AgSolver

From the Selected Works of David J. Muth

August 7, 2014

Crop Decision-making to Protect Soil and Water

David J. Muth

Available at: https://works.bepress.com/david_muth/22/
Crop Decision-making to Protect Soil and Water

AgSolver, Inc

August 7th, 2014
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

Total Sustainable Residue Produced (metric tons)

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

Corn
Barley
Rice
Sorghum
Wheat

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History: Sub-Field Scale Applications

Field 1
- Organic Matter in the top horizon (%):
  - 1.50
  - 1.51 - 2.00
  - 2.01 - 2.50
  - 2.51 - 3.00
  - 3.51 - 4.00

- Sand Fraction in the top horizon (%):
  - 0 - 1.0
  - 1.01 - 1.50
  - 1.51 - 2.00
  - 2.01 - 2.50
  - 2.51 - 3.00

- Surface Slope (%):
  - 0 - 1.36
  - 1.37 - 1.50
  - 1.51 - 1.79
  - 1.80 - 2.04
  - 2.05 - 2.38
  - 2.39 - 2.77
  - 2.78 - 3.26
  - 3.27 - 4.24
  - 4.25 - 13.14

- Grain Yield (bu/ac):
  - 0 - 50
  - 51 - 70
  - 71 - 90
  - 91 - 110
  - 111 - 130
  - 131 - 150
  - 151 - 170
  - 171 - 190
  - 191 - 210
  - 211 - 230
  - 231 - 250

- Residual Removal Rate (tons acre-1):
  - 0.00 - 0.50
  - 0.51 - 1.00
  - 1.01 - 1.50
  - 1.51 - 2.00
  - 2.01 - 2.50
  - 2.51 - 3.00
  - 3.01 - 3.50
  - 3.51 - 4.00

Field 2
- Organic Matter in the top horizon (%):
  - 3.50

- Sand Fraction in the top horizon (%):
  - 11.30
  - 19.70

- Surface Slope (%):
  - 0.11 - 1.32
  - 1.33 - 2.53
  - 2.54 - 3.74
  - 3.75 - 4.95
  - 4.96 - 6.17
  - 6.18 - 7.38
  - 7.39 - 8.60

Field 3
- Organic Matter in the top horizon (%):
  - 1.00

- Sand Fraction in the top horizon (%):
  - 0.00 - 6.60
  - 6.61 - 6.80
  - 6.81 - 7.00
  - 7.01 - 7.20
  - 7.31 - 7.50
  - 7.61 - 7.80
  - 7.91 - 8.10
  - 8.11 - 8.30

- Grain Yield (bu/ac):
  - 0 - 50
  - 51 - 70
  - 71 - 90
  - 91 - 110
  - 111 - 130
  - 131 - 150
  - 151 - 170
  - 171 - 190
  - 191 - 210
  - 211 - 230
  - 231 - 250

- Residual Removal Rate (tons acre-1):
  - 0.00 - 0.25
  - 0.26 - 0.50
  - 0.51 - 0.75
  - 0.76 - 1.00
  - 1.01 - 1.25
  - 1.26 - 1.50
  - 1.51 - 1.75
  - 1.76 - 2.00
  - 2.01 - 2.25
  - 2.26 - 2.50
  - 2.51 - 2.75
  - 2.76 - 3.00
  - 3.01 - 3.25
  - 3.26 - 3.50

- Map Legend:
  - Sustainable
  - SCI < 0
  - Erosion > T

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Environmental Performance: Solving the Mass Balance

Cons. Outputs
SCI
SCI-OM
SCI-FO
SCI-ER
Water Ero
Wind Ero

C Balance
\(c\_\text{rem\_grn}\)
\(c\_\text{rem\_biomass}\)
\(c\_\text{loss\_ero}\)
\(\text{ann\_soil\_c\_delta}\)
\(\text{co2\_flux}\)
\(c\_\text{delta}\)

P Balance
\(p\_\text{rem\_grn}\)
\(p\_\text{rem\_biomass}\)
\(p\_\text{loss\_ero}\)
\(p\_\text{app}\)

N Balance
\(n\_\text{litter\_in}\)
\(n\_\text{rem\_grn}\)
\(n\_\text{rem\_biomass}\)
\(n\_\text{rem\_biomass\ crop\_n\_uptake}\)
\(n\_\text{loss\_ero}\)
\(n\_\text{app}\)
\(n\_\text{no3\_leach}\)
\(n\_\text{2o\_flux}\)
\(n\_\text{2\_flux}\)
\(n\_\text{nh3\_vol}\)
\(n\_\text{precip}\)
\(n\_\text{delta}\)

K Balance
\(k\_\text{rem\_grn}\)
\(k\_\text{rem\_biomass}\)
\(k\_\text{loss\_ero}\)
\(k\_\text{app}\)
Precision Data Solutions: Nutrient Management

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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
Precision Data Solutions: Nutrient Management

Crop Production

Sub field N mass balance

N application

Surface losses

Soil N levels

Biomass N

Sub surface losses

Good

Bad
Precision Data Solutions: Nutrient Management

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...

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Identifying Subfield Profit and ROI: Examples pulled from current reports
Correlating Profit and Sustainability

Summary

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 Year Yld Ave:</td>
<td>170</td>
<td>bu/acre</td>
</tr>
<tr>
<td>50 Year Yld STD:</td>
<td>38</td>
<td>bu/acre</td>
</tr>
<tr>
<td>Profit Average:</td>
<td>$47</td>
<td>$/acre</td>
</tr>
<tr>
<td>Profit STD:</td>
<td>$235</td>
<td>$/acre</td>
</tr>
<tr>
<td>Years Profitable Ave:</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Years Profitable STD:</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Percentage of Field Profitable:</td>
<td>74%</td>
<td></td>
</tr>
</tbody>
</table>
## Summary

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

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit Average</td>
<td>$76</td>
</tr>
<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>
Correlating Profit and Sustainability

Summary

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

<table>
<thead>
<tr>
<th>50 Year Profit Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted Ins Prem - Int Rates</td>
</tr>
<tr>
<td>New Biomass at (200)</td>
</tr>
<tr>
<td>($/acre)</td>
</tr>
<tr>
<td>(200) - (171)</td>
</tr>
<tr>
<td>(171) - (107)</td>
</tr>
<tr>
<td>(107) - (48)</td>
</tr>
<tr>
<td>(48) - 33</td>
</tr>
<tr>
<td>33 - 125</td>
</tr>
<tr>
<td>125 - 167</td>
</tr>
<tr>
<td>167 - 249</td>
</tr>
<tr>
<td>249 - 292</td>
</tr>
<tr>
<td>292 - 376</td>
</tr>
<tr>
<td>376 - 637</td>
</tr>
</tbody>
</table>

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

Stover Removal Management Zones

NO3 Leaching Mitigation Management Zones
Driving Sustainable 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:
- 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
Identifying the Opportunities: Profitability

<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?