Introduction

- History of Agriculture in the 20th Century
- Agriculture and Ecosystem Services— a short summary
- Potential Solution
- Terms Defined
- Agricultural principles project
U.S. Agriculture – 20th Century

- A Tremendous transformation
- Economically – A loss of Economic Ground

### Age Demographics For American Farmers

<table>
<thead>
<tr>
<th>Age Category</th>
<th>1974</th>
<th>2002</th>
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<tbody>
<tr>
<td>Under 25</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>25 to 34</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>35 to 44</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>45 to 54</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>55 to 64</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>65 and over</td>
<td>30</td>
<td>35</td>
</tr>
</tbody>
</table>

### Yearly Statistics

- **Exports**
- **Imports**

<table>
<thead>
<tr>
<th>Year</th>
<th>Exports</th>
<th>Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>2001</td>
<td>120</td>
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<td>2002</td>
<td>140</td>
<td>100</td>
</tr>
<tr>
<td>2003</td>
<td>160</td>
<td>120</td>
</tr>
<tr>
<td>2004</td>
<td>180</td>
<td>140</td>
</tr>
<tr>
<td>2005</td>
<td>200</td>
<td>160</td>
</tr>
<tr>
<td>2006</td>
<td>220</td>
<td>180</td>
</tr>
</tbody>
</table>

### Maps

- Agricultural regions
- Demographic changes
U.S. Agriculture – 20th Century

- A Tremendous Transformation
  - Politically–
  - Environmentally--

Data from Economic Research Service U.S. Department of Agriculture

Tilman et al. 2002
U.S. Agriculture—20th Century

- A Tremendous Transformation
  - Technologically
Transformation of U.S. Agriculture

Four Different Agricultural Systems in the U.S.

- Conventional Cropping Systems
- Supply Chain Livestock
- Organic Production
- Extensive Range Livestock

Open Market

Market

Commodity Program

Conservation

Environmental Emphasis

Conventional

Number of Enterprises

Diverse

Specialized

Market
Transformation of U.S. Agriculture

Dimitri et al.

Note: The average number of commodities per farm is a simple average of the number of farms producing different commodities (corn, sorghum, wheat, oats, barley, rice, soybeans, peanuts, alfalfa, cotton, tobacco, sugar beets, potatoes, cattle, pigs, sheep, and chickens) divided by the total number of farms.
Impacts of Change in Agricultural Structure

- Wheat: 14.4 million hectares
- Corn: 8.2 million hectares
- Soybeans: 6.7 million hectares
- Cotton: 2.5 million hectares
- Sorghum: 2.2 million hectares

Source: USDA/Economic Research Service
Agriculture and Ecosystem Services

- Agriculture has always adapted to and modified the ecosystem – Agro-ecosystems.
- In the U.S., agriculture uses 52% of land (ERS 2002).
- Because of the close working relationship with and dependence on the environment, agriculture has tremendous opportunities to influence ecosystem services.
Agriculture and Ecosystem Services

- In the U.S., agriculture has primarily focused on *Provisioning Services*.
  - Agriculture has been very successful at these services.
    - Yields have increased 150% since 1950 but land area in agriculture has remained steady.
    - Today we are using about 0.2 ha per person to produce food.

Trevawas 2002.
Agriculture and Environmental Services

Other Factors:

- Production is important because population increasing worldwide.
- Humans appropriate approximately 25% of earth’s primary productivity (Halberl et al. 2007).

These increase the importance of agriculture in providing *regulatory services*.

- Critical issue will be maintaining productivity while still providing regulatory services.
Challenges

- Increasingly complex environment.
- Multiple objective decision making.

Producer's Goals
- Production
- Economic
- Social
- Environmental

Exogenous Factors
- Weather/Climate
- Market Conditions
- Government Programs
- New Technology

Management Concerns
- Crop Yield/Quality
- Net Returns
- Pest Management
- Soil/Water/Air Quality
- Resource Conservation

Agricultural System
- Economic Viability
- Social Acceptability
- Environmental Sustainability

Tanaka et al. 2002
Sustainable Agriculture

Need for sustainable agricultural systems:

- Sustainable Agriculture has three legs:
  - Economic
  - Environmental
  - Social

We define Sustainable Agriculture as:

An approach to producing food and fiber which is profitable, uses on-farm resources efficiently to minimize adverse effects on the environment and people, preserves the natural productivity and quality of land and water, and sustains vibrant rural communities (UCSUSA, 2005).
A Potential Sustainable Agricultural System

Integrated Agricultural Systems:

Integrated agricultural production systems are agricultural systems with multiple enterprises that interact in space and/or time and the interactions result in a synergistic resource transfer among enterprises (Hendrickson et al.).

Figure 1. The traditional agricultural cycle (Honeyman, 1991).
Hierarchy of Agricultural Systems

- Basic Agricultural Production Systems
- Diverse Agricultural Production Systems
- Dynamic Agricultural Production Systems
- Integrated Agricultural Production Systems
- Dynamic Integrated Agricultural Production Systems

Increasing Complexity & Management & Sustainability
Increasing Risk
How would Integrated Agricultural Systems Help?

- Reduced dependence on inputs
  - Recycled nutrients
  - Enhanced diversity
- Multiple uses may increase productivity per unit area.
  - Need to look at system productivity not enterprise productivity
- Enterprise diversity may spread risks.
- Increased management requirements may increase community stability.
  - These systems require more management and potentially more labor which could provide more jobs.
Integrated Agricultural System Design

- Back to the Future
- Need to understand basic principles to make it work.
What is a Principle?

A principle is -- A set of concepts or ideas that help to explain how systems operate (Hendrickson 2008).

Principles can be used to:
1. Understand system operation.
2. Develop new management systems.
3. Develop new hypotheses.
Workshop Approach

- Rather than telling people what they should do, we choose to ask people what they were doing.
- Our hypothesis was that there are principles that are common to integrated agricultural systems regardless of the region of the U.S.
  - Producers were asked a series of questions.
  - Use these results to generate principles.
Approach

- Workshops would be held in major agricultural regions of the country.
Mandan, ND

- The first workshop focused on drivers of agricultural systems.
  - December 2008 RAFS
- Mainly, ARS personnel.
- Approach developed.
Auburn, Alabama

- Second workshop
  - Producer panels
    - Poultry– Catfish – Rowcrop – Integrated
  - First use of panels.
    - Farming is not just a job but a lifestyle choice.
    - Commodity driven
    - Lack of control
Same set of questions:

Panels:

- Organic vegetables – Conventional Potatoes – Alternative Livestock (grazing dairy and forage finished beef)
- Want to farm – find a way to make money.
- Strong family and/or social network for decisions.
- Innovative in finding markets. Price setters not price takers.
Madison, Wisconsin

- Represent the Midwest
  - Panels
    - Dairy – Vegetable – Row crop
      - Organic vegetables worked hard on developing their customers and markets.
      - Diversity important to organic producers.
      - Dairies were very integrated.
      - Timing of innovation crucial.
  - Very preliminary thoughts.
Next Steps

- Expand or test concepts we have developed.
- Product describing ‘Principles of Agricultural Systems’.
- Future—impacts on policy making, system development and alternative research hypotheses.
Thank you for your attention.