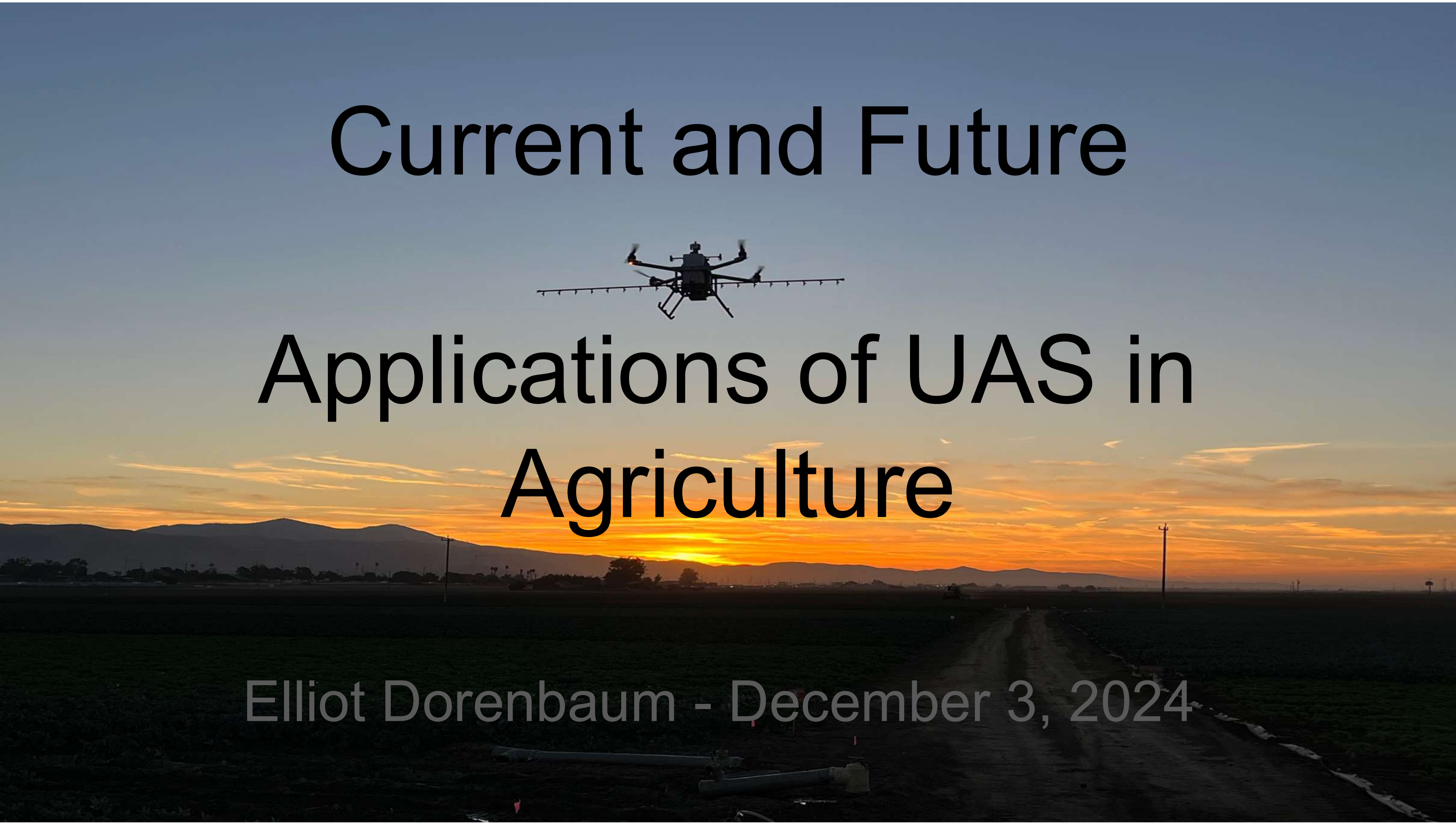


Current and Future Applications of UAS in Agriculture

Elliot Dorenbaum - December 3, 2024

Quick Bio - National Ops Manager - Wilbur-Ellis UAS

- Granular by Corteva
  - Satellite Mapping
- Ceres Imaging
  - Fixed Wing Mapping
- Farm Flight
  - Drone Mapping
- Wilbur-Ellis
  - Regional Tech Generalist
- Soiltech Wireless
  - Probes / Telemetry
- Wilbur-Ellis pt. 2
  - Spray Drones

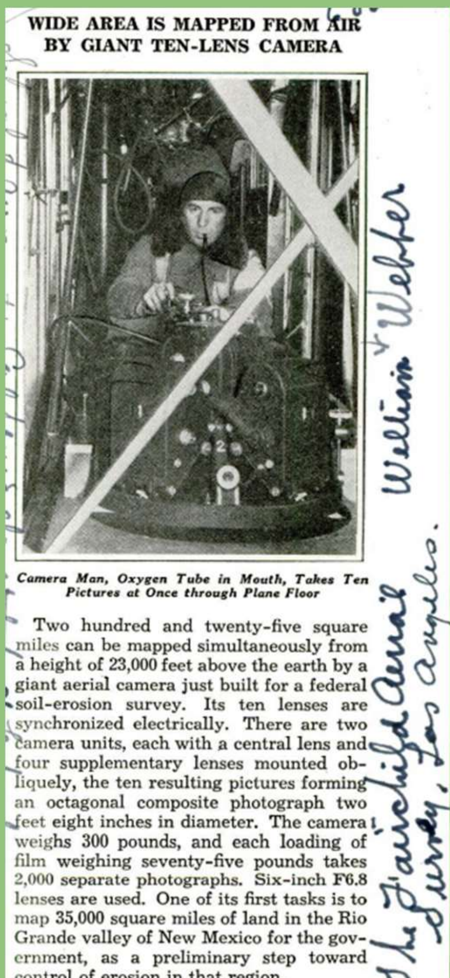
Education: Philosophy, Concentration on Environmental Philo and History of Ideas

On Technology in Agriculture

Overview

1. History and Background
2. Current Applications
    a. Crop Monitoring
    b. Spraying and Spreading
    c. Beneficial Insects
3. Future Applications of UAS in Ag
4. Impacts of AI
5. Questions

History - Background



WIDE AREA IS MAPPED FROM AIR BY GIANT TEN-LENS CAMERA

Camera Man, Oxygen Tube in Mouth, Takes Ten Pictures at Once through Plane Floor

Two hundred and twenty-five square miles can be mapped simultaneously from a height of 23,000 feet above the earth by a giant aerial camera just built for a federal soil-erosion survey. Its ten lenses are synchronized electrically. There are two camera units, each with a central lens and four supplementary lenses mounted obliquely, the ten resulting pictures forming an octagonal composite photograph two feet eight inches in diameter. The camera weighs 300 pounds, and each loading of film weighing seventy-five pounds takes 2,000 separate photographs. Six-inch F6.8 lenses are used. One of its first tasks is to map 35,000 square miles of land in the Rio Grande valley of New Mexico for the government, as a preliminary step toward control of erosion in that region.

1935 - Land Erosion Surveys in New Mexico

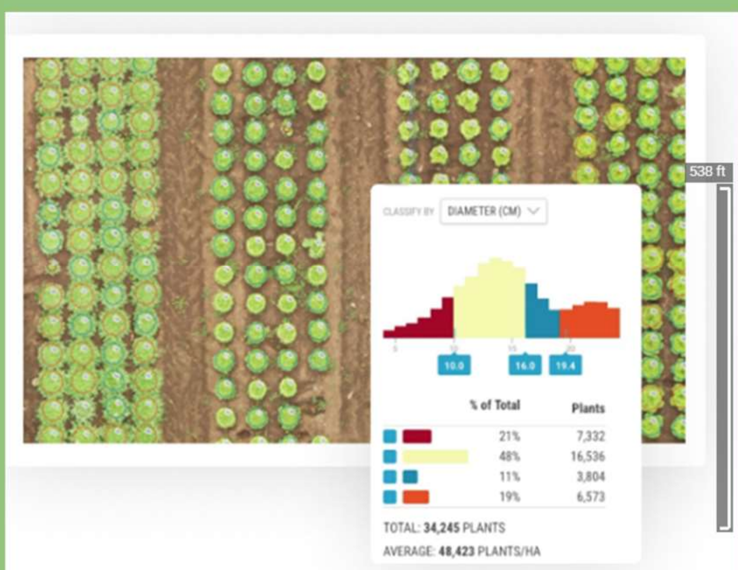
- First Aerial images of crops began in WW1 over cotton fields in west texas
- Commercial services for aerial applications initiated with large scale soil surveys with custom fitted airplanes
- NASA develops Multispectral image capture from space in late 60's and deploys in 70's
- UAS existed as far back as 1840's when balloons were used by Austria to drop bombs over Venice Italy.

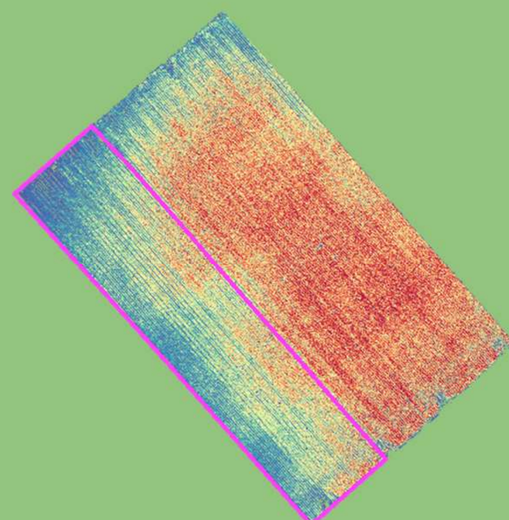
1865 - Attack Balloons used by Union during U.S. Civil War

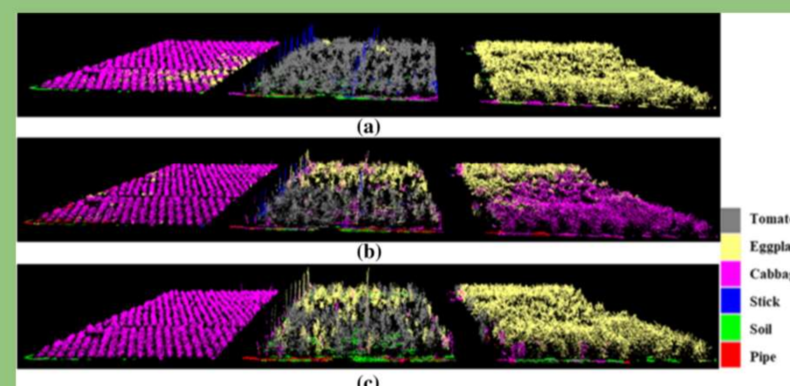
1972 - ERTS-A (Landsat 1) from NASA

Current Applications - Crop Monitoring

- Multispectral Imagery and Zone-based Management
- Precision Management of Inputs and Labor
- Data based decision making for harvest timing
- Plant counts to inform long-term crop schedules
- Validation of novel inputs and treatments







Pix4D

Current Applications - Spraying & Spreading

- Targeted Applications
  - Precision Applications
  - Fine edges
  - Canopy disruption
- Labor Consolidation
  - Single Pilot with Multiple Sprayers
  - Lower Barrier to entry
  - Eliminates some Field Prep-tasks
- Safety Enhancements
  - Ground based
  - Away from Spray
  - Field Hygiene
  - Night Operations

Current Applications - Beneficial Insects

• Reduced chemical usage: By utilizing beneficial insects, farmers can decrease reliance on chemical pesticides

• Cost-effectiveness: Compared to traditional methods, drone applications can be more economical, especially for large-scale operations

• Minimal crop disturbance: Drones can release insects without damaging crops or compacting soil, unlike ground-based machinery

• Rapid response: Drones allow for quick deployment of beneficial insects when pest outbreaks are detected, enabling faster intervention

• Improved crop health: Timely and targeted release of beneficial insects can lead to better overall crop health and potentially increased yields

Future Applications - Autonomous Farm Management

Future Applications

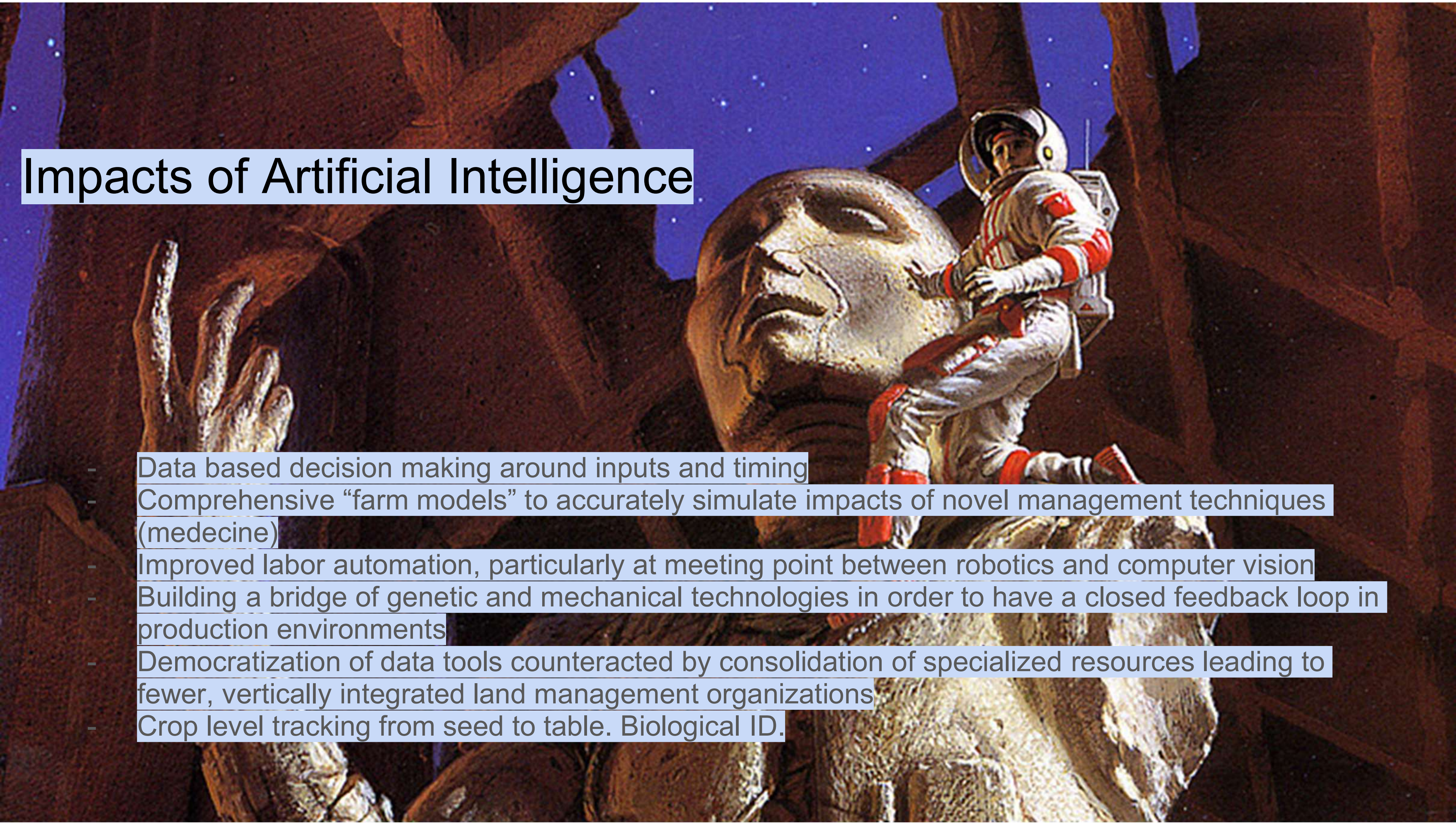
Near Term:

- Multifaceted Systems used for a variety of precision activities not just a single task (Spraying + Mapping + Seeding etc.)
- Improvements in costs, regulatory burden, accessibility to easier to use interfaces
- Enhanced control around payload distribution mechanisms, further advancing need-based application volumes (Precision ag in a box)

Later Term:

- Autonomous Farm Management
- Integration with Farm Management Systems (FMS)
- AI-driven data analysis and decision-making
- Incidental measurements and sample collection
- Fruit picking and pruning capabilities
- IoT integration for comprehensive farm monitoring
- Real-time data transmission and analysis

Impacts of Artificial Intelligence



- Data based decision making around inputs and timing
- Comprehensive “farm models” to accurately simulate impacts of novel management techniques (medecine)
- Improved labor automation, particularly at meeting point between robotics and computer vision
- Building a bridge of genetic and mechanical technologies in order to have a closed feedback loop in production environments
- Democratization of data tools counteracted by consolidation of specialized resources leading to fewer, vertically integrated land management organizations
- Crop level tracking from seed to table. Biological ID.

Questions?