Innovation is our tradition: Perspectives on the future of Soil and Water Quality Research and Management.

Recapitulation of Presentations Discussions on A Matter of Balance: Approaches to Soil Health and Water Quality

By

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Moving To Sustainability

The "<u>four pillars</u>" of sustainability

1) promoting water conservation/quality,
2) eco-friendly farming,
3) reducing the farmer's carbon and water footprint,
4) emphasizing sustainable agricultural community.

Useful concepts from ecology can be used for organizing research questions

- Ecosystems are composed of nested sub-systems
- Use of space and time to define processes
- Long Term Studies are necessary
- Mimic Structure determines function

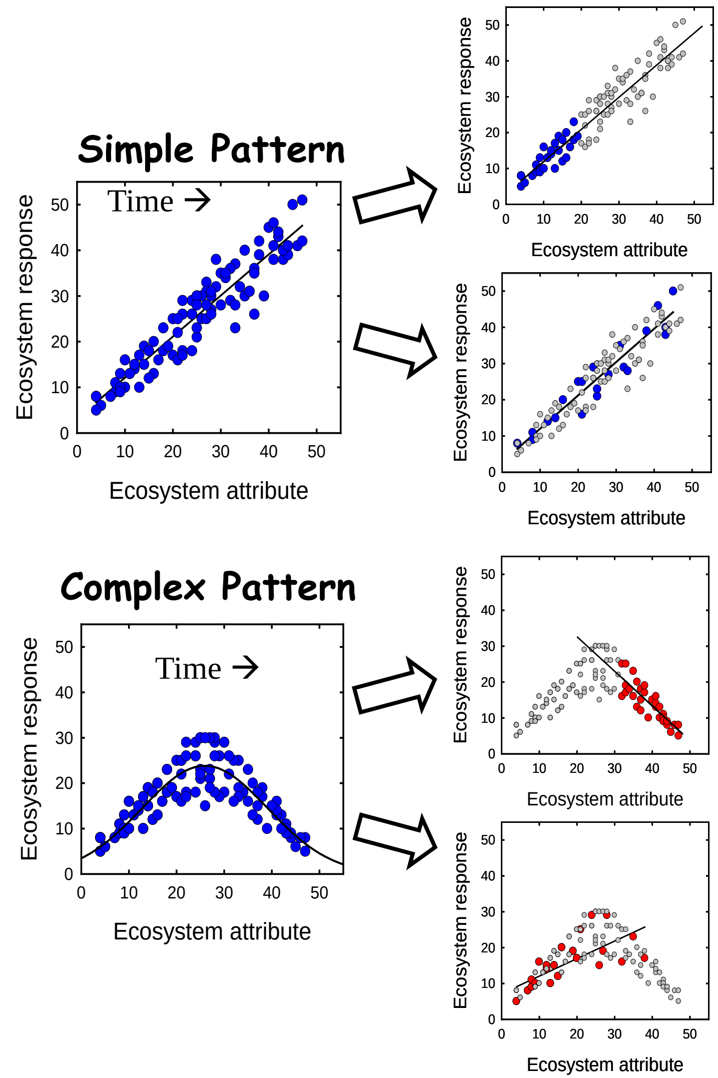
Original Motivation for Long Term Research

- Discovering and understanding temporal patterns and processes that were hidden by our short-term approaches

"There is a serious contradiction between the time scales of many ecological phenomena and the support to finance their study. "

"…high-quality data over the long term will allow generalization of research results and theory over scales of time…great enough to evaluate global change drivers such as climate and land cover change "

Callahan 1984 BioScience



Long Term Agricultural Research

- A framework of long-term monitoring & experimentation around which to focus individual projects with a longer term funding horizon
- Create the ability to address questions at the ecosystem and landscape scales that require long term experiments or multiple data sets
- A well-documented and archived data base for addressing future as-yet undefined questions

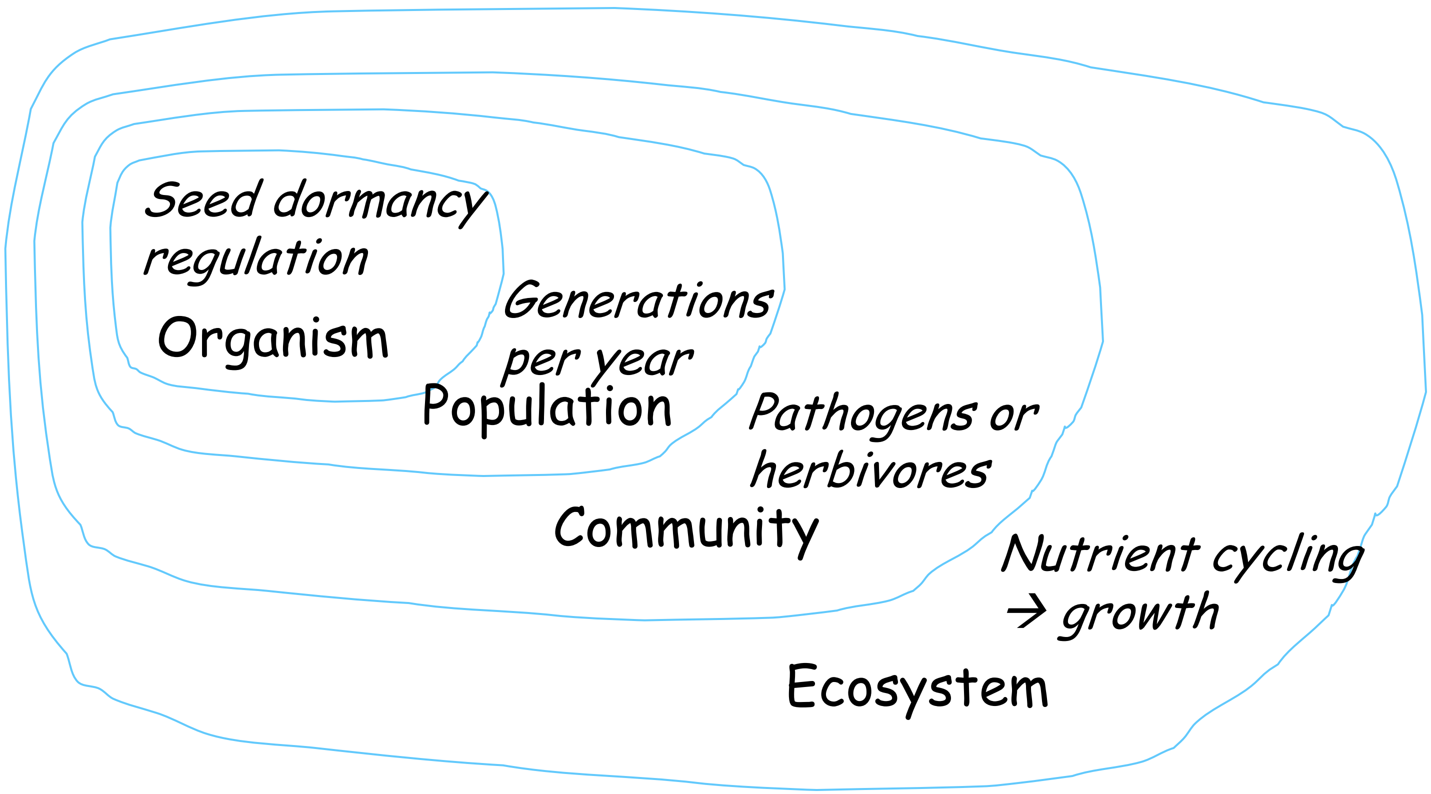
	Reductionist agricultural research	Systems-based research
View of agricultural goals	• Single function predominates • Emphasis on yields, maximizing production	• Multifunctional • Yields as well as ecosystem services and enviromental integrity • Human well being– consumers, farm family and rural communities
Experimental design	• Factorial design is most common • Focus on one component of a production system, i.e. a crop or pest, or a specific practice • Small scale plots on research station • Short duration, 1-2 years	• System is defined, research design is tailored to specific system and problems to be addressed • Multiple components and their interactions are emphasized • Scale–varies from large plots to whole farm, farmer network, community, watershed, food system • Time frame– also varies, years to several decades, depending on processes to be studied
Management guidelines	• Component oriented • Prescriptive– one size fits all • Predictability and simplification at the farm and market level are promoted	• Whole farming systems oriented • Adaptive– Emphasis is on concepts which can be adapted to local conditions and improved by farmers • Promote and reap benefits from ecological and economic complexity; diverse communities and markets
Risk reduction strategy	• Control environmental variability • Tight control of components aimed at minimizing the role of interactions	• Cope with environmental variability through biotic and economic diversification • Interactions and internal feedbacks are fostered– loss of tight control in exchange for increased resilience
Sources of innovation: Solutions and new technologies	• Developed by land grant researchers and private sector	• Developed by participatory groups with diverse stakeholder, scientist, private sector collaborators
Flow of information	• Top-down • Linear information flow predominates • Farmers depend on external solutions from land grants	• Complex web of information and expertise • Networks predominate • Solutions emerge from local knowledge systems in collaboration with scientists

Why use system based approaches?

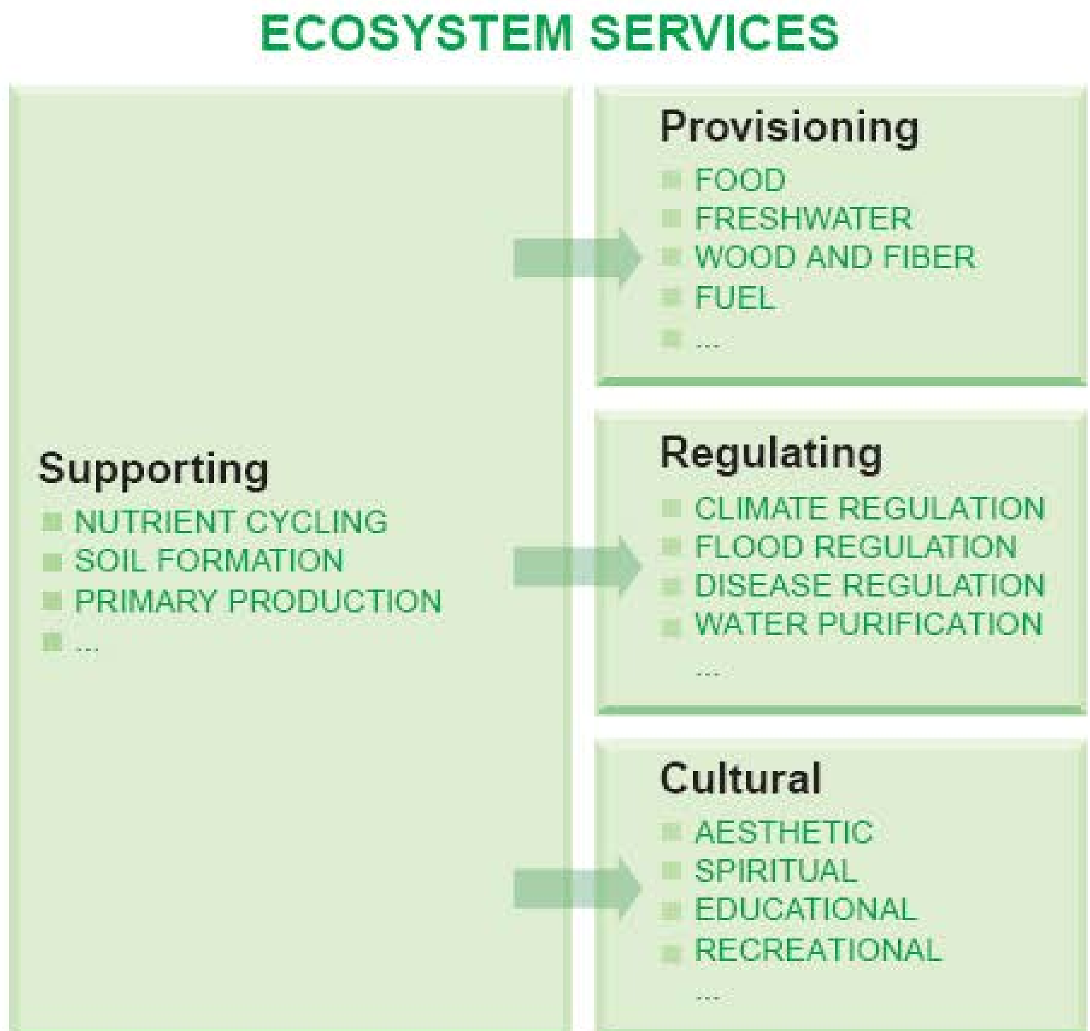
- We need to understand mechanisms regulating ecological processes within farms/fields in order to optimize ecological management
- Assess agroecosystem-scale and ecological function (consequences of management systems beyond yield)
- Identify trade-offs and synergies among management options or enterprises
- New discoveries and novel solutions with regard to Biodiversity

The concept of nested hierarchies applied to weed management

Successful ecological weed control requires integrating knowledge across all these levels—i.e. "Many little hammers" (Liebmann and Gallandt 1997)



Expand Definition Ecosystem Services provided by Agricultural Systems



“Systems Approaches” are required to support the transition to more sustainable agriculture

- Allows for consideration of multiple goals
- Combine expertise from multiple disciplines and functions
- Holistic systems approach→ can cope with interactions and harness reinforcing feedbacks
- Learning from innovative farmers

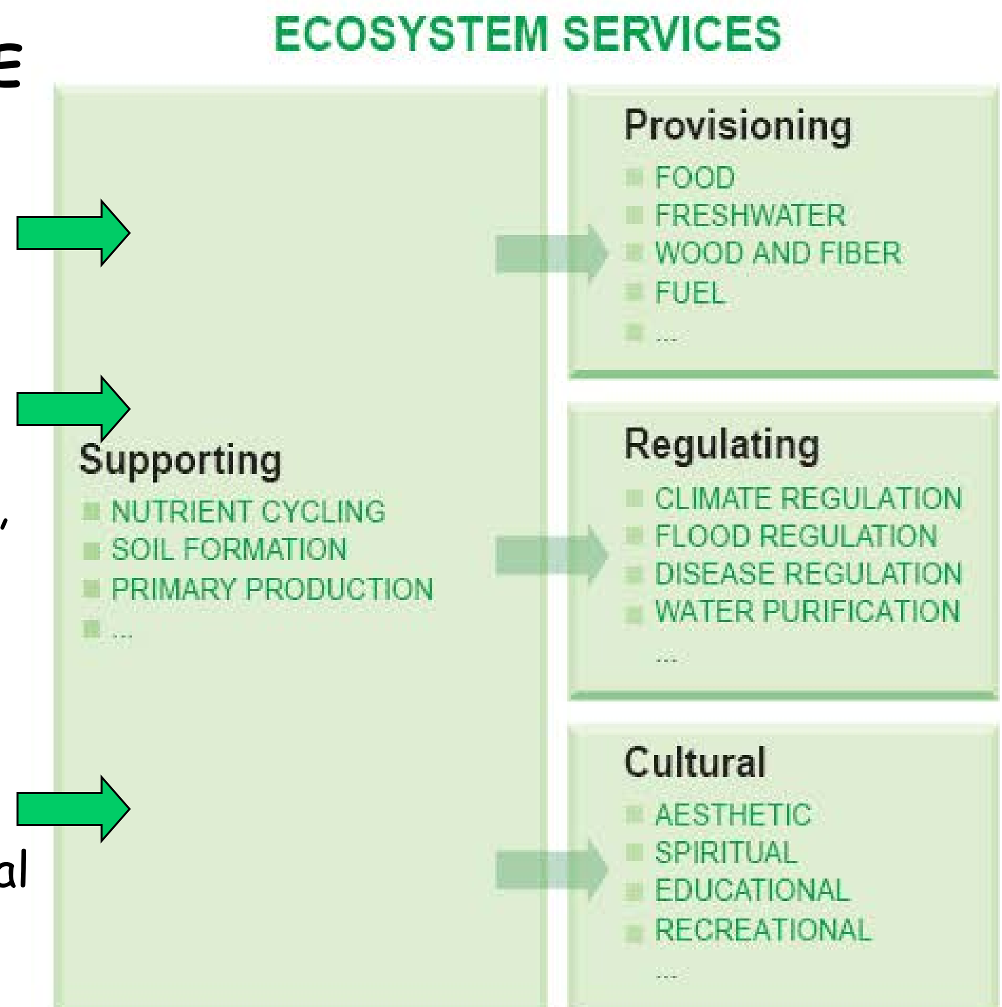
Environmental, biotic and management characteristics drive ecosystem processes

AGROECOSYSTEM STRUCTURE

Physical environment-
Climate, soil type and typology, time

Biotic components-
Biodiversity, community composition, population assemblages

Management-
Plant species in space and time, tillage, inputs, harvest regime, spatial scale of fields, enterprise diversity



Millennium Ecosystem Assessment- www.millenniumassessment.org

Organic agriculture: Example of a systems-based management approach

- Agroecosystem components and management practices serve multiple functions.
  - Cover crops fix or stabilize nitrogen, minimum tillage (or no till), build SOM and soil structure, scavenge nutrients, suppress weeds, reduce erosion, provide habitat for beneficial arthropods. Biodiversity !!!
- Management strategies rely on many distinct practices/processes– "many little hammers" (Liebman and Gallandt. 1997).
  - E.g. weed management relies on rotation, strategic use of tillage, weed suppressive cover crops, seed bed depletion via management and food web based mechanisms).

Summary

- **Systems thinking requires a paradigm shift, a re-assessment of the way we view agroecosystems**
- **There are many resources to draw from in the ecology literature, sustainability science, business world**
- **Planning benefits from structure: Follow a logical progression, set boundaries, use concept mapping**
- **Need to apply a consistent framework to develop general principles and agroecosystem assessment methods based on practioners inputs.**
- **Need to be willing to train th next generation of farmers**

Dr. Sieg Snapp - Soil Health Cover crops

- Above vs below ground
- On farm N additions – alfalfa
- Wheat grass intermediate – forage
- Perennial wheat – land institute
- New resistance
- Nitrate reduce and C increases
- Cover crops provide N credit s
- Proper rotations syncrhony of N
- Active C vs rotation red clover/cereal eye biodiversity

Dirt on clean water – Colleen Forestieri – Practioners

- Van Buren Conservation district GRANTS
- Soil and water conservation
- Watershed scale – target farmers row crops
- Incentivize
- Field print calculator neat tool
- Things go better with Coke ? Sustainability

N and P cover crops - Hoorman

- Ecological farming – skin holistic views
- P forms as a function if tillage and redox that are directly related to management

Ken Blight Farmers Perspective

- Generations – passing the practice on – who trains the next generation

- These scientists have begun working with small groups of farmers, showing them that less fertilizer doesn’t shrink their harvests and can actually fatten their wallets. They’re promoting the use of compost and teaching farmers to apply synthetic fertilizer when and where the plants actually need it.

- The organic fields in Robertson’s experiment, which received no commercial fertilizer or manure, lost only a third as much—but those fields also produced 20 percent less grain. Intriguingly, the “low input” fields, which received small amounts of fertilizer but were also planted with winter cover crops, offered the best of both worlds: Average yields were about as high as those from the conventional fields, but nitrogen leaching was much reduced, almost to the level of the organic fields. If America’s farmers could cut their nitrogen losses to something close to this level

Challenges and Opportunities of Agricultural Science

- We have grown comfortable to the "my kingdom" approach…..(e.g.the waltz through basic science)
- Uncomfortable with research initiatives with strong overarching questions are directed by top-down thinking and management with little input from scientists.
- The phenomenon of attempting to obtain funding for Agricultural research with new large scale, long-term research initiatives is growing.
  - growth is occurring because initiatives can be attractively packaged and sold in the political arena
  - They continue to provide funding to address environmental issues and to help alleviate the erosion of funds available for basic environmental research.

More Opportunities

- There are benefits of participation in Network Level Science since it allows study of regional and global ecosystems which are beyond the scope (space and time) of most Agricultural research.
  - There is a pressing need to identify the extent to which we can extrapolate beyond individual study sites and model systems.
  - Test our "Rules" (general principles that underpin and create patterns) within and among ecosystems and strengthen our ability to generalize agroecosystem responses more broadly (regionally and globally).