Towards Sustainable Agroecosystems: The ARS Long-Term Agro-Ecosystem Research (LTAR) Network

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**Agriculture Marches On:**

- Industrial Revolution
  - Mechanization
- "Green" Revolution
  - Genetics, Irrigation, Fertilizers
- Information Revolution
  - Precision Agriculture, Models, Decision Support
- *Multifunctional Landscapes*
  - Ecosystem Services

Alston, Babcock & Pardey (eds), 2010
But.....New Challenges
Agriculture must transform itself.....

- INTENSIFY RAPIDLY
- RESPOND TO STRESS and OPPORTUNITY
- BE SUSTAINABLE*

*Goals
- Satisfy human needs for **YIELD QUANTITY & QUALITY**
- Enhance **ENVIRONMENTAL QUALITY** & the resources base
- Sustain **ECONOMIC VIABILITY** of producers
- Enhance the **QUALITY OF LIFE** for rural populations & society

*NAS, 2010
Long Term Agroecosystem Research Network

Vision: “Sustainable agro-ecosystems providing goods and services”
(Walbridge & Shafer, 2011)
LTAR: A RESEARCH NETWORK

Purpose: “sustain a land-based infrastructure for research, education, and outreach…”

Mission: “enable understanding & forecasting of capacity to provide agricultural commodities & agroecosystem goods & services under changing conditions”.

Bottom Line Questions:
Are current Business-as-Usual systems sustainable?
Are new, innovative, Aspirational systems sustainable?
What metrics indicate this?
Shared Research Strategy
Data/Metrics/Indices

**Measurements, Models**

**“Barrier”** identification and elimination

**Resistance, Resilience, Flexibility:**
exposure, sensitivity, capacity to adapt

**Soil, Plant/Animal, Atmosphere**

- Productivity; nutrient, energy, water use efficiency;
- soil health; soil erosion; water quality; water availability; gaseous emissions; biodiversity....

What do the data, model projections, indicators, etc. tell us about the sustainability of the system?
Shared Research Strategy

Concerns

**Factors** controlling stability (resistance to change) & recovery from negative impacts (resilience)

**Processes** affecting productivity & other ecosystem services

**Consequences** of decision-making at multiple scales (farmer to policy) on sustainability

Approach via Genetics x Environment x Management
Nothing about the LTAR makes sense without attention to sustainability....

Yield
Environment
Economics
Quality of Life
How can US agriculture be intensified in a sustainable fashion?

1) What factors drive agricultural productivity and its environmental impacts?
2) What are the tradeoffs between productivity, product quality, societal preferences, and ecosystem services?
3) What are the barriers to sustainable intensification?
4) How do we better target our use of resources?
5) What technologies and management strategies are needed for agriculture to be resilient to extreme events (e.g., weather, disease outbreaks, pest infestations)?
6) What scientific synthesis products are needed for decision making?

LTAR investigates sustainable intensification by comparing Business as Usual with Aspirational management of Croplands and Rangelands.

LTAR’s research is supported by Field Experimentation, Remote Sensing, Data management systems, Modeling, and Synthesis.

Above Ground Processes, Functions and Outcomes
- NPP, Harvest Index and Quality, energy/water/sediment/carbon flux, biological diversity

Below Ground Processes, Functions and Outcomes
- Nutrient cycles/fertility, biology/ecology/pathology, GHGs, water availability

Watershed and Landscape Processes and Services
- Micrometeorology, hydrology, water quality, detoxification, biodiversity, habitat availability

Collaboration including:
- LTER, NEON, Expt’l Forests, Climate Hubs
- GRACEnet, CEAP REAP, CZO, AmeriFlux