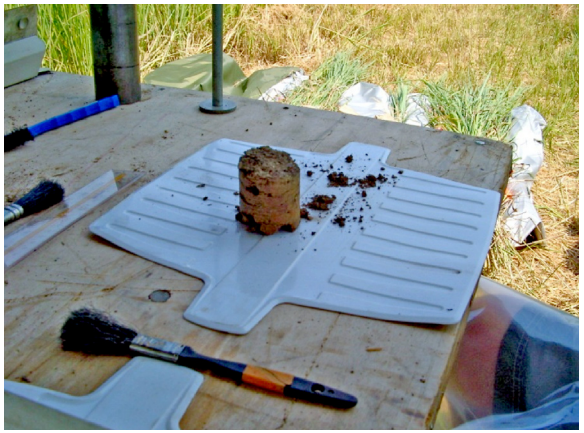
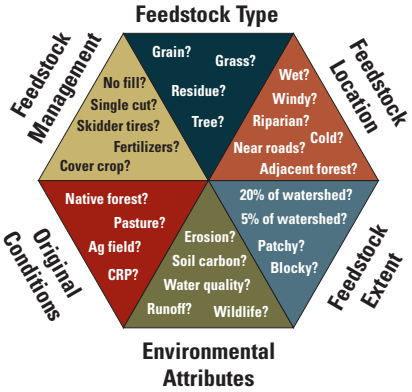
Testing Our Understanding of Key Forces and Implications Via Field Studies

The State of Tennessee Biofuels Initiative cellulosic ethanol facility in East Tennessee will be provided with switchgrass from land that is being converted from corn/soybean rotations. The University of Tennessee and ORNL scientists are collecting baseline soil samples to determine changes in total soil carbon, soil structure, and soil components, which can be compared to predicted changes.



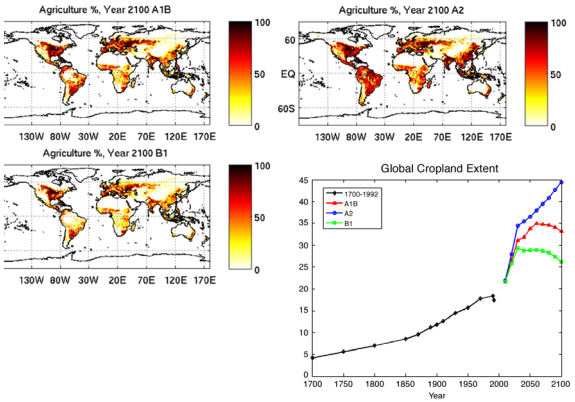
Carbon Sequestration

ORNL examines questions about the physical, biological, and chemical processes controlling soil carbon input, distribution, and longevity through integrated laboratory, greenhouse, and field research, and the development and use of models capable of extrapolating process-based understanding across space and time. This research will contribute to the development of sustainable technologies to enhance carbon sequestration and quantify their potential for mitigating climate change.



Agronomic Feedstock Production and Environmental Impact Analyses

ORNL uses high-resolution projections of feedstock production in analyses of soil carbon change, soil erosion, energy and net greenhouse gas emissions, and water quality/nutrient loading.



Bioenergy-Sustainability Research at Oak Ridge National Laboratory—

An unparalleled history of sustained, integrated environmental research on energy issues

Oak Ridge National Laboratory (ORNL) has a long and rich history of integrating environmental and social science expertise to address sustainability issues. In the 1950s, environmental scientists at ORNL began to address the movement of radionuclides through the environment, pioneering the fields of radioecology and environmental impact assessment. In addition, ORNL scientists laid the groundwork for establishing the major subdisciplines of systems ecology, global change analysis, ecological risk, hierarchy theory, landscape ecology, and, most recently, environmental genomics.

ORNL has drawn on this rich expertise and the expertise of university and other researchers to explore site-specific – to national – to global environmental issues associated with using biomass for bioenergy. In 1996, ORNL scientists published one of the first conceptual frameworks for addressing environmental sustainability in the context of producing energy crops. (Graham et al. 1996. Environmental Management 20:475-486). In 1998, scientists at the Laboratory led and contributed to a special issue of Biomass and Bioenergy on "Environmental Effects of Biomass Crop Production." More recently, ORNL was a leader in the 2005 "Billion-Ton Report" that explored the technological feasibility of sustainably producing 1 billion dry tons of biomass feedstock per year in the US for the bioenergy industry.

ORNL currently invests about $7 million per year in environmental research and outreach related to bioenergy supported by the U.S. Department of Energy (DOE) Energy Efficiency and Renewable Energy, Office of Biomass programs; DOE Office of Science, Biological and Environmental Research Division; the National Aeronautics and Space Administration; and internal laboratory efforts.

Oak Ridge National Laboratory

Biofuels and Land Use Change

ORNL ecologists, social scientists, and geographers document and explore the processes responsible for land-use change and the implications of those changes.

- Investigating the complex forces driving land-use change around the globe.
- Modeling and characterizing the baseline of land-use change to gain an understanding of how biofuel conversion in one area may influence changes elsewhere.
- Exploring a way to design landscapes that optimizes sustainability.

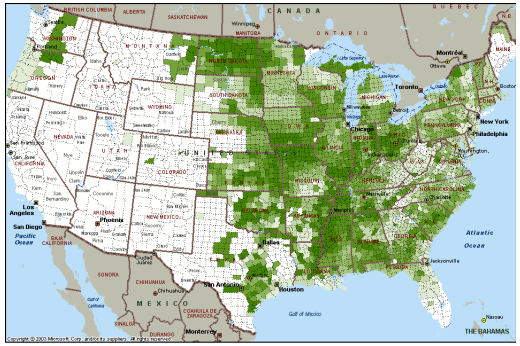
Applying science to the analysis of land-use change is essential to helping the nation successfully meet national renewable fuel targets.

ORNL's bioenergy-sustainability research seeks to

- support the creation of a sustainable bioenergy generation and delivery infrastructure,
- optimize environmental and socio-economic sustainability of biomass production,
- contribute to the development of sustainable technologies to enhance carbon sequestration, and
- quantify the potential of these technologies to mitigate climate change and to improve environmental conditions.

Advancing Geospatial Science and Technology to Analyze and Model the Bioenergy Supply Chain

As a world leader in geospatial science and technology, ORNL has strong research programs in geographic information science, geospatial information systems, and image analysis and remote sensing. The Laboratory unites hundreds of science professionals with the world's most powerful computational systems to create unrivaled analytical capacity to deal with computational, data, and geographic concerns underlying sustainability for bioenergy. With high-performance computing, global geospatial data assets, and advanced visualization, ORNL addresses bioenergy issues:

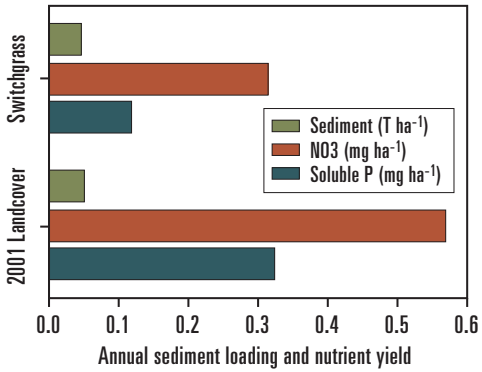


Potential availability of perennial energy crops

- Feasibility of sustainably producing biofuels
- Reliability of biofuel production and distribution
- Security of managing biocrops
- Agility of bioenergy infrastructure to adapt to changing demand and production
- Interdependencies of bioenergy with other energy infrastructures

Investigating the Environmental Impacts and Opportunities of Biofuel Feedstock Decisions to help policy makers understand the environmental and socioeconomic consequences of alternative bioenergy regimes and policies

- Characterizing ecological costs, effects, and opportunities of choices
- Quantifying changes in soils, nutrients, and sediment inputs to rivers associated with land management practices
- Developing scale-dependent metrics for land–nutrient–water Interactions
- Modeling future energy scenarios and their effects
- Estimating changes in agricultural land use as a result of external incentives
- Identifying regions where bioenergy feedstock conversion can occur



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