IN-FIELD PROFITABILITY ASSESSMENT

Analyses & Tools to Aid Profitable In-Field Outcomes

Suzanne Fey
Data Analyst
sfey@iasoybeans.com
Objectives

1. Talk about motivating factors and benefits of studying spatial variability at the field level.

2. Look at how we studied individual and aggregated field data and discuss what we found.

3. Present a few current fields of exploration and some farmer-friendly ISA Analytics tools to aid profitability.
Trend in the number of US farms and average size

-100,000 farms

7 years (-14,285 per year)
### Average commodity prices and input costs

#### Average Corn Market Year Price ($/bu) vs. Est. Crop Production Costs in Iowa ($/bu)

<table>
<thead>
<tr>
<th>Year</th>
<th>Production Cost Cn/Cn</th>
<th>Production Cost Cn/Sb</th>
<th>Sale Price Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>$3.53</td>
<td>$3.51</td>
<td>$4.08</td>
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<tr>
<td>2008</td>
<td>$4.17</td>
<td>$4.10</td>
<td>$4.32</td>
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<td>$4.39</td>
<td>$4.39</td>
<td>$4.59</td>
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<tr>
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<td>$5.00</td>
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<tr>
<td>2011</td>
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<td>$5.00</td>
<td>$5.20</td>
</tr>
<tr>
<td>2012</td>
<td>$5.92</td>
<td>$5.92</td>
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<td>$7.31</td>
<td>$7.40</td>
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<tr>
<td>2016</td>
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</tr>
<tr>
<td>2017</td>
<td>$8.00</td>
<td>$8.00</td>
<td>$8.10</td>
</tr>
</tbody>
</table>

#### Avg. Soybean Market Year Price ($/bu) vs. Est. Crop Production Costs in Iowa ($/bu)

<table>
<thead>
<tr>
<th>Year</th>
<th>Production Cost Soybean</th>
<th>Sale Price Soybean</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>$3.35</td>
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<tr>
<td>2008</td>
<td>$3.40</td>
<td>$4.10</td>
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<tr>
<td>2009</td>
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<td>$13.50</td>
</tr>
<tr>
<td>2017</td>
<td>$9.66</td>
<td>$15.00</td>
</tr>
</tbody>
</table>

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Iowa State University Extension and Outreach-(price source: USDA, NASS)
Farming is largely about risk management

Farmers have limited control over key factors that significantly drive profitability:

- **Input costs** – what and how much to apply
- **Market prices** – what to grow, when and how much to sell
- **Weather** – when to plant, when to fertilize/protect against pests
Why study spatial variability in profit?

- Although costs may be uniform across a field, *yields are not*, therefore average costs don’t usually represent actual individual per bushel costs.

- Even costs applied variably across a field won’t necessarily produce uniform per-bushel costs.
Example: Yield compared to profit

- **2011**: Normal Rainfall
  - Avg. Yield: 191 bu/ac
  - Field Profit: $72,980
  - Profit per bushel: +$1.85/bu

- **2013**: Wet Spring, Dry Summer
  - Avg. Yield: 148 bu/ac
  - Field Profit: -$25,600
  - Profit per bushel: -$0.52/bu

- **2014**: Wet June, Dry July
  - Avg. Yield: 225 bu/ac
  - Field Profit: -$378
  - Profit per bushel: -$1.33/bu

Legend:
- Dry Yield (bu/ac)
  - 0 - 180
  - 180 - 230
  - >230

Graph showing profit ($/ac) with a scale from -500 to 500.
550 site-years from 144 fields

42 Farmers
Data collection methodology

• Each field is represented by an average of 4 years of spatial yield data from between 2007 and 2014.

• Some fields had as many as 8 consecutive years of data.

• Farmer yield files and ISU annual *Estimated Costs of Production* were uploaded into the Profit Zone Manager tool, AgSolver, Inc.
Three spatial profitability measurements

Mean Profit

Return on Investment

Standard Deviation

ROI – Net Profit/Cost of Investment * 100

ROI (%)

Std. Dev. ($/ac)
Spatial data prepared for analyses

- Divided spatial profitability and ROI files into 10 x 10m cells.

- Added farmer management and 40+ soil and weather variables from publicly available sources to each cell.

- The average field in the study contains over 19,000 cells.
Central Iowa – Des Moines Lobe

270 site years, 52 fields, 13 farmers
111 site years, 25 fields, 8 farmers
Histograms help to illustrate relative differences and long term patterns.
Des Moines Lobe – temporal variation

Within-Field Profit
- Soybean
- Corn after Soybean
- Corn after Corn

Bi-modal shape in some years indicates no single factor is responsible for profitability.
Eastern Iowa – temporal variation

Within-Field Profit

- Soybean
- Corn after Soybean
- Corn after Corn
Factors driving spatial variability in mean profit

7 years of yield and management data

Mean Profit Value
- CSR >80: $211.84/acre
- CSR 75-80: $150.21/acre
- CSR <75: $50.21/acre

CSR explained ~25% of the variability in profit
Factors driving standard deviation in profit

Multi-year std. dev. in profit

C-S-R >80: $119.35/acre
C-S-R 75-80: $148.59/acre
C-S-R <75: $194.29/acre

Variability tended to be high for low production areas.

CSR explained ~25% of the variability in Standard Deviation
Factors driving spatial variability in profit

5 Years of yield and management data

CSR explained ~16% of the variability in profit
- CSR >50: $28.91/acre
- CSR 35-50: -$52.61/acre
- CSR <35: -$102.26/acre

Drainage explained ~22% of the variability in profit
- EXCESS: -$81.01
- WELL: $68.86
- POOR: $44.81
- VERY POOR: -$256.18

Soil Organic Matter explained ~15% of the variability in profit
- SOM > 3%: $44.81
- SOM 2 to 3%: $39.23
- SOM <2%: -$81.93
Can we explain variability in spatial profit?

12 fields with yield from multiple years in Central and Eastern Iowa were studied for patterns in the impact of spatial variability in profit from:

- SOM
- Elevation
- Slope
- CSR
- Drainage
- Soil Types

Spatial variability could not be explained by one or two individual factors in the majority of fields.

In a multi-year profit analysis, no significant correlation to any of the selected variables appeared in the majority of 12 fields.
Trend identification through aggregation

- Aggregating fields makes it possible to quantify effects less easily identified using individual fields.

- Results of quantifying aggregated data can then be usefully applied to individuals within the group.

- Through aggregation, we examined the effect of weather on soils by crop rotation.
Central Iowa – Des Moines Lobe

270 site years, 52 fields, 13 farmers
2013 NAIP imagery of fields with potholes

Pothole areas - remnants of glacial activity
Potholes are revealed on profitability maps

- **Profit ($/acre)**
  - 500
  - 400
  - 300
  - 200
  - 100
  - 0
  - -100
  - -200
  - -300
  - -400
  - -500

- **Multi-Year Average Profit ($/acre)**

- **Multi-Year ROI (%)**

- **Multi-Year Std. Dev. ($/acre)**
  - 500
  - 450
  - 400
  - 350
  - 300
  - 250
  - 200
  - 150
  - 100
  - 50
  - 0
Soybean fields (planted later) were unaffected by May rainfall and less affected by June rainfall.
Wet and normal spring: pothole vs. upland areas

A more vertical slope indicates less noise, which indicates less risk.

Soybean
Still largely profitable even in pothole areas in wet spring.

Corn after Soybean
More profitable than Soybean in normal spring.

Corn after Corn
More profitable in normal spring but not profitable in pothole areas in wet spring.
Eastern Iowa – Iowan Surface

111 site years, 25 fields, 8 farmers
Iowan Surface: soil drainage effect

All Crops

- Poorly Drained
- Well Drained
- Excessively Drained

Slightly larger variability in poorly and excessively drained soils.
Eastern Iowa – rainfall effect

Soybean fields were unaffected by Spring rainfall and less affected by July rainfall.
Soybean
Soybean is less affected by rainfall, but excessive drainage has more negative impact on profitability.

Corn after Soybean
Corn fields were less affected by excessive drainage.

Corn after Corn
Corn fields were more profitable and less affected by excessive drainage than soybean.
Key points

1. Spatial profitability comparisons quantify the temporal effects of management, weather, and soil.

2. Multi-year spatial data is valuable in detecting in-field patterns in spatial profitability even when no single factor correlations appear.

3. Aggregated field-level data can provide big-picture observations applicable at the individual field level.

4. When production costs exceed market price and weather is unpredictable, in-field knowledge helps farmers manage profitability.
ISA tools & projects to improve in-field profitability

1. Fungicide Economic Calculator (launched 2011)

2. Risk of Late-Season Nitrogen Deficiency Calculator (launched 2014)

3. Calibrate Agronomic Modeling of Cover Crops and Nitrogen (10:45 AM, room 314)

4. ISA On-Farm Trial Summarization Tool (launch 2018) (1:00 PM, room 314)

5. Study Aerial Imagery’s accuracy to detect Nitrogen Stress (2:15 PM, room 314)
Fungicide Economic Calculator - 2011

Results:

- Yield increase (break-even) required to pay for the treatment without profit
  
  2.7 bu/acre

- Probability of exceeding the direct application cost
  
  43%

- The expected average profit exceeding the direct application cost*
  
  -$2.80 $/ac.

- A range for the expected average profit exceeding the direct application cost
  
  From -$13.90 to $14.78 $/ac.

- A number of years with the expected average profit exceeding the direct application cost
  
  1 out of 7 years.

* Based on the 7-year median yield increase of 2.4 bu/acre across all trials when March through Spring rainfall was more than 12 inches.
• Daily, in-season May-June rainfall updates recalculate probability of N loss by practice.
• Risk table compliments graphic display.
• Map shows deviation from long-term rainfall.
Aggregating historical trial and scouting results with site-specific data.
June - Harvest aerial imagery and late season ground-truthing

To develop predictive analytics for late season nitrogen stress detection.
Modeled soil mineral N and rainfall

Modeling to estimate field-specific N loss reduction potential of cover crops.
How can farmers assess and improve economic return?

- Go to iasoybeans.com/programs/isa-research/get-informed/tools/
  - Track in-season probability of N loss due to rainfall
  - Access the Fungicide Calculator
  - Try out the new Strip Trial Summarization tool

- Participate in studies to assess to explore the economic and environmental impacts of cover crops and commercial products.

- Consider spatial analyses of in-field profitability to guide sustainable land use.
Acknowledgments

• Most of all – our Iowa soybean farmers

• AgSolver, Inc., technical staff, field specialists, and business staff

• Iowa Soybean Association On-Farm Network® and Environmental Programs & Services

• Dr. Peter Kyveryga