Farming for Ecosystem Services: Research and Policy to Make it Happen

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Agriculture as managed ecosystem

- Agriculture is humankind's oldest and largest engineered ecosystem
Agriculture has optimized nature for food, fuel & fiber production

- Genetics optimized for marketable products
  - Plant architecture for higher biomass in grain
  - Animals for leanness, bigger shares of desired cuts
- Agrochemical innovations have allowed timely, low-cost delivery of needed inputs
- Mechanical innovations allow few people to farm
  - Large crop areas
  - Large livestock herds
But does agriculture provide the array of ecosystem services we would like?

- “Ecosystem services are the benefits that people obtain from ecosystems.” (Millennium Ecosystem Assessment, 2005, Ecosystems and Human Wellbeing: Synthesis)

Source: Millennium Ecosystem Assessment
Ecosystem service flows to and from agriculture

**Services TO**
- Climate/air regulation
- Water provision
- Soil provision
- Pollination
- Pest regulation
- Genetic diversity

**Disservices TO**
- Pests & diseases

**Services FROM**
- Food & fiber
- Aesthetics
- Recreation
- Carbon sequestration
- Biodiversity conservation

**Disservices FROM**
- Water pollution
- Health risks from agrochemicals
- Greenhouse gases
- Wildlife habitat loss
- Aesthetics of big farms

Swinton et al, Ecol Econ 2007
But if we design it, will it fit farmer goals?

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<th>Ecosystem services UP ↑</th>
<th>Farm profit UP ↑</th>
<th>Farm Profit DOWN ↓</th>
<th>Win-win</th>
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Win-win Opportunities

- Targeting inputs in time & space
  - Examples:
    - Fertilization - Just-in-time and site-specific
    - Threshold-based pest control (IPM econ threshold)
    - Plant breeding to fit ecosystem niches
  - Effects
    - Boosts production of food, fiber, fuel
    - Cuts wastes – water pollution, N$_2$O emissions
- Optimize natural services to agriculture
No-till cropping can cut greenhouse gas emissions while being profitable.
Trade-offs: When environmental benefits come at a cost

- Direct costs …
  - Example: Cover crop seed & planting for reduced erosion & N loss

- Opportunity costs from reduced income …
  - Setting aside productive land for wildlife habitat
  - Giving up crop yield by lowering N fertilizer rates to cut N$_2$O emissions
Habitat managed for biological pest control

- Soybean aphid = new pest that cuts yields
- Asian lady beetle is predator

Photos: Christine DiFonzo, MSU
Measuring value of soybean aphid biocontrol

Soybean price: 2007-08 USDA price projection $380 Mg\(^{-1}\) = $10.40 Bu\(^{-1}\)

(Landis, Gardiner, van der Werf, and Swinton, PNAS, 2008)
Farm focus groups & survey: Global warming seen as less important “to Me” than “to Society”

- Reducing global warming
- Reducing pesticide risks to humans
- Reducing P runoff
- Reducing N leaching
- Increasing soil conservation
- Increasing soil organic matter

◄ “To Me”  Relative Importance  “To Society” ►
Costs to farmers of providing environmental benefits in 2008 survey of Mich corn-soy growers: 2 options

- A: Corn-soybean
  - Reduced tillage
  - Nitrogen fertilizer just-in-time based on tests

- D: Corn-soybean-wheat
  - Reduced tillage
  - Nitrogen fertilizer just-in-time based on tests
  - Winter cover crop
  - 1/3 cut in fertilizers by applying only over row
**Added costs compared to typical corn-soybean production**

**Crop system D**
- D: Corn-soybean-wheat
- Reduced tillage
- Nitrogen fertilizer just-in-time based on tests
- Winter cover crop
- 1/3 cut in fertilizers by applying only over row

**Added costs**
- Wheat often lower revenue than corn-soy
- OK
- Soil testing during season causes delays
- Costly seed & labor
- Equipment to “band apply” fertilizers
Payment for Environmental Services: Farmer willingness to change

• If a program run by the federal government would pay you $X per acre each year for 5 years for using this cropping system, would you enroll in this program? (Yes) (No)

• If Yes, how many acres would you enroll in this program? ____________

Farmers at focus group, 2007
Small changes cost less to supply, so more land offered
Large farms offer more acreage
To cultivate ecosystem services:
Understand the cultivators, Create incentives

- Farming can supply enhanced ecosystem services
- Farming is both *life style* and *livelihood*
  - Environmental stewardship matters
  - Income matters too
- Win-win technologies are easy if farmers aware
  - → Educate
- Trade-offs (there are many) require incentives
  - Should farmers bear costs if society benefits?
  - → Payment for environmental services
    - Emerging markets for greenhouse gasses
    - Government programs for soil & water conservation
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