Dennis Buckmaster

Professor of Agricultural & Biological Engineering, Purdue University

OATS | Open Ag Technology Systems Group of Purdue (with ECE colleagues J. Krogmeier & A. Ault)
Agriculture as Logistics

LOGISTICS
- The things that must be done to plan and organize a complicated activity
- The handling of details of an operation

French *logistique* art of calculating

Greek *logistikē* art of calculating, from *logos* reason
The Three Tenses of Data in Agriculture

Evaluation of PAST Actions

Logistics of TODAY

Forecasting & Planning for TOMORROW
Data Layers: Thinking of Corn

- Soil characterization
- Topography
- Soil nutrients
- Tillage
- Seeding date
- Hybrid

- Weather
- Pests
- Chemicals
- Grain yield
- Grain moisture
- Stover yield
- Stover moisture

**Varied:**
- Aggregation level
- Quality of data (significant digits)
Data – Agriculture is different

- Science of Agriculture – explains “a lot”
  - Biology
  - Chemistry
  - Physics
  - Mathematics

- “Big” versus “Not Big” data

- Models need (lots of) data, sensors often do not

- Farms and some research labs are small firms without IT department
Data Today: An Example

Prescription Planting Maps

Meet Frank and Andy.
Data Today: An Example
Data Today: An Example

Frank’s Combine with OEM A’s Monitor

OEM A’s Cloud

Yield Data

Frank

Yield Data, Soil Tests, Seed Varieties

Rx Map

Local Agronomi

Frank’s Combine with OEM B’s Monitor

Yield Data

OEM B’s Cloud
Data Today: An Example

Frank's Combine with OEM A's Monitor ➔ Yield Data ➔ OEM A's Cloud ➔ Frank's Computer ➔ Yield Data ➔ Yield Data, Soil Tests ➔ Frank ➔ Yield Data, Soil Tests, Seed Varieties ➔ Local Agronomist ➔ Rx Map ➔ Yield Data ➔ OEM B's Cloud ➔ Frank's Combine with OEM B's Monitor ➔ Yield Data ➔
Data Today: An Example
Data Today: An Example
Data Today: An Example

Frank's Combine with OEM A's Monitor

OEM A's Cloud

Frank's Computer

Fertilizer Co-op

As-Applied Fertilizer Data

Frank

Yield Data, Soil Tests

Rx Map

Irrigator Outlines

Local Agronomist

Local Seed Salesman

Seed Data

Google Earth

Seed Order Receipts

Irrigator Outlines

Frank

Seed Varieties

Seed Data

Frank's Combine with OEM B's Monitor

Yield Data

OEM B's Cloud

Yield Data

Yield Data, Soil Tests, Seed Varieties
Data Today: An Example

Frank’s Combine with OEM A’s Monitor

Yield Data

OEM A’s Cloud

Frank’s Computer

Yield Data, Soil Tests

Fertilizer Co-op

As-Applied Fertilizer Data

Frank’s Planter

Rx Map

Seed Data

Agronomist’s Computer

Local Seed Salesman

Frank

Yield Data, Soil Tests, Seed Varieties

Seed Data

Local Agronomist

Irrigator Outlines

Rx Map

Google Earth

Seed Order Receipts

Irrigator Outlines

Frank’s Combine with OEM B’s Monitor

Yield Data

OEM B’s Cloud

Seed Varieties

Rx Map
Assistance needed in the data area ...
Revisiting Reasons for Data

- Improve decisions – which are largely logistics
  - What
  - Where
  - When
  - How
Revisiting Reasons for Data

- Improve decisions – which are largely logistics
  - What
  - Where
  - When
  - How

- Lack of interoperability hinders adoption

- Lack of ROI/payback hinders adoption

Evaluation of PAST Actions

DATA

Logistics of TODAY

Simple automated records might be the catalyst for TOMOROW
What Data (to get first)?

Many sources of independent data => “cloud big data analytics”

Prefer un- or minimally-processed sensor data

Machine and personal mobile device are the low hanging fruit

**Machines**
- Data Examples:
  - Operations
  - As-planted
  - As-applied
  - Yield
  - GPS

**Mobile Device**
- Data Examples:
  - Who did it
  - What was done
  - Where was it at
  - Apps / Visualizations

Many sources of independent data => “cloud big data analytics”
Working with Data

- Current
  - Tedious
  - “By hand”, with computer (spreadsheets, ArcGIS, proprietary software, import, export, massage, filter, clean)
  - Limited in practical application
Current

- Tedious
- “By hand”, with computer (spreadsheets, ArcGIS, proprietary software, import, export, massage, filter, clean)
- Limited in practical application

Needed

- Write code to implement the ideas
- Remove the constraint to “do it” like others have already done...**free to experiment**
- Requires agricultural professionals to expand their capability to include coding
Metadata is data about data:
- Format
- Source & sensors
- Context
- Conditioning

**Quality**

Automated is likely better than manual ... like IFTTT
Manure App

- Utilize web-based database for multi-device synchronization
- Enable geofencing capabilities to derive field location automatically
- Connect to Bluetooth sensor communicating spreading status
- Just carry your phone & spread
### Autogenic manure records & paths

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Operator</th>
<th>Source Name</th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Nutrient Measure</th>
<th>Spreader</th>
<th>Spreader Capacity</th>
<th>Fill Level</th>
<th>Field</th>
<th>Rate applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/15/2015</td>
<td>7:37</td>
<td>Charlie</td>
<td>Pit2</td>
<td>18</td>
<td>14</td>
<td>12</td>
<td>Lbs/Gallon</td>
<td>Kuhn1</td>
<td>20(Tons)</td>
<td>100%</td>
<td>Adm</td>
<td>64.69 tons/ac</td>
</tr>
<tr>
<td>4/15/2015</td>
<td>7:40</td>
<td>Charlie</td>
<td>Pit2</td>
<td>18</td>
<td>14</td>
<td>12</td>
<td>Lbs/Gallon</td>
<td>Kuhn1</td>
<td>20(Tons)</td>
<td>100%</td>
<td>Adm</td>
<td>61.15 tons/ac</td>
</tr>
<tr>
<td>4/15/2015</td>
<td>7:43</td>
<td>Charlie</td>
<td>Pit2</td>
<td>18</td>
<td>14</td>
<td>12</td>
<td>Lbs/Gallon</td>
<td>Kuhn1</td>
<td>20(Tons)</td>
<td>100%</td>
<td>Adm</td>
<td>56.78 tons/ac</td>
</tr>
<tr>
<td>4/15/2015</td>
<td>7:45</td>
<td>Charlie</td>
<td>Pit2</td>
<td>18</td>
<td>14</td>
<td>12</td>
<td>Lbs/Gallon</td>
<td>Kuhn1</td>
<td>20(Tons)</td>
<td>100%</td>
<td>Adm</td>
<td>54.12 tons/ac</td>
</tr>
<tr>
<td>4/15/2015</td>
<td>7:50</td>
<td>Charlie</td>
<td>Pit2</td>
<td>18</td>
<td>14</td>
<td>12</td>
<td>Lbs/Gallon</td>
<td>Kuhn1</td>
<td>20(Tons)</td>
<td>100%</td>
<td>Adm</td>
<td>57.49 tons/ac</td>
</tr>
<tr>
<td>4/15/2015</td>
<td>7:53</td>
<td>Charlie</td>
<td>Pit2</td>
<td>18</td>
<td>14</td>
<td>12</td>
<td>Lbs/Gallon</td>
<td>Kuhn1</td>
<td>20(Tons)</td>
<td>100%</td>
<td>Adm</td>
<td>55.91 tons/ac</td>
</tr>
</tbody>
</table>
A Current Project

- Capitalize on technology to turn every field into a possible research plot
- Trials Tracker – user oriented note taker with tag flags
“The promise” of data is to provide answers to questions.

Still need layers of data to work together.

This tool should catalyze aggregation by finger.

Farmers may not have statistical background to mine & compare, but researchers should.

BIG data analytics will require this sort of whole-story documentation.
Agriculture, as applied logistics, is a data-based industry; high quality decisions will require high quality data.

Data interoperability remains a problem; data needs to flow without manual intervention.

Higher quality data and metadata are needed ... automatic and “at the time” generation can help get us there.

Ownership of data is key; there are approaches to facilitate aggregation & anonymization.