The Science of Sustainability: Estimating KPI Improvement Potential for US Agriculture
Everything is Connected
Everything is changing
We are all in this together
Continuous Improvement Framework for Sustainability

1. Define
   A. Define Sustainability for the Enterprise
   B. Define Key Performance Indicators
   C. Select Metrics for KPIs

2. Measure
   A. Benchmark KPI Metrics
   B. Set Goals for Each KPI
   C. Develop Strategy to Meet Goals

3. Implement
   A. Implement the Strategy
   B. Measure, Assess and Report Results
   C. Adapt Strategy to Improve Outcomes
ENVIRONMENTAL KEY PERFORMANCE INDICATORS (KPIS) FOR AGRICULTURE

- Greenhouse Gas Emissions
- Soil Loss
- Energy Use
- Water Use
- Land Use
- Water Quality
- Nutrient Use Efficiency
- Habitat/Biodiversity

Common US Initiatives:
- Cotton, Corn, Wheat, Rice, Potatoes
- US Poultry & Egg Federation
- National Pork Board
- Dairy Research Institute
- National Roundtable on Sustainable Aquaculture
Index of Per Bushel Resource Impacts to Produce Soybeans
(United States, Year 2000 = 1)

<table>
<thead>
<tr>
<th></th>
<th>2000 *</th>
<th>Unit - per Bushel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Use</td>
<td>0.027</td>
<td>Planted Acres</td>
</tr>
<tr>
<td>Soil Erosion</td>
<td>0.131</td>
<td>Tons</td>
</tr>
<tr>
<td>Irrigation Water Applied</td>
<td>0.766</td>
<td>Acre Inches</td>
</tr>
<tr>
<td>Energy</td>
<td>44,840</td>
<td>Btus</td>
</tr>
<tr>
<td>Greenhouse Gases</td>
<td>8.2</td>
<td>Pounds CO₂e</td>
</tr>
</tbody>
</table>

* Five-year average 1996 - 2000

Note: Data are presented in index form, where the year 2000 = 1 and a 0.1 point change is equal to a 10% difference. Index values allow for comparison of change across multiple dimensions with differing units of measure.
Framework of Goals

- Aspirational
- Strategic
- Tactical
- Operational

Breadth of Goal

Planning Horizon

Long

Short
How to Move the Curve

Moving the Curve through targeted BMP adoption

No-Till Erosion
2010 Soil Erosion

0.10 tons/bushel
No Till Average

0.131 tons/bushel
2010 National Average

Highest Erosion Fields
Sector-Level Continuous Improvement Versus Site Certification

- **Continuous Improvement Approach**
  - Benchmark Year
  - Minimum Acceptable Performance Level (MAPL)

- **Site Certification Approach**
BMP-driven Analysis of KPI Performance Gap

Maximum KPI Improvement Potential for BMP<sub>i</sub> = \[ \sum \left[ 1 - \left( 2010 \text{ BMP}_i \text{ Adoption Rate (\%)} \right) \right] \times \left( \text{BMP}_i \text{ KPI}_j \text{ Improvement Potential (\%)} \right) \times 2010 \text{ KPI}_j \text{ performance} \]
Geospatial Assessment of BMP Adoption – by HUC8, County
US Ag Sustainability Programs
Adopting the Framework

US Poultry
National Institute for Animal Agriculture
Pork Checkoff
Innovation Center for U.S. Dairy
USSEC
American Peanut Council
USA Rice Federation
Cotton Incorporated
SUSTAINABILITY GOALS:
The pathway to continuous improvement

The U.S. Soybean Sustainability Assurance Protocol

U.S. SOY for a growing world
Setting the Goals

• Identify what is technologically possible TODAY with implementation of BMPs for KPI improvement.

• The target BMP is NOT a proscriptive practice, but simply provides an analytical estimate of what could be possible with one practice for a KPI.

• Goals should be established for crop production based on an increased adoption of the target BMP (30%, 60%, 90%).
Soybean Benchmark KPIs

<table>
<thead>
<tr>
<th>Key Performance Indicator</th>
<th>Unit of Measure</th>
<th>Value</th>
<th>Metric Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Use</td>
<td>Planted acres per bushel</td>
<td>0.027</td>
<td>Efficiency</td>
</tr>
<tr>
<td>Soil Erosion</td>
<td>Tons per bushel</td>
<td>0.131</td>
<td>Efficiency</td>
</tr>
<tr>
<td>Total Soil Erosion</td>
<td>Million tons per year</td>
<td>364.6</td>
<td>Impact</td>
</tr>
<tr>
<td>Irrigation Water Use</td>
<td>Acre inches per bushel</td>
<td>0.77</td>
<td>Efficiency</td>
</tr>
<tr>
<td>Total Irrigation Water Use</td>
<td>Million acre inches per year</td>
<td>42.2</td>
<td>Impact</td>
</tr>
<tr>
<td>Energy Use</td>
<td>BTUs per bushel</td>
<td>44,840</td>
<td>Efficiency</td>
</tr>
<tr>
<td>Total Energy Use</td>
<td>Trillion BTUs per year</td>
<td>116</td>
<td>Impact</td>
</tr>
<tr>
<td>GHG Emissions</td>
<td>Pounds CO₂e per bushel</td>
<td>8.2</td>
<td>Efficiency</td>
</tr>
<tr>
<td>Total GHG Emissions</td>
<td>Billion Pounds CO₂e per year</td>
<td>22.0</td>
<td>Impact</td>
</tr>
</tbody>
</table>
# BMPs That Improve KPIs for US Soybeans

<table>
<thead>
<tr>
<th>Key Performance Indicator</th>
<th>No Till</th>
<th>Conservation Till</th>
<th>Narrow Rows</th>
<th>Cover Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Use</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Soil Erosion</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Irrigation Water Use</td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Energy Use</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GHG Emissions</td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td><strong>Other Performance Indicators</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop Yield</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Water Quality</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Soil Health</td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Weed Management</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>
2006 Tillage data for the top 19 soy-producing states in the U.S.

<table>
<thead>
<tr>
<th>Tillage Practice</th>
<th>No Till</th>
<th>Conservation Till</th>
<th>Reduced Till</th>
<th>Conventional Till</th>
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</thead>
<tbody>
<tr>
<td>State Average</td>
<td>44</td>
<td>30</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>Highest Rate of Adoption</td>
<td>77</td>
<td>58</td>
<td>25</td>
<td>66</td>
</tr>
<tr>
<td>Lowest Rate of Adoption</td>
<td>9</td>
<td>12</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>
U.S. SOY PRODUCERS SUSTAINABILITY GOALS FOR U.S. SOYBEANS BY 2025, FROM 2000 BENCHMARK

<table>
<thead>
<tr>
<th>Key Performance Indicators</th>
<th>Unit of Measure</th>
<th>Total Potential Reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Use</td>
<td>Planted acres per bushel</td>
<td>10</td>
</tr>
<tr>
<td>Soil Erosion</td>
<td>Tons per bushel</td>
<td>25</td>
</tr>
<tr>
<td>Energy Use</td>
<td>BTUs per year</td>
<td>10</td>
</tr>
<tr>
<td>GHG Emissions</td>
<td>Pounds CO2e per year</td>
<td>10</td>
</tr>
</tbody>
</table>

www.ussec.org/ssap
A Life Cycle Analysis of BMPs in U.S. Pork Production

University of Arkansas Pork Sustainability Team
Marty Matlock, Ph.D., P.E., B.C.E.E.
Greg Thoma, Ph.D., P.E.
Rick Ulrich, Ph.D.
Eric Boles, MS, EIT
Heather Sandefur, EIT
James McCarty, EIT
GHG emissions associated with consumption of pork in the US.
Benchmark KPIs for GHG

- Packaging
- Consumption
- Retail Processing
- Live animal production

- Fuel
- Electricity
- Manure
- Feed
- Piglets

Percentage Contribution to GHG

Emissions

Life Cycle Total

Farm Gate Total
Benchmark KPIs for GHG

- Life Cycle Analysis of Alternative Pork Management Practice
  - Anesthesia during castration or tail docking
  - Immuno-Castration Methods
  - Removal of Ractopamine as a feed additive
  - Removal of Antimicrobials to prevent disease and promote growth
  - Pen Gestation Housing
Benchmark KPIs for GHG

Global Warming Potential (kg CO2e) / kg at farm gate

- Anesthesia
- Ractopamine
- Immuno-castration
- Growth Promoting
- Preventative
- Lammers Pens
- McClone Pens
- Entire Males
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