problems

Thank you!

- Questions?

https://www.behance.net/gallery/31724883/Cotton-Fields

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