Towards Data-based Decisions in Agriculture

Stephen W. Searcy
Professor and Department Head
2 billion people will be added to our population by 2050

Feeding them requires exploiting the equation,

$$P = G + E + G\times E$$

- **P** – phenotype property such as crop yield
- **G** – genotype such as crop type and variety
- **E** – environment such as weather and field characteristics
We can affect Genotype

- Crop breeding
  - *phenotypic properties* are measured
  - superior plant selections are made
  - genetics are improved
- High-throughput phenotyping (HTP)
  - sensor arrays on ground or aerial UAVs
  - enable vastly more plant phenotypes and genetic variation to be analyzed
  - increase rate at which G can be affected
U.S. Corn: Yield per Acre
1866 to 2010

Source: USDA

Source: http://mjperry.blogspot.com/2011/05/corn-yields-have-increased-6x-since.html
We partially can affect Environment

• By improving field characteristics through farm operations
  – precise application of crop inputs (seed, water, fertilizer, plant protection chemicals, etc.)
  – further improvements in precision agriculture (PA) depend on
    • development of prescriptive analytics
    • to account for spatial and temporal variation in field characteristics
Dynamic nature of weather and impact on yield

- predicting medium term weather trends allows proactive management
- measuring actual weather on small scale provides assessment of crop status and needed actions
High Throughput Phenotyping and Precision Agriculture

• Data volumes are large
• Research issues involve
  – data management
  – analysis
  – interpretation
Precision Ag. Data Layers

Source: Sonka and Coaldrake 1996
Hyperspectral Data Cubes

Möckel et al., 2014
Climate Corp./Monsanto

The Role of Data Science in Agriculture

Helping farmers to increase productivity, utilize resources more efficiently

Annually, all farmers assess risks to make decisions when growing crops. Shared knowledge about these risks helps them improve their farms.

Advancements in Crop Agriculture
Focus on 800 ha TAMU Exp. Farm west of campus
- Weekly flights in 2015
- AERO & ESSM Flight Teams
- BAEN – imaging sensors
- GeoSAT – image processing
- SCSC – agronomists & breeders use data
4 band image mosaic of ~80 ha field = 1400 distinct images, 2 Gb data
Agricultural Data Challenges?

- Data volumes are large
- Processes to be modeled are dynamic, non-linear and time critical
- Research issues are numerous
Whose help do we need?

• Prescriptive Analytics
  – Spatial statisticians
  – Machine-learning experts

• Data Management
  – Compressed-sensing experts
  – Wireless experts

• Modeling for Proactive Management
  – Weather forecasting
  – Management responses
Interested?

Contact:
• Alex Thomasson
  thomasson@tamu.edu
• Steve Searcy
  s-searcy@tamu.edu