Sustainable What?
The Role of US Sustainable Agriculture Initiatives in Global Economic Competitiveness

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Center for Agricultural and Rural Sustainability
University of Arkansas • Division of Agriculture

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Everything is Connected

ECOSYSTEM SERVICES

Provisioning
- Food
- Fresh water
- Wood and fiber
- Fuel
- ...

Supporting
- Nutrient cycling
- Soil formation
- Primary production
- ...

Regulating
- Climate regulation
- Flood regulation
- Disease regulation
- Water purification
- ...

Cultural
- Aesthetic
- Spiritual
- Educational
- Recreational
- ...

CONSTITUENTS OF WELL-BEING

Security
- Personal safety
- Secure resource access
- Security from disasters

Basic material for good life
- Adequate livelihoods
- Sufficient nutritious food
- Shelter
- Access to goods

Freedom of choice and action
- Opportunity to be able to achieve what an individual values doing and being

Health
- Strength
- Feeling well
- Access to clean air and water

Good social relations
- Social cohesion
- Mutual respect
- Ability to help others

Source: Millennium Ecosystem Assessment
Everything is changing
Sustainability 2050: The Challenge

UN Population Projections

Population (Billions) vs. Year (1950-2050)

- Population projected to increase from 2 billion in 1950 to approximately 12 billion in 2050.
UN Population Projections

Projected with current fertility rates

Population (Billions)

Year

UN Population Projections

Population (Billions)

Year


Median Estimate

UN Population Projections

Sustainability 2050: The Challenge
Sustainability 2050: The Challenge

UN Population Projections

What we do in the next 10 years will shape Earth and Humanity for the next 100 years.

When technology and culture collide technology prevails, culture changes.
We are all in this together

Human Activities Dominate Earth

Croplands and pastures are the largest terrestrial biome, occupying over 40% of Earth’s land surface.
Exports to Most Regions Grow in FY 2013

+$1 bil
+$1.5 bil
+$1.3 bil
+$1.6 bil
+$1 bil
+$0.6 bil
+$0.3 bil
+$0.2 bil
-$0.5 bil
+$0.5 bil
+$0.5 bil
+$0.3 bil
The Food Supply Chain

Production → Processing

Distribution

Direct Mktg → Wholesale

Retail

Consumption

Safety
Security
Stability
Key Sustainability Challenges for Agriculture

1. In order to meet projected demands for food, feed, fiber and fuel from the land we must increase production (output per year) by 50 to 100 percent in the next four decades.

2. If global production is not increased, US and European production must compensate by increasing even more.

3. If we want to preserve biodiversity and other land-based ecosystem services we must freeze the footprint of agriculture.

4. Thus yield (output per area) must more than double in the next 40 years in the US and Europe.

5. Energy scarcity will drive innovation while limiting expansion of productivity.

6. Water scarcity will limit productivity globally.
Meeting Food Needs by 2050

Freezing the Footprint of Food
How to triple food production on the same amount of land by 2050

The role of research

2000 2025 2050
100% 150% 200% 250% 300%

Genetics 50%
Poor Management Practices 50%
Technology 40%
Underperforming Land 25%
Property Rights 20%
Waste 10%
Overconsumption 5%
**Document name** | RTRS Standard for Responsible Soy Production Version 1.0
---|---
**Document reference** | RTRS_STD_001_V1-0_ENG_for responsible soy production
**Date** | 10 June 2010
**Produced by** | The RTRS International Technical Group (ITG)) as an output of their meeting to review the RTRS Principles and Criteria for Responsible Soy: Field Testing Version (Sao Paulo, Brazil 24-27 March 2010) Approved by the RTRS Executive Board 12 May 2010 and by the RTRS General Assembly 10 June 2010
Sustainability Index Framework

1. Define Key Performance Indicators (KPI)
2. Define critical impact metrics for each KPI
3. Benchmark performance for each metric
4. Develop and adopt goals for improvement across each metric
5. Implement improvement strategies
6. Measure each metric using best scientific methods at prescribed frequencies
7. Report results
8. Adjust and adapt practices as necessary
Criteria for Metrics of Sustainable Agriculture

1. Outcomes Based.
2. Science Driven.
3. Technology Neutral.
4. Transparent.
Key Environmental Performance Indicators for Agriculture

1. Greenhouse Gas Emissions
2. Energy Use
3. Water Use
4. Land Use
5. Water Quality
6. Nutrient Use Efficiency
7. Habitat/Biodiversity

Units of Measure:

Direct Measurements (for direct comparisons)

Efficiency (per acre, bushel, year)

Impact (climate change, eutrophication, toxicity…

Measuring Sustainability with LCA

Life Cycle Assessment (LCA): A method for measuring the inputs and outputs in a process in a step towards quantifying sustainability

Standard methods for LCAs
- ISO 14040 and 14044 Standards
- PAS 2050 for greenhouse gases
- USDA NAL developing standard for Life Cycle Inventory
- CARS developing guidelines for water, land use, habitat, ecosystem services metrics
Life Cycle Analysis (LCA) to Understand and Manage Supply Chain Processes
LCA allows for impact assessment from cradle to grave

![Diagram showing the flow from Raw Material A, through Raw Material B, to Product 1.]
LCA allows for impact assessment from cradle to grave

Boundaries matter
Life Cycle Inventory Data Sources

• Sources of data for LCA are critical.
• US data sources are among the best in the world.
• USDA ERS and NASS datasets meet the criteria for sustainable agriculture metrics.
• The US National Agriculture Library Digital Data Commons provides a clearinghouse for US-based agricultural LCA data.
• No other country in the world has publicly available data of this quality and resolution.
Field to Market
The Alliance for Sustainable Agriculture
Field to Market Membership

The Keystone Alliance for Sustainable Agriculture
How We Define Sustainable Agriculture

Meeting the needs of the present while improving the ability of future generations to meet their own needs

• Increasing productivity to meet future food and fiber demands
• Improving the environment
• Improving the social and economic well-being of agricultural communities
National Indicators Report: The Sustainability Story of U.S. Agriculture
2012 Indicators Report

Criteria
- National scale trends over time
- Transparent and credible science, public data
- Outcomes-based
- Practice/technology neutral
- On-farm production outcomes within a grower’s control

Data & Methods
- Crops: corn, cotton, potatoes, rice, soybeans, and wheat
- Indicators: environmental and socioeconomic
- Data: publicly available, 1980-2011
- Methods: based on available science
- Peer reviewed
2012 Indicators Report

Environmental Indicators

- Production and Yield
- Land Use
- Soil Erosion
- Irrigation Water Applied
- Energy Use
- Greenhouse Gas Emissions

Socioeconomic Indicators

- Debt to Asset Ratio
- Returns Over Variable Costs
- National and State Gross Domestic Product
- Non-fatal Injury
- Fatality
- Labor Hours
Field to Market Report Findings

• Efficiency gains over time, along with increased production
• Improvements on a number of economic and social indicators
• Continued challenges ahead for meeting increased demand within limits of natural resources and social and economic needs
• With the collaboration of U.S. farmers, tools and metrics are emerging to help track and communicate progress and identify opportunities for continued improvement
## Corn Sustainability Metrics

### Corn Summary of Results:

<table>
<thead>
<tr>
<th>Resource Area</th>
<th>Indicator</th>
<th>Percent Change* 1980-2011</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Trend Direction</td>
</tr>
<tr>
<td>Crop Yield</td>
<td>Total Production</td>
<td>↑</td>
</tr>
<tr>
<td></td>
<td>Bushels per Acre</td>
<td>↑</td>
</tr>
<tr>
<td>Land Use</td>
<td>Total Planted Acres</td>
<td>↑</td>
</tr>
<tr>
<td></td>
<td>Acres per Bushel</td>
<td>↓</td>
</tr>
<tr>
<td>Soil Erosion</td>
<td>Total Tons</td>
<td>↓</td>
</tr>
<tr>
<td></td>
<td>Tons per Acre</td>
<td>↓</td>
</tr>
<tr>
<td></td>
<td>Tons per Bushel</td>
<td>↓</td>
</tr>
<tr>
<td></td>
<td>Total Volume</td>
<td>↑</td>
</tr>
<tr>
<td>Irrigation Water Applied</td>
<td>Volume per Irrigated Acre</td>
<td>↓</td>
</tr>
<tr>
<td></td>
<td>Volume per Bushel</td>
<td>↓</td>
</tr>
<tr>
<td>Energy Use</td>
<td>Total Btu</td>
<td>↑</td>
</tr>
<tr>
<td></td>
<td>Btu per Acre</td>
<td>↓</td>
</tr>
<tr>
<td></td>
<td>Btu per Bushel</td>
<td>↓</td>
</tr>
<tr>
<td>GHG Emissions (CO₂ Equivalents)</td>
<td>Total Pounds</td>
<td>↑</td>
</tr>
<tr>
<td></td>
<td>Pounds per Acre</td>
<td>↑</td>
</tr>
<tr>
<td></td>
<td>Pounds per Bushel</td>
<td>↓</td>
</tr>
</tbody>
</table>

*Percent change results are based on least squares trends analyses from 1980 - 2011.
# Soybean Sustainability Metrics

<table>
<thead>
<tr>
<th>Resource Area</th>
<th>Indicator</th>
<th>Trend Direction</th>
<th>Entire Period</th>
<th>Compound Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crop Yield</strong></td>
<td>Total Production</td>
<td>↑</td>
<td>96</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td>Bushels per Acre</td>
<td>↑</td>
<td>55</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Land Use</strong></td>
<td>Total Planted Acres</td>
<td>↑</td>
<td>24</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>Acres per Bushel</td>
<td>↓</td>
<td>(35)</td>
<td>(1.4)</td>
</tr>
<tr>
<td><strong>Soil Erosion</strong></td>
<td>Total Tons</td>
<td>↓</td>
<td>(28)</td>
<td>(1.0)</td>
</tr>
<tr>
<td></td>
<td>Tons per Acre</td>
<td>↓</td>
<td>(41)</td>
<td>(1.7)</td>
</tr>
<tr>
<td></td>
<td>Tons per Bushel</td>
<td>↓</td>
<td>(66)</td>
<td>(3.5)</td>
</tr>
<tr>
<td><strong>Irrigation Water Applied</strong></td>
<td>Total Volume</td>
<td>↑</td>
<td>271</td>
<td>4.3</td>
</tr>
<tr>
<td></td>
<td>Volume per Irrigated Acre</td>
<td>↓</td>
<td>(9)</td>
<td>(0.3)</td>
</tr>
<tr>
<td></td>
<td>Volume per Bushel</td>
<td>↓</td>
<td>(42)</td>
<td>(1.8)</td>
</tr>
<tr>
<td><strong>Energy Use</strong></td>
<td>Total Btu</td>
<td>↑</td>
<td>3</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>Btu per Acre</td>
<td>↓</td>
<td>(17)</td>
<td>(0.6)</td>
</tr>
<tr>
<td></td>
<td>Btu per Bushel</td>
<td>↓</td>
<td>(48)</td>
<td>(2.1)</td>
</tr>
<tr>
<td><strong>GHG Emissions (CO₂ Equivalents)</strong></td>
<td>Total Pounds</td>
<td>↑</td>
<td>1</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Pounds per Acre</td>
<td>↓</td>
<td>(18)</td>
<td>(0.6)</td>
</tr>
<tr>
<td></td>
<td>Pounds per Bushel</td>
<td>↓</td>
<td>(49)</td>
<td>(2.1)</td>
</tr>
</tbody>
</table>

*Percent change results are based on a least squares trends analyses from 1980 - 2011*
### Cotton Summary of Results:
**Trends in U.S. Production, Resource Use / Impact, 1980-2011**

<table>
<thead>
<tr>
<th>Resource Area</th>
<th>Indicator</th>
<th>Trend Direction</th>
<th>Entire Period</th>
<th>Compound Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crop Yield</strong></td>
<td>Total Production</td>
<td>↑</td>
<td>55</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>Pounds per Acre</td>
<td>↑</td>
<td>43</td>
<td>1.2</td>
</tr>
<tr>
<td><strong>Land Use</strong></td>
<td>Total Planted Acres</td>
<td>↑</td>
<td>11</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>Acres per Pound</td>
<td>↓</td>
<td>(30)</td>
<td>(1.2)</td>
</tr>
<tr>
<td><strong>Soil Erosion</strong></td>
<td>Total Tons</td>
<td>↓</td>
<td>(42)</td>
<td>(1.7)</td>
</tr>
<tr>
<td></td>
<td>Tons per Acre</td>
<td>↓</td>
<td>(50)</td>
<td>(2.2)</td>
</tr>
<tr>
<td></td>
<td>Tons per Pound</td>
<td>↓</td>
<td>(68)</td>
<td>(3.6)</td>
</tr>
<tr>
<td><strong>Irrigated Water Applied</strong></td>
<td>Total Volume</td>
<td>↓</td>
<td>(35)</td>
<td>(1.4)</td>
</tr>
<tr>
<td></td>
<td>Volume per Irrigated Acre</td>
<td>↓</td>
<td>(46)</td>
<td>(2.0)</td>
</tr>
<tr>
<td></td>
<td>Volume per Pound</td>
<td>↓</td>
<td>(75)</td>
<td>(4.4)</td>
</tr>
<tr>
<td><strong>Energy Use</strong></td>
<td>Total Btu</td>
<td>↑</td>
<td>9</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>Btu per Acre</td>
<td>↓</td>
<td>(2)</td>
<td>(0.1)</td>
</tr>
<tr>
<td></td>
<td>Btu per Pound</td>
<td>↓</td>
<td>(31)</td>
<td>(1.2)</td>
</tr>
<tr>
<td><strong>GHG Emissions</strong> (CO₂ Equivalents)</td>
<td>Total Pounds</td>
<td>↑</td>
<td>20</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>Pounds per Acre</td>
<td>↑</td>
<td>9</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>Pounds per Pound</td>
<td>↓</td>
<td>(22)</td>
<td>(0.8)</td>
</tr>
</tbody>
</table>

*Percent change results are based on least squares trends analyses from 1980 - 2011.
Wheat Sustainability Metrics

<table>
<thead>
<tr>
<th>Resource Area</th>
<th>Indicator</th>
<th>Trend Direction</th>
<th>Entire Period</th>
<th>Compound Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop Yield</td>
<td>Total Production</td>
<td>↓</td>
<td>(16)</td>
<td>(0.6)</td>
</tr>
<tr>
<td></td>
<td>Bushels per Acre</td>
<td>↑</td>
<td>25</td>
<td>0.7</td>
</tr>
<tr>
<td>Land Use</td>
<td>Total Planted Acres</td>
<td>↓</td>
<td>(33)</td>
<td>(1.3)</td>
</tr>
<tr>
<td></td>
<td>Acres per Bushel</td>
<td>↓</td>
<td>(18)</td>
<td>(0.7)</td>
</tr>
<tr>
<td>Soil Erosion</td>
<td>Total Tons</td>
<td>↓</td>
<td>(57)</td>
<td>(2.7)</td>
</tr>
<tr>
<td></td>
<td>Tons per Acre</td>
<td>↓</td>
<td>(34)</td>
<td>(1.3)</td>
</tr>
<tr>
<td></td>
<td>Tons per Bushel</td>
<td>↓</td>
<td>(47)</td>
<td>(2.1)</td>
</tr>
<tr>
<td>Irrigation Water</td>
<td>Total Volume</td>
<td>↓</td>
<td>(12)</td>
<td>(0.4)</td>
</tr>
<tr>
<td>Applied</td>
<td>Volume per Irrigated Acre</td>
<td>↑</td>
<td>6</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>Volume per Bushel</td>
<td>↓</td>
<td>(12)</td>
<td>(0.4)</td>
</tr>
<tr>
<td>Energy Use</td>
<td>Total Btu</td>
<td>↓</td>
<td>(26)</td>
<td>(1.0)</td>
</tr>
<tr>
<td></td>
<td>Btu per Acre</td>
<td>↑</td>
<td>9</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>Btu per Bushel</td>
<td>↓</td>
<td>(12)</td>
<td>(0.4)</td>
</tr>
<tr>
<td>GHG Emissions</td>
<td>Total Pounds</td>
<td>↓</td>
<td>(17)</td>
<td>(0.6)</td>
</tr>
<tr>
<td>(CO₂ Equivalents)</td>
<td>Pounds per Acre</td>
<td>↑</td>
<td>21</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>Pounds per Bushel</td>
<td>↓</td>
<td>(2)</td>
<td>(0.1)</td>
</tr>
</tbody>
</table>

*Percent change results are based on least squares trends analyses from 1980 - 2011*
Sustainable Agriculture Matters

• US Agricultural producers are the most sustainable across every category of indicators.
• We have to measure and report what we do in order to secure and expand access to global markets.
• National and sector-based initiatives are the most effective strategies for developing and implementing sustainability programs.
• The Field to Market Initiative, Unites Soybean, The Dairy Research Institute, National Pork Board, and others are leading the way.
Information Sources

- http://www.responsiblesoy.org/
- http://www.fieldtomarket.org/
- http://www.unitedsoybean.org/category/topics/sustainability/
- http://bettercotton.org/
- http://www.lcacommons.gov/