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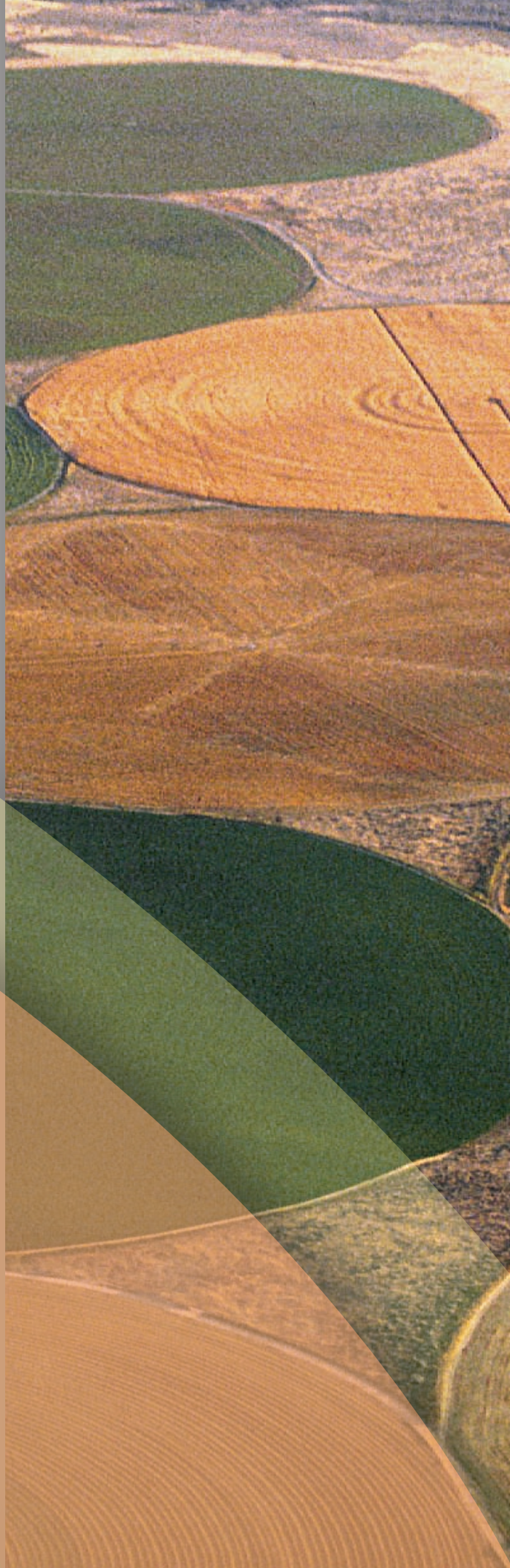
Environmental Effects of Agricultural Practices—

Summary of Workshop Held on June 14–16, 2005



Scientific Investigations Report 2006–5215

U.S. Department of the Interior
U.S. Geological Survey

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By U.S. Geological Survey

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DIRK KEMPTHORNE, Secretary

U.S. Geological Survey
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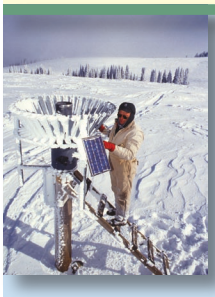


(Facing Page) Center-pivot sprinklers controlled by a central computer irrigate wheat, alfalfa, potatoes, and melons along the Columbia River near Hermiston, Oregon. *Photograph by Doug Wilson.*

Definitions of Selected Acronyms Used in This Report

[Acronyms are also defined where first used in the text.]

ARS	Agricultural Research Service (USDA)
CAFO	Confined Animal Feeding Operation
CEAP	Conservation Effects Assessment Project (USDA-NRCS)
CRISP	Central Region Integrated Science Partnership (USGS)
CRP	Conservation Reserve Program (USDA)
CSREES	Cooperative State Research, Education, and Extension Service (USDA)
DOD	U.S. Department of Defense
DOI	U.S. Department of Interior
EC	endocrine disruption
EDC	endocrine disruption chemicals
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
FSA	Farm Service Agency (USDA)
IAFWA	International Association of Fish and Wildlife Agencies
MOU	Memorandum of Understanding
NASA	National Aeronautics and Space Administration
NAWQA	National Water-Quality Assessment Program (USGS)
NGO	non-governmental organization
NPS	National Park Service
NRCS	Natural Resources Conservation Service (USDA)
NRI	National Resources Inventory (USDA-NRCS)
PEC	predicted environmental concentration
USDA	United States Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WMI	Wildlife Management Institute

Mahantango Creek watershed near Klingerstown, Pennsylvania. The combination of land use, soil properties, and hydrogeology mostly determine the vulnerability of surface-water and ground-water contamination by agricultural activities. *Photograph by Scott Bauer.*

Environmental Effects of Agricultural Practices—

Summary of Workshop Held on June 14–16, 2005

By U.S. Geological Survey

Executive Summary

A meeting between the U.S. Geological Survey (USGS) and its partners was held June 14-16, 2005, in Denver, CO, to discuss science issues and needs related to agricultural practices. The goals of the meeting were to learn about (1) effects of agricultural practices on the environment and (2) tools for identifying and quantifying those effects. Achieving these goals required defining the environmental concerns, developing scientific actions to address assessment of environmental effects, and creating collaborations to identify future research requirements and technical gaps. Five areas of concern were discussed—emerging compounds; water availability; genetically modified organisms; effects of conservation practices on ecosystems; and data, methods, and tools for assessing effects of agricultural practices.

Key Issues and Comments

Emerging Compounds

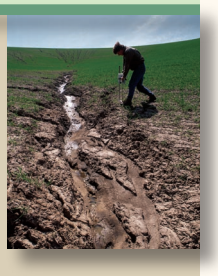
- Persistence of new animal drugs in the environment.
- Monitoring for veterinary and human pharmaceuticals.
- Comparison and validation of previous environmental assessments (predicted environmental concentrations or PECs).
- Prions.

Water Availability

- Comprehensive information on availability and use, including snow survey, drought monitoring, and irrigation management.
- Comprehensive field data to verify no-tillage and residue effects on individual soil-water-balance components.
- Land-use and land-cover information for assessing (1) competition with urban uses, (2) urban growth and rural trends, (3) irrigated cropland extent, and (4) forecasts.
- Improve forecasts of future water availability in regard to climate change and areas where availability will decline or improve.

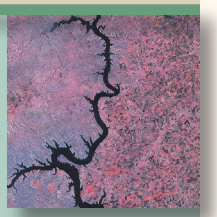
Genetically Modified Organisms (GMO)

- Characterize the impacts on non-target organisms, food-chain effects, indirect changes to community relationships, and other ecological impacts.
- Effects of GMO plants on biodiversity. Potential competitive advantage of GMO animals over wild strains.



Effects of Conservation Practices on Ecosystems

- More than the summarization of acres devoted to specific conservation practices and programs is needed to document effects of conservation programs and policies.
- Quantify and describe effectiveness of specific conservation practices in meeting diverse environmental and social goals.



Data, Methods, and Tools for Assessing Effects of Agricultural Practices

- There is a need for accurate spatially and temporally variable climatic, topographic, land-use, and soils data.

Next Steps

- Mine and analyze existing data.
- Synergistic opportunities with other agencies.
- Collaboration with other Federal agencies where their study areas (for example, United States Department of Agriculture [USDA] benchmark watersheds) may overlap with USGS study areas (for example, National Water-Quality Assessment Program [NAWQA] watersheds).
- Establish a consistent research contribution to the Farm Bill and conservation issues.
- Keep up-to-date on budget initiatives and impacts of policy change (for example, Conservation Reserve Program [CRP]).
- Enhance and expand contacts with Federal and State natural resource management agencies and non-governmental organizations (NGOs).
- Finalize the Memorandum of Understanding (MOU) between the USGS, Farm Service Agency (FSA), U.S. Fish and Wildlife Service (USFWS), and Natural Resources Conservation Service (NRCS).
- Apply integrated approach to monitoring and research.
- Communicate results to landowners involved in agricultural conservation programs, the public, and those who design and administer agricultural conservation programs.

Angus cattle on pasture. *Photograph by Scott Bauer.*

Introduction

A meeting between the USGS and its partners was held June 14-16, 2005, in Denver, CO, to identify and discuss science issues and needs related to environmental impacts of agricultural practices. The meeting goal was to learn about the effects of agricultural practices on the environment and potential tools and methods for identifying and quantifying those effects. Achieving this goal required defining agriculturally related environmental concerns, developing scientific actions to address assessment of environmental effects, and creating collaborations between existing and new partners to identify future research requirements, technical gaps, and data needs. Five key areas of concern were discussed—emerging compounds; water availability; genetically modified organisms; effects of conservation practices on ecosystems; and data, methods, and tools for assessing effects of agricultural practices.

The workshop format used presentations focused on the five areas of concern to provide descriptions of the issues, followed by comments from partners. The last day was devoted to individual breakout sessions on each of the five areas to discuss future technical directions, communication strategies, partnerships, and next steps needed to enhance our understanding of environmental issues related to agricultural production and land use. What follows are summaries of the five key areas of concern. Each summary includes a description of each issue, comments and notes from the presentations, key points from the breakout sessions, and next steps needed to define issues.

The keynote address by Skip Hyberg (USDA-FSA) highlighted several key points:

- The deficit matters.
- Communication is essential.
- U.S. agricultural policy balances production and conservation.
- Restructuring of government research efforts.

Skip defined the four C's he believed necessary for conservation communication: *Clear*, *Concise*, *Consistency*, and *Cooperation*. Agricultural issues identified as being of particular interest to the FSA include invasive species, genetically modified organisms, wetlands, grasslands, wildlife, and greenhouse gases. The key question: "Is conservation working?"

One critical component in land management is georeferenced data. Georeferenced data are available from:

- NRCS: Soils and the National Resources Inventory (NRI).
- FSA: Common Land Units.
- USGS: National Wetlands Inventory.
- USFWS: Four-Square-Mile Survey.

Efforts must be made to integrate data into a common information system, develop temporal and spatial modeling capacity for ecosystem functions, and develop common measures and indicators of conservation benefits. To be most useful, these measures and indicators must be tied to conservation activities administered by the USDA and be applicable across regions.

The following text is a summary of the presentations and discussions for each of the five topics covered in the workshop.

USGS geologists investigating soil properties responsible for spatial patterns of sagebrush (*Artemisia tridentate*; shrubs in background) and invasive cheatgrass (*Bromus tectorum*; reddish grass in foreground). San Juan County, Utah. *Photograph by Mark Miller, USGS.*

Emerging Compounds

Introduction

"Emerging compounds" is a generic term used to identify new compounds with unknown effects on the environment, or compounds that have been in use for some time but whose effects on the environment are newly understood or previously misunderstood. Little may be known about their impact on living organisms. Examples include wastewater chemicals and microbiological contaminants in both urban and rural streams, compounds associated with confined animal feeding operations (CAFOs), veterinary pharmaceuticals, and prions.

Comments from the Presentations

Research needs include an improved understanding of the persistence of new animal drugs in the environment, continued monitoring for veterinary and human pharmaceuticals, comparison and validation of previous environmental assessment predicted environmental concentrations (PECs), focus on key emerging issues, and management of contaminant releases. Prions in the environment appear to have long-term survival in soils, little is known about their environmental fate and transport, there are no validated methods for detecting or quantifying them in environmental media, and they are resistant to many common methods of disinfection.

Comments by Agency

- Food and Drug Administration (FDA) has a personal-care products working group in which the USGS participates. USGS work on monitoring for veterinary and human pharmaceuticals directly supports FDA risk assessments. Work by the USGS Upper Midwest Environmental Sciences Center on aquaculture drug research and development is important to FDA. FDA sees a critical need to broaden cooperation on pharmaceuticals in the environment; in particular, hormones are becoming an increasingly important issue. Research is needed in both point and non-point sources of endocrine-disrupting chemicals (EDCs). More focus on field data is critical.

- USDA Cooperative State Research, Education, and Extension Service (CSREES): Science issues include fate and transport of manure as it is spread, irrigation systems that might potentially concentrate salts and pollutants and affect return flows, animal hormones and implants (are they coming out into the environment?), intensive grazing in comparison to manure spreading, urban biosolids and urban chemical application, pesticide compounds and their effects, water shortages, gray-water application from cities on agricultural lands and its implications for food products, emerging pesticide compounds, soybean rust, tile lines, and tile drainage. Because of the pressure to remove antibiotics in animals, arsenic and zinc are being used instead. This will increase these compounds in the environment. What effects will they have?

- National Park Service (NPS): An emerging issue is the effect of pesticides on amphibians. This is a major consideration not included in past risk assessments of most pesticides. Some information is available on effects of Roundup and Atrazine on amphibians. There is very little information on other current pesticides. If research with LD50s (Lethal Dose 50%) and basic toxicology of pesticides on amphibians is conducted, results can be used in NPS decision-making. Some of the desired information may be available from EPA, but more interagency communication is critically needed.

- USFWS: As land managers, USFWS needs to know how combinations of compounds affect amphibians, fish, and other organisms, not just effects of individual compounds. More in-situ studies are needed.

To measure nitrogen runoff in the Pacific northwest, plant physiologist Steve Griffith collects water samples from a monitor well inside the riparian zone near the Calapooia River, OR. *Photograph by Brian Prechtel.*

Using a freezer mill, chemist Laura McConnell prepares amphibian tissue samples for pesticide analysis. *Photograph by Stephen Ausmus.*

Breakout Session

Future Technical Directions

1. Improvement of chemical methods.

   Need lower detection limits.

   Wider range of compounds needs to be analyzed (including hormones).

   Get current methods reviewed and approved; make methods available to broader scientific community.

2. Improvement of biological methods.

   Methods to identify specific pathogens, bacteria, viruses.

3. Immunoassay methods.

   Potentially useful for field-screening to define where to focus more intensive study.

4. Quantifying exposure and the ecological effects from this exposure.

   Begin analyzing only for compounds that have demonstrable effects.

5. Establish consistent national-scale monitoring methods (sampling, analysis) for emerging compounds, pathogens, and microbes. Train technical staff in these methods.

6. Establish biological infrastructure for long-term monitoring using consistent protocols.

7. Research on source/transport/fate for emerging compounds.

8. Obtain basic chemical data on emerging compounds (for example, kinetics). This information may be available from chemical producers.

Communication

1. Present results to emphasize compounds of most concern, rather than a long alphabetical listing.

2. Keep abreast of current agricultural practices (for example, CAFOs, cultivation methods, GMOs, and effects related to them).

3. Improve communication with both the regulated community and the regulating community. The regulated community may have much useful data on their products. Also, improve communication with the general public.

4. Information transfer at the local level through such activities as open houses at science centers, local conferences, and participation in conferences organized by various agriculture/water/biology groups.

5. Improve communication with local land managers.

Partnerships

1. All Federal agencies participating in the Agriculture Practices Workshop.
2. State agriculture, natural resources, and fish and wildlife agencies.
3. Agriculture and pharmaceutical producers.

Next Steps

1. Opportunities exist for mining and analyzing existing data to look, for example, at possible relationships between emerging compounds and nutrients in various environmental compartments (sediments, soils, water, and others).
2. Look for synergistic opportunities with other agencies and among USGS disciplines.
3. Develop a Central Region Integrated Science Partnership (CRISP) proposal on emerging compounds. There may be a good opportunity to integrate this with a proposal on GMOs.
4. Look for opportunities for collaboration with USDA where their study areas (for example, benchmark watersheds) may overlap with USGS study areas (for example, NAWQA watersheds). We could provide retrospective information about these areas or conduct limited new data collection for one or two parameters that would enhance the usefulness of the datasets for both agencies.

Corn harvest in Columbia, Missouri. *Photograph by Bruce Fritz.*

Water Availability

Introduction

The topic of Water availability encompasses the amount and spatial distribution of the Nation's water resources as well as the temporal trends affecting water supply and use. The availability, quality, and use of water are persistent long-term issues with wide-ranging implications for human activities, wildlife, and ecosystem conditions. The availability of water is a critical land-use issue with environmental and economic concerns. Among other factors, water availability is affected by climate variability and change, soil conditions, surface-water and ground-water interactions, water quality, and water use.

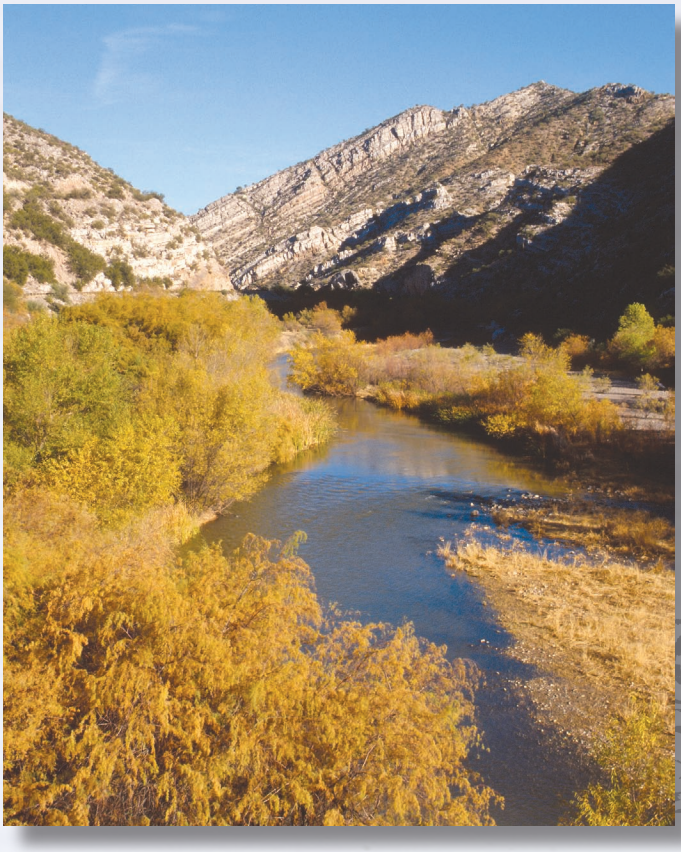
Comments from the Presentations

Effective management of water resources requires comprehensive information on availability and use, including snow survey, drought monitoring, and irrigation management. Comprehensive field data are needed to verify no-tillage and residue effects on individual soil-water-balance components as well as effects on surface-water quality and implications related to quality of aquatic habitats. Land-use and land-cover information is needed on (1) competition of agricultural land use with urban uses, (2) urban growth and rural trends, (3) irrigated cropland extent, and (4) forecasts. Agricultural land use has feedback effects on climate and hydrology. Forecasts of future water availability need to be improved especially in regard to climate change and areas where availability will decline or improve.

Comments by Agency

- NRCS: More information is needed on pesticides in surface water. The interaction between surface water and ground water is an important issue. There is a need to better understand the movement of contaminants.
- Department of Interior (DOI): Water quality is the big issue that affects water availability in USFWS refuges and in the NPS. Water quality drives habitat management options. There are point-source and non-point-source water-quality impacts from agriculture that affect wildlife habitat availability.
- NPS: The impact of pesticides on amphibians is needed for decision-making. Information on the effects of most pesticides, past and current, is lacking.
- USFWS: Information on wetland continuum is valuable for making management decisions. What will be the impacts of increased production of corn and other biofuels caused by a new Energy Bill and the 2007 Farm Bill?
- USDA-CSREES: It is anticipated that there will be an increase in planting of drought-resistant genetically modified crops to save water. More work is needed to address the balance between appropriate water withdrawal and environmental needs. This includes urban use and the economic concerns associated with water availability. Need information on invasive plants and the management of phreatophytes. Changes in agricultural practices and irrigation efficiencies have implications on return-flow water quality and aquatic life.
- FSA: The conversion of 34 million acres of CRP land back to crop cultivation will impact water availability. Need information and model scenarios on the changes in CRP land coverage and distribution.
- USGS: Research is needed on the effects of changes in irrigation practices on ground water. What is the impact of changes in water availability on migratory birds and other wildlife?

Estimating the volume of water contained in snowpack is vital to forecasting how much water will be available for agricultural and other uses. Southwestern Idaho. *Photograph by Scott Bauer.*



Although pretty at certain times of the year, saltcedar is an invasive exotic weed that is harming both agriculture and the environment. Here, it is overtaking native vegetation along the Gila River in Arizona. *Photograph by Jack Dykinga.*

Original art by Carol A. Quesenberry (USGS).

Breakout Session

Future Technical Directions

1. More information is needed on the interaction of surface water and ground water.
2. Improve data and models of water use and distribution, such as downstream water-use data and metered pumpage.
3. Identify water-quality contamination from agricultural sources and its impacts on water availability.
4. Improve modeling of contaminant movements.
5. Impacts of CAFOs.
6. Impact of competition of agricultural land use with urban uses.
7. Monitor agricultural land-use change along with water availability.
8. Continue the work on northern prairie pothole wetland continuums.
9. Research to understand the impact of CRP land going back into cultivation.
10. Geospatial models of changes in land use resulting from changes in agricultural programs are needed.
11. Improve crop inventory and irrigation mapping through remote sensing.
12. Understand the impact of the Energy Bill and 2007 Farm Bill on agricultural practices and on water availability. For example, what are the impacts of increased corn production for ethanol?
13. Quantify the effects of emerging agricultural practices on water availability. For example, what are the impacts of GMO crops and no tillage?
14. A better understanding is needed of the effects of invasive species on availability and use of water.
15. Sediment and phosphorous sources and the impact on water habitat.

Great blue heron. *Photograph by Scott Bauer.*

Communication

1. Identify and communicate clear goals related to water availability and use.
2. Communicate with agencies participating in the workshop.
3. Improve communication with land managers (for example, USFWS, NPS).
4. Improve our understanding of agricultural community needs related to water issues and effects of conservation policies as they affect landowners and rural communities.

Partnerships

1. All Federal agencies and workshop participants (FSA, NRCS, USFWS, NPS).
2. State agencies.

Next Steps

1 Establish a consistent research contribution to the Farm Bill and conservation issues.

2. Identify the major regional concerns where the USGS can make an immediate contribution. For example, what are the impacts of policy change? (Such as policy changes that affect the CRP.)
3. Keep up-to-date on budget initiatives such as the CSREES initiative for balancing water withdrawals with environmental and human needs.
4. Follow up on opportunities expressed by the other agencies.

Donald Merrit, a research biologist for the University of Maryland's Horn Point Center for Environmental Studies, pilots a boat from which USDA Agricultural Research Service chemists Laura McConnell (left) and Jennifer Harman-Fetcho collect samples of oysters, water, and sediment from the Choptank River on Maryland's Eastern Shore. *Photograph by Scott Bauer.*

Original art by Carol A. Quesenberry (USGS).

Genetically Modified Organisms

Introduction

A genetically modified organism (GMO) is a plant, animal, or microorganism whose genetic code has been altered; that is, genetic material subtracted or added (either from the same species or a different species) in order to give it characteristics that it does not have naturally. Examples of GMOs used on a global basis are (1) herbicide-resistant soybeans, corn, canola, and cotton and (2) insect-resistant corn, canola, and cotton crops that have been genetically modified using genetic material from the *Bacillus thuringiensis* bacterium. The advantages of having crop plants selectively resistant to herbicides and insect pests are obvious. In addition to these types of GMOs, extensive efforts are underway to utilize plants and animals in a transgenic mode to produce pharmaceutical active ingredients, incorporate enhanced nutritional factors, and as living factories to produce otherwise difficult to obtain materials. Efforts in the arena of GMO research are increasing exponentially, and the application of genetic modifications appears to be nearly unlimited.

Comments from the Presentations

Research opportunities identified included genomic mapping of plants and animals, metabolic control and engineering, enhancing nutritional value of food crops and animals, enhanced growth and reduced time to market of GMO animals, and using genetic modification to restore threatened and endangered plants and animals. Examples of areas of concern include characterizing the impacts on non-target organisms, food-chain effects, indirect changes to community relationships and other ecological impacts, effects of GMO plants on biodiversity, and potential competitive advantage of GMO animals over wild strains.

Trout DNA analysis will help researchers produce fish that grow faster, are more disease resistant, and tolerate stress better. *Photograph by Stephen Ausmus.*

Comments by Agency

- Environmental Protection Agency (EPA) does not have a monitoring program to audit the effectiveness of regulations. For example, EPA permits field trials of plants engineered to make pesticides but does not monitor the release of these plants. If the USGS could provide monitoring, it would drive numerous research efforts and EPA would be supportive. New topics of interest include industrial and pharmaceutical active ingredient chemicals in plants and animals. EPA needs soil and water measurements of the product chemicals, distribution of pollen from genetically modified plants, and other data. EPA is currently supporting development of a pollen dispersion model. A specific example of potential ecological impact is *Bacillus thuringiensis* crops. Assessment of the occurrence and potential incorporation of the *Bacillus thuringiensis* toxin-producing gene in microbial communities of animal intestines, soil and water microorganisms, and plant-associated microbial communities is needed.

- NPS is interested in using GMOs in a variety of ways. Examples include using genetic modifications to produce plants resistant to such diseases as Chestnut blight, Dutch Elm disease, Butternut canker, and others. Questions arise related to using conventional hybrids, which may take 6-8 generations to make, or using genetic modification of the plant genome and produce a resistant plant in one generation. NPS is also interested in efforts to modify microbes in mosquito intestines to prevent transmission of the West Nile virus, particularly to threatened and endangered birds. Where does the NPS get help in the Federal research community? We see a definite role for the USGS.

- USFWS is concerned about the rapid increase in the use of genetically modified crops. For example, growers are able to use more herbicides on genetically modified crops. What does this do to the environment around the treated fields? What are the habitat and microhabitat changes due to robust use of herbicides? What are the effects on fringe habitats, migratory birds, and threatened and endangered species? What are the implications of western expansion of drought-resistant genetically modified crops on land use, habitats, and distribution of wildlife? The USGS has a role in answering all these questions.

- USDA needs data on the ecological effects of transgenic plants and animals, particularly those designed to produce industrial chemicals and pharmaceutical active ingredients. Need to understand the long-term effects of transgenic microbes on indigenous rhizosphere microbes. Also need information on the ecotoxicology of transgenic plants. The USGS has expertise to play a critical role.

Breakout Session

Future Technical Directions

1. Development of monitoring programs for determining ecological effects of GMOs.

   Direct changes in ecological community structure.

   Indirect changes to community relationships.

2. Development of molecular techniques for rapid, effective screening of modified genes.

   Pest populations directly affected and potential for mutation.

   Non-target populations potentially affected.

3. Quantify exposure at all ecologically relevant levels.

4. Establish consistent national-based monitoring methods. Provide training to technical staff involved in monitoring efforts.

5. Conduct research to determine the potential impacts of GMOs on susceptible threatened and endangered species.

   Develop methods to identify gene transfer into wild strains from domestic animal populations.

6. Conduct research to delineate potential food-chain effects of GMOs.

7. Conduct research to determine the potential for loss of biodiversity related to GMOs.

Environmentally friendly ultra-low-volume herbicide application methods developed by USDA Agricultural Research Service plant physiologist Chester McWhorter (now retired) and colleagues could significantly reduce the use of agricultural chemicals. *Photograph by Keith Weller.*

To check elms for tolerance, geneticist Alden Townsend inoculates a tree through a small predrilled hole with *Ophiostoma ulmi*, the fungus that causes Dutch elm disease. *Photograph by Scott Bauer.*

Communication

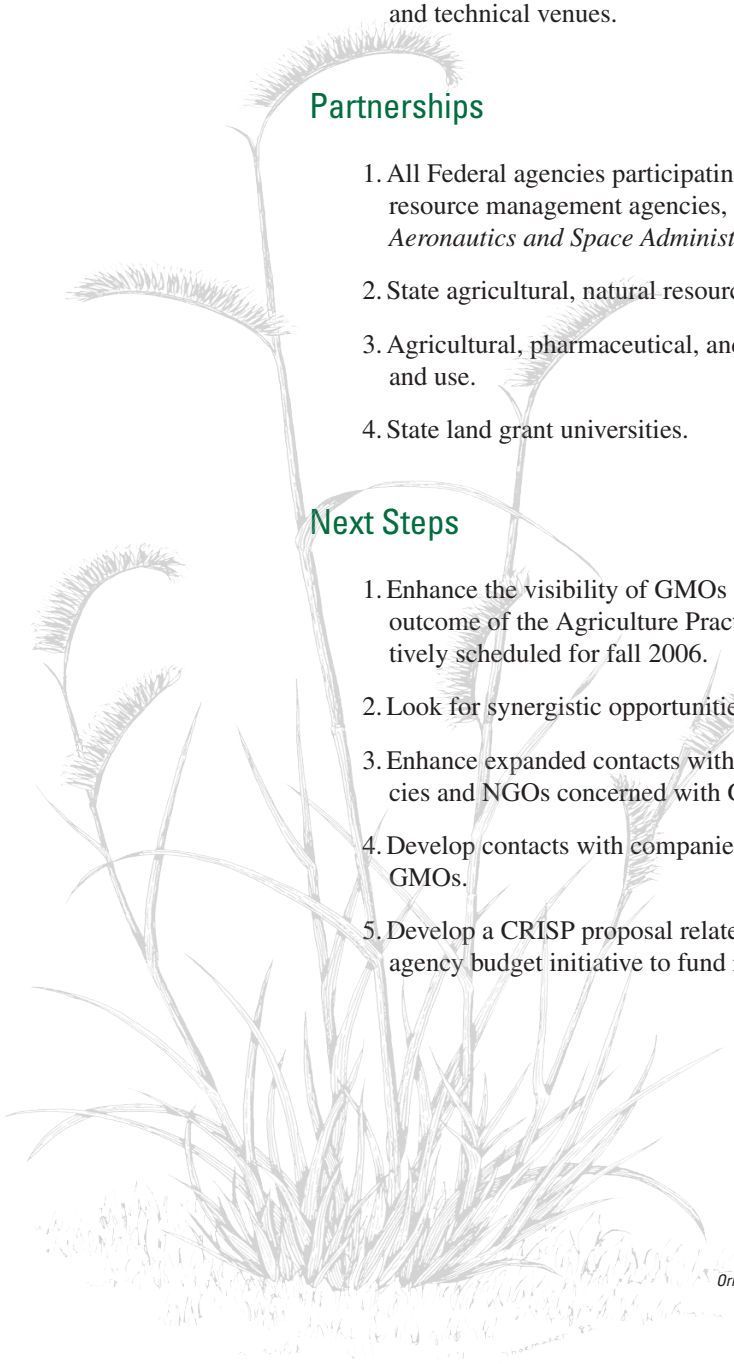
1. Keep current on new developments in the GMO field as related to agriculture practices and share this information among all USGS disciplines.
2. Keep abreast of changes in regulations related to GMOs and share such information among all USGS disciplines.
3. Enhance communications with the agricultural community, regulatory community, and within the USGS disciplines (that is, maximize opportunities for integrated research projects).
4. Enhance communications with resource managers—Federal, State, and local.
5. Promote and increase information transfer and technical assistance at all levels; that is, from local events (for example, open houses at USGS Centers) to participation in scientific meetings and conferences to publication of research results in both nontechnical and technical venues.

Partnerships

1. All Federal agencies participating in the Agriculture Practices Workshop, all natural resource management agencies, U.S. Department of Defense (DOD), and *National Aeronautics and Space Administration (NASA)*.
2. State agricultural, natural resource, and conservation agencies.
3. Agricultural, pharmaceutical, and industrial producers involved in GMO development and use.
4. State land grant universities.

Next Steps

1. Enhance the visibility of GMOs as a potential research area within the USGS. A direct outcome of the Agriculture Practices Workshop is a planned GMO Workshop tentatively scheduled for fall 2006.
2. Look for synergistic opportunities with other agencies and USGS disciplines.
3. Enhance expanded contacts with Federal and State natural resource management agencies and NGOs concerned with GMOs.
4. Develop contacts with companies and organizations involved in development and use of GMOs.
5. Develop a CRISP proposal related to GMOs. Use this as a springboard to develop an agency budget initiative to fund research in the broad-based GMO area.



Original art by Jennifer Shoemaker (USGS).

Effects of Conservation Practices on Ecosystems

Introduction

Various conservation practices are widely applied to control soil erosion, manage runoff water, improve soil quality, control nutrients and pests, and enhance distribution and quality of fish and wildlife habitats associated with agricultural land use. Approaches to conservation are diverse, ranging from no-till/minimum-till cultivation, increasingly judicious use of agrochemicals, and establishment of conservation infrastructures (for example, terraces and riparian buffers) to removal of environmentally sensitive land from production under USDA programs such as CRP. Rising costs for energy likely will affect farming through greater adoption of minimum-tillage production alternatives and will elevate demand for bioenergy products derived from agricultural landscapes.

While production of food and fiber will remain the principal use, many non-market services derived from agriculturally dominated ecosystems are increasingly recognized as being important to American society. Sustainable management of resources, clean air and water, wildlife, and rural economic enhancement are but a few recognized benefits brought by effectively intertwining agricultural and conservation policies. However, information is needed to lessen unwanted effects of agricultural production and to bring even greater environmental benefits to farmers as well as the American public. Key questions to be addressed include: How effective are specific conservation practices, programs, and policies? Are they meeting private and public needs by achieving, or progressing toward, realistic goals?

Severe soil erosion in a wheat field near Washington State University. *Photograph by Jack Dykinga.*

Comments from the Presentations

Budgetary constraints define adoption of conservation policies and programs by governmental agencies and landowners managing agricultural lands. Consequently, measures of efficiency in performance and accomplishment in reaching goals are needed to define effectiveness of conservation policies and programs. To describe and improve success of conservation on agricultural lands, much more than summarization of acres devoted to specific conservation practices and programs is needed. The ability to quantify and describe conservation effectiveness in meeting diverse environmental and social goals are of importance to farm operators, Federal and State agencies, and those who forge agricultural policies on a national scale.

Comments by Agency

- USDA-FSA: Because government resources are finite, the budget is important in defining acceptable conservation policies and how those policies are implemented on the ground at field, farm, and landscape scales. Continued Congressional and Departmental support for conservation programs will require definition of clear goals and a program of accountability to describe how well these objectives are being attained. Quantitative descriptions and measures of the performance of individual practices and programs are needed. The USDA desires to know what conservation measures work, how effective they are in attaining goals, and how to most effectively integrate conservation into agricultural land use on a multi-farm, landscape scale.

- USDA-NRCS: The Conservation Effects Assessment Project (CEAP) is a program intended to quantify environmental benefits of conservation practices on watershed and landscape scales. The CEAP is a multi-agency effort that includes data collection, model development, model application and refinement, and research. Annual reports of results are expected to begin in 2006. There is an NRCS audience that does not regularly have access to USGS publications. Points of contact for selected issues should be established and strengthened between the NRCS and the USGS.

- USFWS: Agricultural conservation policies affect migratory and non-migratory wildlife and their habitats on private as well as public lands. Information is needed on what management and conservation actions are required to meet specific environmental goals. What are the effects of changing agricultural and conservation practices on landscape-level environmental issues? Although information is needed on how well conservation practices achieve goals, transfer of existing and new knowledge to landowners and land management agencies is equally important. The transfer of knowledge has been a weak link in the resource community. There is lots of information, but what does it all mean? More attention needs to be given to synthesis of existing information and getting it to those who need it on the ground. NPS and NRCS representatives also stated a need for greater emphasis on provision of synthesis material describing results and implications from many studies.

- USGS: The last century brought dramatic changes to American agriculture that include greater efficiency in production, specialization in crops produced, dependence on chemical inputs, and advances in technology. These far-reaching changes have resulted in many agricultural lands being farmed more intensively at a cost of lost habitat for wildlife, greater impacts to ground-water and surface-water quality, and dramatic alterations in the social and economic composition of rural communities. Greater efficiency in production can be expected to result in an overall decline in land area needed for agriculture in future years. However, those lands remaining in production can be expected to experience increasing intensity of use. USDA conservation policies have been beneficial in lessening unwanted effects of agricultural production, but quantitative descriptions of how well individual practices and programs meet landscape-level environmental goals remain problematic.

U.S. long-grain rice. *Photograph by Keith Weller.*

- International Association of Fish and Wildlife Agencies (IAFWA) represents State fish and game agencies and is an advocate to accomplish common policy and environmental goals. Although each State is affected differently by agriculture and conservation policies, it is hoped that the USGS can furnish scientifically reliable information upon which IAFWA can make recommendations concerning agricultural conservation. The IAFWA meets annually in association with the North American Wildlife and Natural Resources Conference, and it holds four regional meetings annually. Representatives of the USGS are invited to all of these meetings. Scientifically reliable information that addresses issues of concern to the IAFWA is welcome from the USGS.

- CSREES provides leadership to land-grant university partners in research, education, and extension programs related to agricultural programs and natural resource issues. CSREES representatives believe there are numerous studies completed that may assist in documentation of environmental benefits of conservation practices. To date, there has been no effort to pull all such studies together into a synthesized presentation. Less appears to be known about agricultural impacts on wildlife than is known about water-quality issues. An effective way to communicate results of completed investigations to interested agencies needs to be found.

Breakout Session

Future Technical Directions

1. Focus immediate attention on synthesis of existing information related to issues of greatest concern to USDA conservation policies.
2. Focus on applied research useful for land managers in addressing current land management issues and policies.
3. Increase monitoring on the subwatershed level in basins where significant conservation activity has taken place.
4. Think ahead. Work with USDA to identify subbasins or other geographic sites where new conservation activities are planned. Baseline (pre-project) data is essential for defining impacts of conservation policies.
5. Place greater emphasis on assessment of the effects of specific conservation practices. For example, what are water-quality and aquatic habitat implications of differing types of riparian vegetated buffers?
6. Increase monitoring of conservation practices within specific watersheds or subbasins with an emphasis on communication of results to the local level.

Communication

1. Identify and rank land-use and monitoring issues of greatest priority to the USDA.
2. Get information on conservation results and effectiveness to landowners and county-level USDA staff directly involved in on-ground implementation of conservation policies.

Partnerships

1. Encourage and expand partnerships with agriculturally related resource agencies (for example, conservation districts) and other NGOs involved in agricultural issues.
2. Look for ways to further involve landowners in identification of local environmental priorities and methods so they become involved in monitoring the effectiveness of conservation practices.

Next Steps

1. Find ways to cost-share the financial burden of long-term monitoring of agricultural production and conservation practices between Federal agencies. An expectation that the USDA (under current funding design) will be able and willing to carry the entire economic burden will bring only disappointment.

Data, Methods, and Tools for Assessing Effects of Agricultural Practices

Introduction

This workshop brought together governmental earth science, life science, and agricultural professionals to discuss current research directions into the effects of agricultural practices on the environment. In addition, the need for specific scientific tools, methods, and directions to define and measure these effects was discussed. Current technologies that can be used to evaluate and measure the impacts of agricultural practices include remote sensing and geospatial technologies and tools, field data collection and techniques, hydrologic models, and decision-support tools. The USGS capabilities in these areas are well developed and suited to meet the needs for assessing effects of agricultural practices.

Landsat 2 multispectral scanner satellite image of Lake Oahe, Missouri River, South Dakota, May 1976. *USGS image.*

Comments from the Presentations

An overview of the CEAP identified the need for spatially and temporally variable climatic, topographic, land-use, and soils data. Better spatial data can improve hydrologic representation, and seasonally variable land-use data is important for accurate simulations and for remotely sensed estimates of soil moisture. CEAP has two major components: (1) the NRCS-led National Assessment provides estimates of conservation benefits at the national scale, and (2) the ARS- (Agricultural Research Service) and NRCS-led Watershed Assessment Study provides more detailed information on conservation effects and benefits in selected benchmark watersheds. A CEAP farmer survey provides data on farming activities and conservation practices. The CEAP was established to quantify the environmental benefits of conservation practices. The initial focus is on cropland; future plans include assessments for wildlife, grazing lands, and wetlands.

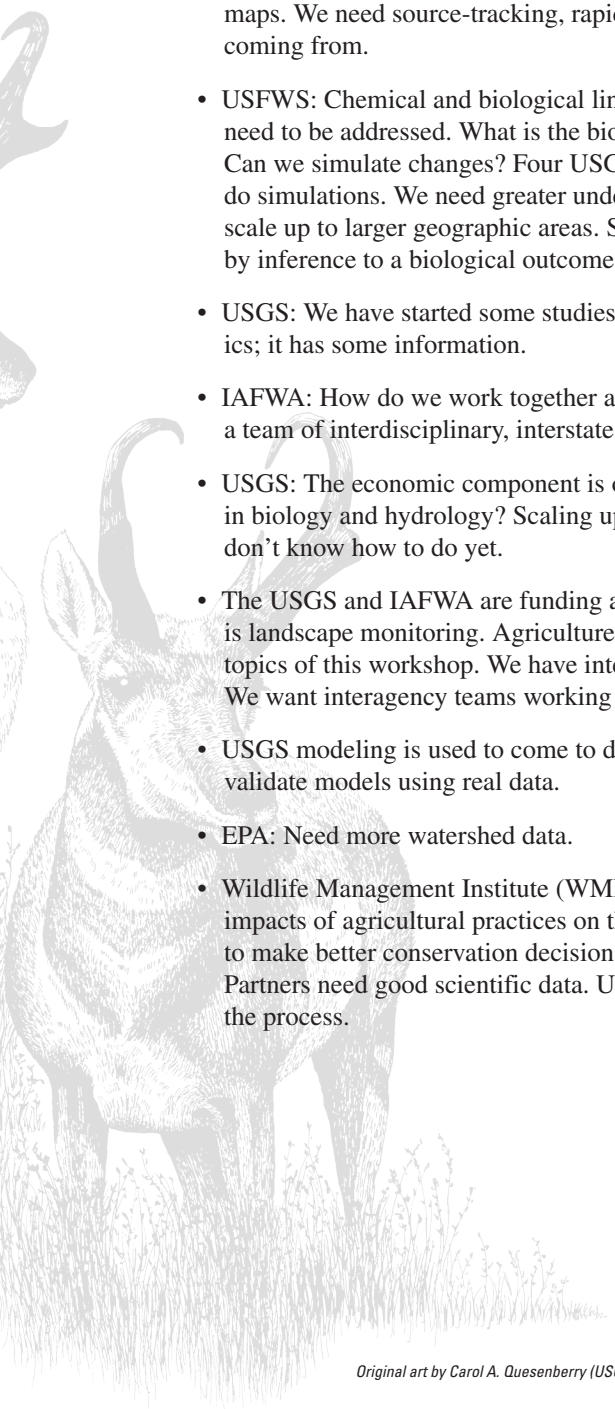
Several models were discussed. Simulation modeling (1) captures the diversity of land use, soils, climate, and topography, (2) estimates the loss of materials from farm fields at the field scale where the science is best developed, and (3) provides a statistical basis for aggregating results to the national and regional levels. Watershed modeling tools include HUMUS (Hydrologic Unit Model of the United States) and SWAT (Soil Water Assessment Tool). SWAT is a physical process model that simulates runoff and streamflow in large river basins. SWAT also estimates transport of sediment, nutrients, and pesticides. HUMUS is a modeling system that includes input databases needed to run SWAT for every 8-digit watershed in the U.S. (See *http://water.usgs.gov/GIS/huc.html* for maps showing U.S. watersheds and for explanations of the coding of such watersheds.)

The ARS Watershed Assessment Study provides a quantitative assessment of environmental benefits of USDA conservation programs. Anticipated products include (1) water, soil, management, and economic data system, (2) quantification of effects of conservation practices on environmental quality, (3) validation of models and quantification of uncertainties of model predictions, (4) evaluation of cost-effectiveness of selection and placement of conservation practices, and (5) development of regional watershed models.

Antelope on sagebrush grassland in northwestern Colorado. *Photograph by Craig Brunstein (USGS), May 5, 2005.*

Comments by Agency

- NRCS: The NRCS values insight on the agricultural contributions to water-quality problems. Insight on such problems is gained from the USGS NAWQA and wildlife programs. The USGS is doing a good job on these programs. Please continue that work. National pesticide and nutrient syntheses are effective in defining problems and help us make decisions we need to make. The NRCS needs more information on effects of conservation practices, and we encourage any additional work you can do (like the Discovery Farms work). This work will make the USGS very relevant. We want to include the USGS in CEAP. These issues will take us through the next 10 years.
- USDA-CSREES: The USGS should work with the Economic Research Service. They do a lot of megatrend work and have a Web page of products, including georeferenced maps. We need source-tracking, rapid assessments to address where contaminants are coming from.
- USFWS: Chemical and biological linkages (inferences, cause and effect) 2-4 years out need to be addressed. What is the biological effect of endocrine disruption chemicals? Can we simulate changes? Four USGS science disciplines are uniquely positioned to do simulations. We need greater understanding of local processes and then we need to scale up to larger geographic areas. Science can answer some questions, but we manage by inference to a biological outcome.
- USGS: We have started some studies. There is a Web site for endocrine disruption toxics; it has some information.
- IAFWA: How do we work together and coordinate our efforts? Should we pull together a team of interdisciplinary, interstate, and Federal agency people to think about this?
- USGS: The economic component is overlooked in the USGS. How do we integrate that in biology and hydrology? Scaling up our results to landscape scale is something we don't know how to do yet.
- The USGS and IAFWA are funding an international position. One of the FY 06 thrusts is landscape monitoring. Agriculture practices are major issues in each of the first four topics of this workshop. We have interdisciplinary teams working on a plan of action. We want interagency teams working on these topics.
- USGS modeling is used to come to decisions. What pieces are missing? We need to validate models using real data.
- EPA: Need more watershed data.
- Wildlife Management Institute (WMI): We need to go to the next level of understanding impacts of agricultural practices on the environment. What answers are being provided to make better conservation decisions? Ask all the partners what information they need. Partners need good scientific data. USGS needs to go outside and bring the partners into the process.



Original art by Carol A. Quesenberry (USGS).

Domestic turkeys. *Photograph by Scott Bauer.*

Breakout Session

Future Technical Directions

1. Determine what kinds of models are needed.
2. Resolve scalability (plot to region).
3. Synthesize current activities and information.
4. ARS photographs (need to expand coverage and detail of agricultural practices photographic documentation).
5. Agencies are automating data (geospatial).

Communication

1. Training, assistance with remote sensing.
2. Cottonwood Lake example.
3. Newsletter.
4. New data derived from Digital Elevation Models (DEMs), Landsat images, etc.
5. Basis+ search of agriculture projects.
6. Agencies need to articulate their issues and locations of concern.

Partnerships

1. USDA, NRCS, and ARS.
2. USGS disciplines.
3. USFWS.
4. NPS.
5. EPA.

Next Steps

1. MOU—first between the USGS and the FSA; now to be expanded to include the FSA, USFWS, NRCS, and USGS.
2. USGS CRISP project, other USGS projects.
3. Fact Sheet (will describe research capabilities that could be used to address the science questions posed by agricultural practices).
4. Other meetings where the USGS is participating.
5. Landscape thrusts (FY 06).

    Prairie potholes.

    Integrated landscape monitoring.
6. Geospatial model (prairie potholes).

    Soils erosion.

    Wildlife (habitat and populations).
7. Monitoring.

    Validate simulation models for assessment of resources.

    Adaptive management impacts on agricultural practices.

    Use an integrated science approach.

    Long-term sites (research stations).

Conclusion

The key outcome from the workshop was the networking between the USGS and its partners. Relationships were established that will enhance collaboration and address the key issues and needs identified by the partners. The USGS is developing a Fact Sheet for the partners that will describe research capabilities that could be used to address the science questions posed by agricultural practices. Key to enhancing collaboration will be the MOU between FSA, USFWS, NRCS, and USGS. This document will formalize the cooperative relationship among these bureaus and places importance on the need for working together to address the complex questions associated with the environmental effects of agricultural practices.

Original art by Margaret Austin (USDA).

Sunflower crop near Fargo, North Dakota. *Photograph by Bruce Fritz.*

Appendixes

Appendix 1. Poster Session

- **Towards a Ground-Water-Level Climatology of the Southwestern United States**, Mike Dettinger (USGS/Scripps Institution of Oceanography), Randall Hanson (USGS), Mark Newhouse (USGS/ California State University at Sacramento), and Pasha Groisman (NOAA, NCDC [U.S. Department of Commerce National Oceanic and Atmospheric Administration National Climatic Data Center])
- **Agricultural Land Use Trends in the Edwards-Trinity Aquifer Region**, Benson Sherrouse and David Hester (USGS, Rocky Mountain Geographic Science Center).
- **Development of Crop Type Maps to Support Water Quality Management in South Dakota**, Susan Maxwell (USGS, Eros Data Center).
- **Flow-accumulated Variables in the Vermillion River Watershed in South Dakota**, Pam Waisanen, Bruce Worstell, Miguel Restrepo, and Kristine Verdine (USGS, Eros Data Center).
- **The Inorganic Analytical Chemistry of Soils**, James Crock (USGS, Denver, CO).
- **Contribution of Atmospheric Deposition of Pesticides to Surface Water Runoff**, Michael Majewski and Celia Zamora (USGS, Sacramento, CA), William Foreman (USGS, Denver, CO), and Charles Kratzer (USGS, Sacramento, CA).
- **Deposition of Pesticides in Rocky Mountain and Glacier National Parks**, Serena Skaates, M. Alisa Mast, William Foreman, David Manthorne, and Donald Campbell (USGS, National Water Quality Laboratory).
- **Determination of Fipronil and Degradates in Environmental-Water Samples by Solid-Phase Extraction and Gas Chromatography/Mass Spectrometry (GS/MS)**, Mark Sandstrom (USGS, National Water Quality Laboratory).
- **Fate and Effects of Nitrogen and Phosphorus in Shallow, Vegetated Aquatic Ecosystems**, James Fairchild, L. Flenniken-Vradenburg, Jennifer Jones, and T. Canfield (USGS, Columbia Environmental Research Center).
- **An Integrated Assessment of the Eutrophication of Fort Cobb Reservoir, Oklahoma**, James Fairchild, B. Lakish, Duane Chapman, Kathy Echols, T. Johnson, and Susan Jones (USGS, Columbia Environmental Research Center).
- **Historical Changes in Land Use in the Cedar River Basin, Iowa: Implications for Land Management Activities to Increase Denitrification Rates**, James Fairchild, P. Waisainen, Douglas Schnoebelen, Kathy Echols, B.T. Johnson, and Steven Kalkhoff (USGS, Columbia Environmental Research Center).
- **Seasonal Trends of Microcystin Toxins in Algal Blooms of a Midwestern Reservoir**, Kathy Echols, James Fairchild, Duane Chapman, Kevin Feltz, Carl Orazio, and Susan Jones (USGS, Columbia Environmental Research Center).
- **Passive Sampling of Antibiotics and other Contaminants Resulting from Field Application of Poultry Litter in the Delmarva Peninsula**, David Alvarez, Walter Cranor, James Huckins, Randal Clark, J. Lebo, Jim Petty, and B. McGee (USGS, Columbia Environmental Research Center).
- **Fertilizer Consumption in the United States**, Deborah Kramer and Joyce Ober (USGS, Minerals Team, Reston VA).
- **Changes in Herbicide Concentrations in Relation to Use, Midwestern Rivers, 1989-2002**, William Battaglin and Elizabeth Scribner (USGS, Colorado Water Science Center, Denver CO).

- **Hydrologic Investigations in Support of the Amphibian Research and Monitoring Initiative**, William Battaglin (USGS, Colorado Water Science Center, Denver CO).
- **Comparison of 7 Protocols to Identify Fecal Contamination Sources Using *Escherichia coli***, Don Stoechkel (USGS, Ohio Water Science Center), Melvin Mathes (USGS, West Virginia Water Science Center), and Ken Hyer (USGS, Virginia Water Science Center).
- **Sustainable Land Use Requires Attention to Ecological Signals, a Case Study from Sonora, Mexico**, William Halvorson, A. Castellanos, J. Murrieta, and J. Goldenetz (USGS, Southwestern Biological Science Center).
- **Discovery Farms Program Overview**, D. Frame, F. Madison, Todd Stuntebeck, and Matthew Komiskey (USGS, Wisconsin Water Science Center).
- **Manure Management Impacts on Surface-Water Runoff at One Discovery Farm**, D. Frame, F. Madison, Todd Stuntebeck, and Matthew Komiskey (USGS, Wisconsin Water Science Center).
- **Observations for the First Year of Monitoring Data on Two Discovery Farms**, D. Frame, F. Madison, Todd Stuntebeck, and Matthew Komiskey (USGS, Wisconsin Water Science Center).
- **Conservation Effects Assessment Project: Studying Effects of Conservation Practices on the Environment**, Robert Kellogg (USDA, Natural Resources Conservation Service, Beltsville MD).
- **Effects of Structural Changes in U.S. Animal Agriculture on Fecal Coliform contamination of Streams**, Richard Smith, Richard Alexander, Gregory Schwarz, and Michael Lerardi (USGS, Reston, VA).
- **Studies by the U.S. Geological Survey on Sources, Transport, and Fate of Agricultural Chemicals**, Paul Capel (USGS, Minnesota Water Science Center) and Martha Erwin (USGS, Reston, VA).
- **Use of the Water, Energy, and Biogeochemical Model (WEBMOD) and the Soil and Water Assessment Tool (SWAT) to Identify Hydrologic Flow Paths at Five Agricultural Sites Including the U.S. Geological Survey National Water Quality Assessment Program**, Richard Webb (USGS, Colorado Water Science Center), David Wolock (USGS, Kansas Water Science Center), Josh Linard (USGS, Nebraska Water Science Center), and Michael Wiecsorek (USGS, Maryland Water Science Center).
- **Well Flowmeter and Down-Hole Sampler**, S. Jerrod Smith and James Greer (USGS, Oklahoma Water Science Center).
- **The Geochemical Landscapes Projects: Pilot Studies for a Proposed Soil Geochemical Survey of North America**, David Smith and Martin Goldhaber (USGS, Denver, CO).

Sheep graze near Odell Lake on the U.S. Sheep Experiment Station in the Centennial Mountains of southwestern Montana. *Photograph by Scott Bauer.*

Appendix 2. Participants

International Association of Fish & Wildlife Agencies
Jen Mock

Wildlife Management Institute
Ronald Helinski

U.S. Department of Agriculture, Agricultural Research Service
David Bosch
Gale Dunn
Clarence Richardson

Cooperative State Research, Education, and Extension Service
Daniel Jones
Mary Ann Rozum

Farm Service Agency
Skip Hyberg

Natural Resources Conservation Service
Diane Eckles
Mike Gillespie
Robert Kellogg
Frank Riggle

U.S. Environmental Protection Agency
Bob Brobst
Roger Dean
Bob Frederick
John Larson
Wendy O'Brien
Suzanne Wuerthele
Qian Zhang

Federal Drug Administration
Charles Eirkson

National Park Service
Terry Cacek

U.S. Fish and Wildlife Service
Terry Sexson
Everett Wilson

U.S. Geological Survey
Arthur Allen
Thomas Armstrong
Bill Battaglin
Zachary Bowen
Sky Bristol
Elly Brouwers
Robert Buchmiller
Tom Casadevall
Bobby Cox
Jim Crock
Frank D'Erchia
Tim Dinardo
Paul Dresler
Mark Drummond
David Dupre
Max Ethridge
James Fairchild
Stephen Faulkner
Bill Foreman
Jill Frankforter
Ed Furlong
Martha Garcia
Sarah Gerould
Robert Gleason
Jason Gurdak
Sheridan Haack
Randy Hanson
Sue Haseltine
Pam Haverland
Jay Hestbeck
Dave Hester
Glenn Holcomb
Stephen Jasinski
Pat Jellison
Matt Komiskey
Tom Loveland
Rob Middlemis-Brown
Cheryl Morris
Doug Muchoney
Randy Olsen
Jim Petty
Jim Preacher
Joe Richards
George Ritz
Gary Rowe
Walt Sadinski
Roger Sayre
Mark Shasby
David Shaver
Ben Sherrouse
Jan Simmons
David Smith
Rick Sojda
Bill Steiner
Wesley Stone
Robert Szaro
PhilipVerplanck
Bruce Vondracek
Janice Ward
Kim Winton
Woody Woodward

U.S. Geological Survey Contractors
Jolie Goldenetz
Bill Mauck
Susan Maxwell
Pamela Waisanen

Ecologists Charlie Cooper (left) and Scott Knight sample bottom sediments in Thighman Lake, Mississippi, for small invertebrates that indicate ecosystem health. *Photograph by Scott Bauer.*

Appendix 3. Workshop Agenda

Environmental Effects of Agricultural Practices Workshop

Auditorium, Building 810, Denver Federal Center, Lakewood, CO

Meeting Goal: Learn about the effects of agricultural practices on the environment and about tools for identifying and quantifying those effects. Define environmental concerns. Develop scientific actions to address assessment of environmental effects. Create collaborations to identify future research requirements and technical gaps.

Tuesday, 14 June 2005

7:15–8:00 a.m. **Registration**

8:00–8:30 a.m. **Welcome, Introductions, Workshop Format**
Tom Casadevall, USGS, Central Region Director, Denver, CO
George Ritz, USGS, Workshop Planning Committee

8:30–9:00 a.m. **Investigating the Environmental Effects of Conservation Practices: Opportunities and Challenges**
Skip Hyberg, USDA, Farm Services Agency, Office of Policy and Economic Analysis, Washington, D.C.

EMERGING COMPOUNDS

Moderators: David Smith, USGS, Central Region Mineral Resources Team, Lakewood, CO, and Kim Winton, USGS, Oklahoma Water Science Center, Oklahoma City, OK

9:00–9:15 a.m. ***Wastewater Chemicals Found in Colorado and Iowa Streams and Ground Water: It's Not Just an Urban Problem***
William A. Battaglin, USGS, Colorado Water Science Center, Denver, CO, Lori A. Sprague, USGS, Colorado Water Science Center, Denver, CO, Edward T. Furlong, USGS, National Water Quality Laboratory, Denver, CO, Dana W. Koplin, USGS, Iowa Water Science Center, Iowa City, IA

9:15–9:30 a.m. ***Comparison of Emerging Chemical and Microbiological Contaminants in Surface Water in Agricultural versus Urban Settings in Michigan***
Sheridan Haack, USGS, Michigan Water Science Center, Lansing, MI

9:30–10:00 a.m. BREAK (30 min.)

10:00–10:15 a.m. ***CAFOs and Emerging Contaminants—Research by the USGS Toxics Program***
Edward T. Furlong, USGS, National Water Quality Laboratory, Denver, CO, Dana W. Kolpin, USGS, Iowa Water Science Center, Iowa City, IA, Michael T. Meyer, USGS, Kansas Water Science Center, Lawrence, KS

10:15–10:30 a.m. ***Veterinary Pharmaceuticals in the Environment***
Charles Eirkson, FDA, Center for Veterinary Medicine, Rockville, MD

10:30–10:45 a.m. ***Prions in the Environment: Sources, Stability, and Species Specificity***
Wendy O'Brien, EPA Region 8, Denver, CO

10:45–11:00 a.m. *Emerging Compounds* Question Session

11:00–12:15 p.m. LUNCH (1 hour and 15 minutes.)

WATER AVAILABILITY

Moderators: Mark Drummond, USGS, Rocky Mountain Geographic Science Center Denver, CO, and Janice Ward, USGS, Office of Water Quality, Lakewood, CO

12:15–12:30 p.m.	***No-Tillage and Residue Management to Enhance Soil Water Storage and Appropriate Crop Rotations to Make Best Use of Stored Water*** *Gale Dunn, USDA, Agricultural Research Service, Fort Collins, CO*
12:30–12:45 p.m.	***Snow Survey and Water Supply Forecasting*** *Michael Gillespie, USDA, Natural Resources Conservation Service, Golden, CO*
12:45–1:00 p.m.	***Consequences of Land Cover Change on Surface Hydrology, Regional Weather, and Climate Variability*** *Thomas Loveland, USGS, National Center for Earth Resources Observation and Science, EROS Data Center, Sioux Falls, SD*
1:00–1:15 p.m.	***Effects of Flow and Channel Modification on Aquatic Habitat*** *Zachary Bowen, Fort Collins Science Center, Fort Collins, CO*
1:15–1:30 p.m.	***Simulating Irrigated Agriculture with the Farm Package in MODFLOW [MODular three-dimensional finite-difference ground-water FLOW model]*** *Randy Hanson, USGS, California Water Science Center, San Diego, CA*
1:30–1:45 p.m.	***Agricultural Land Use Trends in the Edwards-Trinity Aquifer Region*** *Ben Sherrouse, USGS, Rocky Mountain Geographic Science Center, Denver, CO, David Hester, USGS, Rocky Mountain Geographic Science Center, Denver, CO*
1:45–2:00 p.m.	*Water Availability* Question Session
2:00–2:30 p.m.	BREAK (30 minutes)

GENETICALLY MODIFIED ORGANISMS (GMOs)

Moderators: Jim Petty, USGS, Central Region, Office of the Regional Biologist, Columbia, MO, and George Ritz, USGS, Central Region, Office of the Regional Hydrologist, Denver, CO

2:30–2:45 p.m.	***Introduction to Genetically Modified Organisms*** *Jim Petty, USGS, Central Region, Office of the Regional Biologist, Columbia, MO*
2:45–3:00 p.m.	***U.S. Department of Agriculture Support of GMO Research*** *Daniel Jones, USDA, Cooperative State Research, Education, and Extension Service, Washington, D.C.*
3:00–3:15 p.m.	***From Gene Flow to the Ecology of Non-Target Species: How EPA Research Supports the Regulation of Biotechnology*** *Robert J. Frederick, EPA, Office of Research and Development, Washington, D.C.*
3:15–3:30 p.m.	***U.S. Fish & Wildlife Service Interest In, And Data Needs with Regard to, Genetically Modified Organisms*** *Everett F. Wilson, USFWS, Department of Environmental Quality, Arlington, VA*
3:30–4:00 p.m.	***Genetically Engineered Plants: Source of New Environmental Compounds*** *Suzanne Wuerthele, EPA Region 8, Denver, CO*
4:00–4:15 p.m.	*Genetically Modified Organisms* Question Session
4:15 –5:00 p.m.	GENERAL QUESTIONS AND DISCUSSION
6:00–8:00 p.m.	ICEBREAKER at Denver West Sheraton Hotel in City Lights first and second floor

Wednesday, 15 June 2005

EFFECTS OF CONSERVATION PRACTICES ON ECOSYSTEMS

Moderators: Art Allen, USGS, Fort Collins Science Center, Fort Collins, CO, and Carol Finn, USGS, Central Region, Office of the Regional Geographer, Rolla, MO

8:30–8:45 a.m.	***Modeling and Assessment of Conservation Practices and Effects on Aquatic Ecosystems in Farmed Landscapes*** *Bruce Vondracek, USGS, University of Minnesota, Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, MN*
8:45–9:00 a.m.	***Overview of Wetland Evaluations in the Northern Great Plains*** *Robert Gleason, USGS, Northern Prairie Wildlife Research Center, Jamestown, ND*
9:00–9:15 a.m.	***Changes in the Terrestrial Agricultural Landscape: Implications for Wildlife and Assessment of Conservation Reserve Program (CRP) Grasslands*** *Art Allen, USGS, Fort Collins Science Center, Fort Collins, CO*
9:15–9:30 a.m.	***Farm Services Agency Monitoring and Assessment Needs: Ongoing and Future*** *Skip Hyberg, USDA, Farm Services Agency, Washington, D.C.*
9:30–10:00 a.m.	BREAK (30 min.)
10:00–10:15 a.m.	***Effects of Agricultural Practices: Does the Fish and Wildlife Service Really Have Research Needs?*** *Terry Sexson, U.S. Fish and Wildlife Service, Regional Office, Denver, CO*
10:15–10:30 a.m.	***Natural Resources Conservation Service Conservation Effects Assessment Program (CEAP) Wildlife and Wetland Assessments*** *Diane Eckles, USDA, Natural Resources Conservation Service, Beltsville, MD*
10:30–11:00 a.m.	*Conservation Practices* Question Session
11:00–1:00 p.m.	LUNCH (delivered) and Poster Session (Posters will be available for viewing during entire meeting.)

USGS meteorological station established to monitor climate (temperature, precipitation, wind direction and strength) and geologic processes (erosion and deposition) for studies of land use and landscape change on the Colorado Plateau (USGS Earth Surface Dynamics Program, http://climweb.cr.usgs.gov/info/sw/clim-met/). San Juan County, Utah. *Photograph by Rich Reynolds (USGS).*

DATA, METHODS, AND TOOLS FOR ASSESSING EFFECTS OF AGRICULTURAL PRACTICES

Moderators: Frank D'Erchia, USGS, Central Region, Biological Science Coordinator, Denver, CO, and Susan Maxwell, USGS, EROS Data Center, Sioux Falls, SD

1:00–1:15 p.m.	***Instrumentation and Modeling Methods for Studying Pothole Wetlands in an Agricultural Landscape*** *Rick Sodja, USGS, Northern Rocky Mountain Science Center, Bozeman, MT*
1:15–1:30 p.m.	***Development of Monitoring and Sampling Design Protocols to Assess Conservation Practices in the Mississippi Alluvial Valley (MAV)*** *Stephen Faulkner, USGS, National Wetlands Research Center, Lafayette, LA*
1:30–1:45 p.m.	***Holistic Assessment of Ground-Water Quality in an Agricultural Landscape: The High Plains Aquifer*** *Jason Gurdak, USGS, National Water Quality Assessment Program, Denver, CO*
2:00–2:30 p.m.	BREAK (30 min.)
2:30–2:45 p.m.	***Basin-Scale Characterization of Agricultural Impacts*** *David Bosch, USDA, Agricultural Research Service, Tifton, GA*
2:45–3:00 p.m.	***Data and Models Used by NRCS to Assess the Effects of Conservation Practices for the CEAP Cropland National Assessment*** *Robert Kellogg, USDA, Natural Resources Conservation Service, Beltsville, MD*
3:00–3:15 p.m.	***CEAP Watershed Scale Modeling*** *Clarence Richardson, USDA, Agricultural Research Service, Temple, TX*
3:15–3:30 p.m.	*Data, Methods, and Tools* Question Session
3:30–4:00 p.m.	GENERAL QUESTIONS AND DISCUSSION
4:00 p.m.	ADJOURN

Thursday, 16 June 2005

8:00–8:30 a.m.	**Central Region Integrated Science Partnership Opportunity** *Randy Olsen, USGS, Central Region Science Coordinator, Denver, CO*
8:30–9:45 a.m.	***Partner and USGS Discussions to Address Technical Gaps, Common Needs, and Future Directions (15 minutes each topic)*** —Emerging Compounds —Water Availability —Genetically Modified Organisms —Effects of Conservation Practices on Ecosystems —Data, Methods, and Tools for Assessing Effects of Agricultural Practices
9:45–10:00 a.m.	BREAK (15 minutes)
10:00–11:00 a.m.	***Summary of Discussion and Identification of Next Steps, Priorities (5-minute summary of each topic discussed and then overall priority identification)*** *Moderator: George Ritz, USGS Workshop Planning Committee*
11:00–11:15 a.m.	THANKS TO PARTNERS: *Tom Casadevall*

USGS INTERNAL MEETING—FUTURE TECHNICAL DIRECTIONS, COMMUNICATION, PARTNERSHIPS, NEXT STEPS

11:15 a.m.–12:30 p.m.	LUNCH (1 hour and 15 minutes)
12:30–1:30 p.m.	***Concurrent Breakout Sessions*** (handout, directions to breakout rooms) Session Moderators lead discussion in breakout rooms —Emerging Compounds —Water Availability —Genetically Modified Organisms —Effects of Conservation Practices on Ecosystems —Data, Methods, and Tools for Assessing Effects of Agricultural Practices
1:30–1:45 p.m.	BREAK (15 minutes)

BREAKOUT SESSION—REPORTS ON RECOMMENDATIONS

Future Technical Directions, Communication, Partnerships, Next Steps
Moderator: Pam Haverland, USGS, Office of the Director, Central Region, Denver, CO

1:45–2:00 p.m.	***Emerging Compounds***
2:00–2:15 p.m.	***Water Availability***
2:15–2:30 p.m.	***Genetically Modified Organisms***
2:30–2:45 p.m.	***Effects of Conservation Practices on Ecosystems***
2:45–3:00 p.m.	***Data, Methods, and Tools for Assessing Effects of Agricultural Practices***
3:00–4:00 p.m.	**Identification of Next Steps, Priorities, and Proposals** *Moderator: Pam Haverland, USGS, Office of the Director, Central Region, Denver, CO*
4:00 p.m.	THANKS AND ADJOURN: *Tom Casadevall*

USGS personnel collecting a water sample at J.B. Converse Lake, Alabama. *Photograph by Ann K. McPherson (USGS).*

A USDA Agricultural Research Service experimental sugarcane field near Canal Point, Florida. *Photograph by Scott Bauer.*

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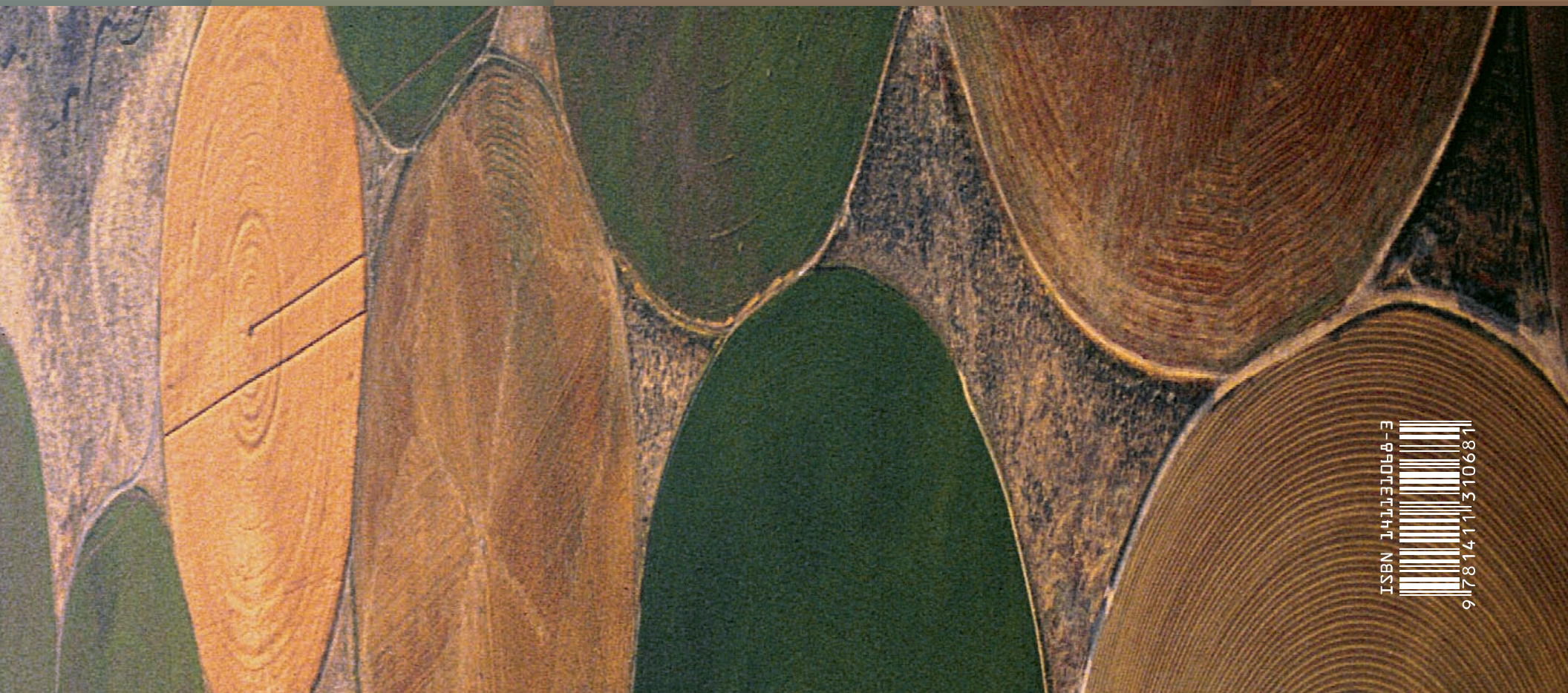

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