Overview of Agricultural Production Systems

Guillermo Podestá

University of Miami, Rosenstiel School
A Difficult Task...

- Provide overview of relevant issues in agricultural production systems

  BUT...

- Quite diverse audience:
  - Climate variability and predictability
  - Land use change, ecosystem services, sustainability
  - Biofuels
What I will try to do...

- Provide overview of agricultural ecosystems (for the various audiences)
- Present a few ideas to foster discussion
Agricultural Ecosystems

- Complex natural/human systems
- Have characteristics of natural ecosystems
  - Non-linearities, feedbacks, multiplicity of scales
- PLUS complexities of human decision-making under uncertainty
- Understanding agroecosystems requires integrated approach
Agricultural Ecosystems - 2

- Production decisions **mostly made by individuals**, embedded in a social context
  - Multiple objectives, often conflicting
- Individual characteristics
  - Risk tolerance, loss aversion
- Social interactions
  - Social networks: learning, technology diffusion
Agricultural Ecosystems - 3

- Related global change issues:
  - Land use changes
  - Irrigation is main user of scarce freshwater
  - Deforestation, desertification
  - Global food security
  - Biodiversity, GMOs
Agricultural Ecosystems - 4

- Huge economic importance
- Globalized trade

Soybeans Production 2005 (M tons)

- LPB Countries: 95648
- USA: 83368

Source: FAO Statistics
Agriculture and Climate

- Human sector most sensitive to climate variability/change

- Confluence of events:
  - Enhanced technological capabilities
  - Better understanding of climate system
  - Higher awareness of climate influence on human activities

- RESULT: Increased demand for climate information in agriculture
Climate Information Systems

- An effective climate information system (or climate service) will *not* develop spontaneously.

- A climate information system has to be informed and supported by an appropriate research program *throughout* its initial phase.

- Research supporting climate information systems must evolve:
  
  Exploratory ➔ Pilot ➔ (Semi)operational
Associations between climate and agriculture?

- Statistical analyses of historical data
- Simple modeling
- Issue scoping: surveys, focus groups

**Partners:** academic institutions or governmental research agencies
Historical Maize Yields & ENSO

Maize Yield & Technology Trend

Maize Relative Yield Residuals from Trend
Research Stages - Pilot

- More sophisticated, realistic modeling
- Risk management studies
  - Can we react to climate info? How? Why not?
- Economic, social, institutional dimensions
  - Understanding decision-making process
  - Value of climate information
  - Best institutional structures?
Mapping Realistic Decisions

**Owned Land**
- \(\frac{1}{3}\) Maize
- \(\frac{1}{3}\) Wheat
- \(\frac{1}{3}\) Soybean

**Land Allocation Decisions**
Over 50% of agriculture in the Pampas is done on rented land

**Rented Land**
- 100% Soybean
Research Stages – Operational (?)

- Research topics: broad spectrum, but highly specific issues
  - Continuous assessment
- Strategic partnerships crucial: with BOTH operational agencies AND stakeholder groups
## Relevant Climate Scales

<table>
<thead>
<tr>
<th>Scale</th>
<th>Issues</th>
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</thead>
<tbody>
<tr>
<td>Weather</td>
<td>Tactical decisions</td>
</tr>
<tr>
<td>Intra-seasonal</td>
<td>Crop stresses; Yield prediction</td>
</tr>
<tr>
<td>Interannual</td>
<td>Yield and income variability; Use of seasonal forecasts</td>
</tr>
<tr>
<td>Interdecadal</td>
<td>Infrastructure planning; Land use change</td>
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</tbody>
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Climate Information Components

Historical data and statistics

Recent climate conditions
Seasonal climate forecasts

Also: “plausible” decadal scenarios, longer scales?
Decadal Climate Variability

- Drastic changes in agricultural production systems in the Pampas in recent decades
- **Partly** due to climate variability, but also other factors:
  - Increased global demand for commodities
  - Macroeconomic changes
  - New technologies
  - New institutions (e.g., INTA, AACREA, AAPRESID)
Changes in Production Systems

Northern Cordoba: climatically marginal region

Proportion of area under livestock and agriculture in Cordoba

Hectares of each crop in Cordoba

Courtesy Ing. Federico Bert
Key Questions - 1

- What will be the consequences of “transplanting” production systems from the Pampas to marginal regions?
How will production systems that evolved partly in response to enhanced climate respond if conditions revert to drier epochs or change permanently?
Can agricultural area be sustained or expanded if climate gets drier?
Two Main Biofuels

Bioethanol

Biodiesel
Contentious/Uncertain Issues

- Food security vs. fuel security
- Biofuel balances
  - Economic ($$)
  - Energetic
  - Greenhouse gases
- Small farmers vs. large operators
- Intensive (costly?) technologies
Summary

- Agricultural ecosystems are complex natural/human systems
  - Real-world decisions of economic importance
  - High relevance to many global change issues
- Climate is an important source of risk to agriculture, but not the only one...
- There is an increasing demand for climate information to support agricultural decisions
Summary - 2

- An effective climate information system (or climate service) will *not* develop spontaneously
- A climate information system has to be informed by an appropriate research program
A proposal for discussion...

- IAI / CLIVAR / IDRC may sponsor development of a series of “white papers”:
  - Opportunities and impediments for use of new climate knowledge
  - Perspectives for biofuel production in the Americas
  - Future agricultural production in the Americas (global demand, land use, sustainability, technological innovations)
Content of “white papers”

- Survey/integrate current knowledge
- Clearly identify knowledge gaps
- Acknowledge multiple perspectives (often value-laden) about an issue
- Address topics from an “integrative science” perspective
- Provide policy guidance based on “best available science”
Funding Gratefully Acknowledged!

- Methods & Models for Integrated Assessment
- Biocomplexity in the Environment: Dynamics of Coupled Natural & Human Systems
- Environment and Sustainable Development
- Human Dimensions of Global Change
- Regional Integrated Science & Assessments
- Initial Science Program – Phase 2
- CRN Program – Phase 2
Plausible scenarios – Cordoba

Linear trends fitted to moving 25-year windows

Fitted trends projected (starting from median of last 10 yrs)
Risk to Soybean Profits

NOTE: No adaptation!
Strategic Partnerships

- AACREA: non-profit farmers’ organization
- Groups of 8-12 farmers
- About 150 groups in Argentina
- “Early adopters”
- “De facto” extension functions
- Large multiplicative effect
Why historical information?

- Lack of knowledge about local climatology
  - What is “normal”?
  - Recent arrivals to agriculture
  - Greater memory of recent events

- How to interpret seasonal forecasts
  - Boundaries between terciles?
Why diagnostic information?

- Provides context for decision-making
  - Refine previously-made decisions
  - Helps interpret forecasts
- Relevant span is sector-dependent