Big Data and the Precision Business Plan

David Muth Jr., PhD
AgSolver, Inc

November 7th, 2014
AgSolver Agronomic Decision Services: Changing the Scale of Decisions

Development of Precision Agriculture

Challenge:
Better Data + Better Control Systems ≠ better decisions

The Target is Set...
High Resolution Precision Management that Optimizes:
- Crop Selection
- Hybrid Selection
- Plant Population
- Nutrient Utilization
- Profitability

AgSolver’s integrated data management and simulation methods turn precision data into better decisions

turning data into decisions for agriculture™
The AgSolver Value Proposition

Precision data is available, but current use isn’t maximizing value for actionable decisions

AgSolver is delivering products that:
• make unlike information work together
• extend the value of information with specific, high impact decisions
• find the intersection between compliance/certification and profitability

Data is coming from a broad range of sources, often incompatible
How we do it

Integrated data management and environmental process simulation

Changing the way environmental process simulation tools are used

Extensible, scalable, affordable compute resources

Turning data into decisions for agriculture™
AgSolver Core Products and Competencies

- **Product Categories**
  - Compliance and Certification
  - Nutrient and Residue Management
  - Coupling Precision Data with Financial Instruments and Transactions

- **R&D and Prospecting Projects**
  - Large Agronomic Scenario Sets
  - N, P, K, & C Mass Balances Across Large Spatial Extents
  - Integrated Landscape Designs
  - Coupling Precision Ag Data with Conservation Designs

turning data into decisions for agriculture™
History

Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply

April 2005

2011 National Sustainable Agricultural Residue Removal Scenario

Sustainable Removal Rate by Crop (metric tons ha⁻¹)

Total Sustainable Residue Produced (metric tons)

Turning data into decisions for agriculture™
History: Sub-Field Scale Applications
Subfield Variability
Subfield Profit and ROI
Environmental Performance and Economic Performance are driven by the same goal:

Maximize the output per unit of input
**Subfield Financials: Current Practices**

<table>
<thead>
<tr>
<th>Summary</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 Year Yld Ave:</td>
<td>170 bu/acre</td>
</tr>
<tr>
<td>50 Year Yld STD:</td>
<td>38 bu/acre</td>
</tr>
<tr>
<td>Profit Average:</td>
<td>$47 $/acre</td>
</tr>
<tr>
<td>Profit STD:</td>
<td>$235 $/acre</td>
</tr>
<tr>
<td>Years Profitable Ave:</td>
<td>31</td>
</tr>
<tr>
<td>Years Profitable STD:</td>
<td>14</td>
</tr>
<tr>
<td>Percentage of Field Profitable:</td>
<td>74%</td>
</tr>
</tbody>
</table>

50 Year Profit Average ($/acre)

- (933) - (784)
- (784) - (576)
- (576) - (404)
- (404) - (195)
- (195) - (76)
- (76) - 11
- 11 - 101
- 101 - 168
- 168 - 223
- 223 - 611
Subfield Financials: Release Acres

Summary

Discontinue ops on areas with ave loss > $250/acre with risk adjusted ins prem’s and int rates

<table>
<thead>
<tr>
<th>Profit Average:</th>
<th>$76</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit STD:</td>
<td>$124</td>
</tr>
<tr>
<td>Percentage of Field Profitable:</td>
<td>72%</td>
</tr>
<tr>
<td>Percentage of Field Used Profitable:</td>
<td>81%</td>
</tr>
</tbody>
</table>
Subfield Financials: Risk Management Through Agronomy

Summary

New production at loss > $200/acre with adjusted ins prem’s and int rates

Profit Average: $105 $/acre
Profit STD: $149 $/acre
Percentage of Field Profitable: 79%

50 Year Profit Average
Adjusted Ins Prem - Int Rates
New Biomass at (200)
$/acre
(200) - (171)
(171) - (107)
(107) - (48)
(48) - 33
33 - 125
125 - 167
167 - 249
249 - 292
292 - 376
376 - 637
Subfield Financials: Risk Management Through Agronomy

**Summary**

- New production at loss > $200/acre with adjusted ins prem’s, int rates, and cash rent
- Profit Average: $105 $/acre
- Profit STD: $71 $/acre
- Percentage of Field Profitable: 95%

**50 Year Yld Ave:**
- 170 bu/acre

**50 Year Yld STD:**
- 38 bu/acre

**Profit Average:**
- $47 $/acre

**Profit STD:**
- $235 $/acre

**Percentage of Field Profitable:**
- 74%

---

**50 Year Profit Average**
- Adjusted Ins Prem - Int Rates
- Profit Based Cash Rent
- New Biomass at (200)

- Profit Average: $105 $/acre
- Profit STD: $71 $/acre
- Percentage of Field Profitable: 95%

50 Year Profit Average
- (933) - (784)
- (784) - (576)
- (576) - (404)
- (404) - (195)
- (195) - (76)
- (76) - 11
- 11 - 101
- 101 - 168
- 168 - 223
- 223 - 611

---

**50 Year Profit Average**
- Adjusted Ins Prem - Int Rates
- Profit Based Cash Rent
- New Biomass at (200)

- Profit Average: $47 $/acre
- Profit STD: $235 $/acre
- Percentage of Field Profitable: 74%

50 Year Profit Average
- (200) - (169)
- (169) - (66)
- (66) - 8
- 8 - 54
- 54 - 93
- 93 - 119
- 119 - 172
- 172 - 206
- 206 - 289
- 289 - 322

---

**Summary**

- 50 Year Yld Ave: 170 bu/acre
- 50 Year Yld STD: 38 bu/acre
- Profit Average: $47 $/acre
- Profit STD: $235 $/acre
- Percentage of Field Profitable: 74%
Driving Agronomic Decisions through ROI

Not all acres can perform at a level justifying high input costs

Three performance zones:
• Revenue: aggressively pursue yield
• Expense Limited: retail and agronomic choices within expense limit
• No cost: no historic ROI potential – find alternative uses, USDA programs, conservation practices

Objectives:
• Enable the interaction between the service provider/retailer and grower using ROI as the decision point
• Leverage grower intuition with quantified thresholds at the right scale, i.e. for Zone X, $350/ac inputs requires 175 bu, is that reasonable...
• Couple the agronomic plan to the financial plan – crop insurance, lender, landlord
Profit Zone Manager

Leverages available data to calculate and interact with profitability and return on investment at a 30ft (or higher) resolution.

Automated spatial data import, translate, & upload
- Yield
- As-applied fertilizer
- As-planted
- Field boundaries and soil sample data

Streamlined crop budget data entry tools – 5 minute target

Web-tool and web-service enabled cloud framework

Approx. 2 weeks to beta deployment

Turning data into decisions for agriculture
Environmental Performance: Solving the Mass Balance

### C Balance
- `c_rem_grn`
- `c_rem_biomass`
- `c_loss_ero`
- `ann_soil_c_delta`
- `co2_flux`
- `c_delta`

### N Balance
- `n_litter_in`
- `n_rem_grn`
- `n_rem_biomass`
- `n_loss_ero`
- `crop_n_uptake`
- `n_app`
- `no3_leach`
- `n2o_flux`
- `n2_flux`
- `nh3_vol`
- `n_precip`
- `n_delta`

### P Balance
- `p_rem_grn`
- `p_rem_biomass`
- `p_loss_ero`
- `p_app`

### K Balance
- `k_rem_grn`
- `k_rem_biomass`
- `k_loss_ero`
- `k_app`

---

Turning data into decisions for agriculture™
Precision Data Solutions: Nutrient Management

turning data into decisions for agriculture™
Precision Data Solutions: Nutrient Management

Soil Erosion

tons / acre / year

- 0.0 - 1.0
- 1.1 - 2.0
- 2.1 - 3.0
- 3.1 - 4.0
- 4.1 - 5.0
- 5.1 - 20.0

Iowa Phosphorus Index

P runoff risk

- 0.0 - 1.0
- 1.1 - 2.0
- 2.1 - 3.0
- 3.1 - 4.0
- 4.1 - 5.0
- 5.1 - 6.0
- 6.1 - 7.0
- 7.1 - 20.0
Precision Data Solutions: Nutrient Management

- Agronomic management to address key performance metrics
- Cover Crop
  - Select Acres
  - $30 / acre Cost
  - On select acres >$50 / acre N, P & K savings
  - Potential Yield Increase

Iowa Phosphorus Index

P runoff risk
- 0.0 - 1.0
- 1.1 - 2.0
- 2.1 - 3.0
- 3.1 - 4.0
- 4.1 - 5.0
- 5.1 - 6.0
- 6.1 - 7.0
- 7.1 - 20.0

P Application

11-52-0 lbs/acre
- 70 - 90
- 91 - 110
- 111 - 130
- 131 - 150
- 151 - 170
- 171 - 190
- 191 - 210

turning data into decisions for agriculture™
Precision Data Solutions: Nutrient Management
Precision Data Solutions: Nutrient Management

Sub field mass balance

Crop Production

- N application
- Sub surface losses
- Surface losses

Soil N levels

Biomass N

Bad

Good

turning data into decisions for agriculture™
Apply crop models to determine:
- Subfield population selection
- Subfield variety selection
- Subfield fertilization rates

This was solved with publically available data and a yield map...

Turning data into decisions for agriculture™
High Resolution Biogeochemistry Framework

Carbon
- Biomass
- Gas Flux
- Erosion
- Biomass
- Manure

System Boundary

Nitrogen
- Manure
- Fertilizer
- Biomass
- Gas Flux
- Leaching/Drainage
- Runoff

Phosphorus
- Biomass
- Runoff
- Manure
- Fertilizer
Operationalizing
Operationalizing

Stover Removal Management Zones

NO3 Leaching Mitigation Management Zones

turning data into decisions for agriculture™
## Identifying the Opportunities

<table>
<thead>
<tr>
<th>Acres in supply area:</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>793,956</td>
<td>865,644</td>
<td>862,309</td>
<td>847,237</td>
</tr>
<tr>
<td>Soybeans</td>
<td>725,539</td>
<td>653,852</td>
<td>657,187</td>
<td>672,258</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acres in corn at least 3 of 4 years:</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>246,973</td>
<td>238,295</td>
<td>263,077</td>
<td>279,790</td>
</tr>
</tbody>
</table>
Identifying the Opportunities

Sustainable stover supply from 100% sustainable fields

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable Stover Supply (short tons)</td>
<td>542,917</td>
<td>607,923</td>
<td>464,658</td>
<td>649,703</td>
</tr>
</tbody>
</table>

Percentage of Field Sustainable

- 0% - 20%
- 20% - 40%
- 40% - 60%
- 60% - 80%
- 80% - 100%

Fields where removal is sustainable on all acres.

Fields where removal is sustainable on >75% of acres.

turning data into decisions for agriculture™
Identifying the Opportunities

NW Corner of 30 Mile Radius

2010-2015 crop rotation

Soils Assessment

- bin 1
- bin 2
- bin 3
- bin 4

turning data into decisions for agriculture™
Identifying the Opportunities

<table>
<thead>
<tr>
<th>Year</th>
<th>Acres not profitable</th>
<th>Acres with loss &gt;$200/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>6,960,494</td>
<td>1,999,639</td>
</tr>
<tr>
<td>2011</td>
<td>5,785,424</td>
<td>1,564,059</td>
</tr>
<tr>
<td>2012</td>
<td>16,282,478</td>
<td>3,476,371</td>
</tr>
<tr>
<td>2013</td>
<td>10,384,392</td>
<td>1,821,062</td>
</tr>
<tr>
<td>All 4 Years</td>
<td>4,836,364</td>
<td>1,259,901</td>
</tr>
</tbody>
</table>
Questions?