AI and the Big Challenges in Ag and Food

- Agriculture has been hugely successful
- Big health and environmental challenges
- How AI can be a solution

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American farmers now produce four times as much with almost the same inputs.

Source: Abridged version of Figure 1 in Pardey and Alston (forthcoming).
The world produces 250% more cereals with only 15% more land.

Change in cereal production, yield, land use and population, World

All figures are indexed to the start year of the timeline. This means the first year of the time-series is given the value zero.

Source: Our World in Data based on World Bank; Food and Agriculture Organization of the United Nations
OurWorldInData.org/crop-yields • CC BY
Higher productivity means lower prices

Prices down 50% since 1960 (adjusted for inflation)

https://agdatanews.substack.com
Food now a much lower percent of American household budgets.
Productivity has improved the most in rich countries.

Prevalence of undernourishment in developing countries, 1970 to 2015

The share of individuals that have a daily food intake that is insufficient to provide the amount of dietary energy required to maintain a normal, active, and healthy life.

Percent undernourished is down by 65% in developing countries

Source: Food and Agriculture Organization of the United Nations and ESS Indicators
Note: Data from 1990 onwards is well-established within FAO estimates. Earlier estimates are significantly more uncertain.
OurWorldInData.org/hunger-and-undernourishment/ • CC BY
Lower prices and tasty and convenient ultra-processed food means people eat more.
"Over half the population in OECD countries is overweight, with nearly 1 in 4 people considered obese."

"8.4% of the health budget of OECD countries will be spent to treat the consequences of overweight over the next thirty years.”

Source: Heavy Burden of Obesity, oecd.org
Converting land to crops causes massive carbon losses

Excess fertilizer application pollutes waterways
Increasing population implies more food demand.

Increasing incomes mean more demand for resource-intensive food.

Meat demand projected to increase 50% in the next 30 years.

Source: Food and Agriculture Organization of the United Nations
Productivity growth has slowed
Can AI technology accelerate growth?

Panel B: Modern genetics and precision agriculture technologies

Note: Adoption rates represent shares of farms or farm area adopting. Source: Alston and Pardey (2020).
Food is abundant and inexpensive, but
- deteriorating health
- environmental and climate challenges
- global food demand will increase

Problem: Externalities
- Costs of eating decisions not borne by current self ("internality")
- Costs of healthcare not borne by individual
- Costs of pollution not borne by farmer
- Benefits of innovation flow beyond innovator
- Benefits of data flow beyond provider

Solution: Public funding of ethical technologies to benefit society
- Focus on areas with substantive externalities
What do we mean by ethics?

Three core questions

1. Who wins and who loses?
2. Who bears risk?
3. Who decides?

Example AI Technologies

- Autonomous weeder
- Precision seeding and fertilizer application
- Supply chain optimization
- Automatic pathogen detection in food processing
- Diet customization tools
- Engineering healthful foods
NSF has funded ~25 research institutes

USDA-NIFA co-funds 5 institutes

I am part of the AI Institute for Next Generation Food Systems (AIFS)
Who is Responsible for Responsible AI?

Everyone is responsible

• regulations cannot govern what they do not see (e.g., micro decisions about which data to include)

• fund the AI we want!

We interviewed AIFS researchers

• researchers express confidence in academic research practices and outcomes; skeptical of private sector

• researchers must **navigate a complex landscape** to get data, comply with regulations, test and deploy products, and pivot quickly.

• sometimes trustworthiness makes an AI tool **less likely** to be used (“Better not to Know”).
Farmer Survey: Why are you concerned about sharing your data?

- **47% unconcerned**
- **Most of the concerned give multiple reasons**

Source: Author calculations from survey of Illinois corn and soybean farmers
Farmer Trust and AI Technology Adoption

- modern American farmers use a lot of technology

- farmers are concerned with regulatory burden, labor scarcity, and financial pressures

- main barriers to adoption are not trust, but whether AI will solve these problems
The Challenge
Continued Productivity Gains AND Better Health and Environment

• Invest in problems beset by externalities
  • these are problems private firms won’t solve

• Negative externalities: health, pollution
  • for farmers, save cost and reduce pollution
  • foods that are more appealing and more healthful

• Positive externalities: systems, infrastructure, data
  • build data resources and infrastructure

• Ethical RD&D requires continuous vigilance

1. Who wins and who loses?
2. Who bears risk?
3. Who decides?