Agro-biodiversity and organic research in the USA and internationally

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Focus: Research on use and conservation of biodiversity in organic agriculture

How do biodiversity-friendly practices support organic agriculture?
Biodiversity is seen as a key factor for provision of ecosystem services.

Relevant to organic agriculture.
IFOAM’s Principle of ecology

- Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.
  - “organic farming, pastoral and wild harvest systems should fit the cycles and ecological balances in nature”
  - “inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources”
  - “organic agriculture should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity”.
  - “those who produce, process, trade, or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air and water”.
The landscape complexity hypothesis

Organic farms have more species than conventional farms, except in complex landscapes where neighboring ecosystems provide a richer species pool.

Tscharntke et al. 2005
DIVERSITAS perspective

- Earth System Science Partnership (IGBP, IHDP, GWSP, GECAFS): Global change programs
- Interactive biodiversity science, linking biological, ecological and social disciplines to produce socially relevant new knowledge
Three Foci:

- Determining the factors that increase biodiversity in agricultural landscapes and anticipating the impacts of social and environmental change
- Using biodiversity in agricultural landscapes to enhance ecosystem goods and services
- Ensuring that society supports the use of biodiversity for sustainable agriculture and equitable sharing of the benefits of conservation of agrobiodiversity
Can organic agriculture maintain productivity and increase environmental quality?

If so, what is the role of crop biodiversity?

Approach:
- What practices worked most effectively?
- Capture innovation and adaptive management using descriptive multivariate statistics

Smukler et al. 2008

Tanimura and Antle Inc.’s organic management
- Many organic nutrient sources
- Drip irrigation
- Organic pesticides/insectaries
- Many commodities
- Diversity in plant populations

Smukler et al. 2008
Three-year study of two Salinas Valley ranches

Indicators change with time:
- Higher relative yields
- Sufficient plant nutrients
- Lower soil nitrate leaching potential
- Increased soil C pools
- Low sporadic disease & insect damage
Crop mix

- 26 crop taxa during the 3-yr transition
- Crop diversity decreased as the transition progressed, but still more taxa than conventional

Year 3 had greater crop evenness, lower crop diversity, and fewer plantings per ha
Crop diversity best explains higher relative yields (yield/taxon’s max. yield)

Method: Classification and Regression Tree (CART)
Outcomes

- High crop biodiversity was one of the methods used during successful organic transition
- Learning curve
  - “Trial and error” to find the best suited crops and cultivars
  - Lower organic pesticides and sprays
  - Higher soluble organic fertilizer
- Facilitate adaptive management
  - Participatory research
  - Multivariate statistics to find patterns
  - Find ‘sustainable’ combinations of biodiversity and other inputs
Farmscaping with woody species

- How does farmscaping with perennial plants affect biodiversity and nutrient cycling/storage in different farm habitats?

- Selecting a farmscape
  - Similar soil in all habitats
  - Participatory research
  - Monitoring for 2 years

Tomato and grain fields, riparian, hedgerow, drainage ditch and pond habitats at Rominger organic farm in Yolo County, CA

Jackson et al., in prep
Farmscaping

- Enhancing and restoring non-production areas around the farm
  - Tailwater ponds
  - Hedgerows
  - Filter strips
  - Riparian tree plantings

- Promoted by federal, state and local agencies (e.g. EQIP, Audubon California)
Farmscaping and ecosystem services

Important for management decisions, payments for ecosystem services, and cap & trade policy for greenhouse gas emissions

**Mg C ha\(^{-1}\)**

**Farm carbon distribution**

- **16%**
- Riparian corridor
- Hedgerow
- Southfield
- Northfield
- Tailwater pond
- Ditches
Landscape inventories for evaluating management practices

- Geographic Information Systems (GIS)
- Ecological assessments
- Farmer practices and attitudes
- Methods development needed to show social-ecological benefits of organic farming
Landscape assessment of organic practices in California

Biodiversity and ecosystem services increase with use of organic practices

With use of non-renewable inputs such as fossil fuels, synthetic fertilizers and pesticides (i.e. agricultural intensification), there is:

- lower diversity of soil microbial, soil nematode, and plant communities
- lower environmental quality

Culman et al., ms. subm.
Research directions for organic farming

- Biodiversity conservation and use
- Multiple benefits
  - Production
  - Environmental quality
  - Human well-being
- Multiple scales
  - ‘Genes to landscapes’
  - Local, regional and global perspective
Thank you for listening!

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