Argonne NATIONAL LABORATORY | Energy Systems Division

The systems approach to biomass feedstock production: where productivity meets sustainability.

Integrated field demonstration, analysis and modeling of an alternative biomass production scenario

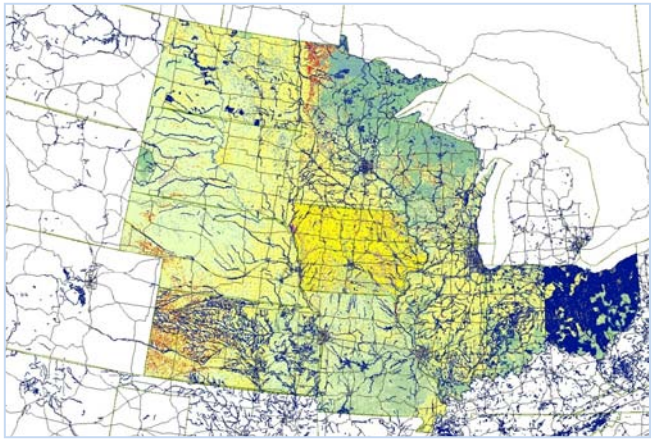
The problem

Meeting the EISA production goals will require finding economically viable and sustainable biomass production strategies to increase the penetration of crops for advanced biofuels in the agricultural sector. Land use change, greenhouse gas emissions, water use and water quality are the main sustainability indicators for biomass production, as discussed in the new Renewable Fuels Standard Program II, and in the draft standard issued by the Council for Sustainable Biomass Production. Novel approaches to fulfill biomass production requirements need by-design to integrate sustainability metrics into biomass production methods.

Nitrogen fertilizers are a large contributor to the cost of farming and to the GHG emissions of agriculture: agricultural soil management practices (such as fertilization) accounted for approximately 68% of N_2O emissions in the US in 2008. Nitrogen use efficiency by corn is still unacceptably low at 40-60%. Nitrogen losses, from fertilized cropland through riparian land into surface water and groundwater, are a source of N_2O emissions, as well as a major source of non-point water pollution, both of which impact sustainability.

Our approach

We propose a "systems approach" where the agricultural, energy and environmental sectors are considered as components of a single system and environmental liabilities are used as recoverable resources for biomass feedstock production.



GIS analysis has shown the overlap between degraded land and water and has highlighted opportunities to increase biomass production by recovering nutrients and water for the sustainable production of biomass

Our DOE-funded analysis to date has shown that there is a significant opportunity to greatly increase the land available for biomass production if underproductive acreage in edge of field, riparian and roadway buffers is used, even partially. Further, increases in biomass productivity in these lands, potentially doubling the harvestable biomass, are achievable through the reuse of impaired water and entrained nutrients from

upstream grain farming. Optimizing conservation goals with biomass and grain production will determine which of this land can be prioritized for each land use.

Eventually, we hypothesize that using this systems approach we could achieve feedstock intensification, decrease transportation costs, achieve a better nitrogen use efficiency at the farm scale, restore contaminated water and mitigate greenhouse gas emissions from both biomass and grain crops.

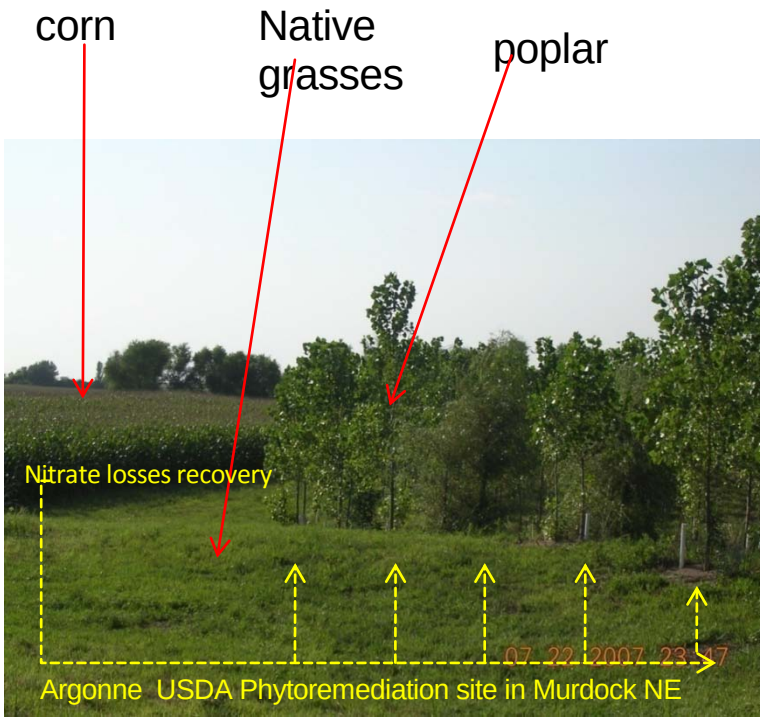
A new production scenario for biomass crops

The *in-situ* capture and reuse of nutrient-enriched water exfiltrating from cropland for the ferti-irrigation of lignocellulosic biomass crops in buffer strips has emerged from our analysis as a viable scenario to (1) boost biomass productivity and improve the use efficiency of nitrogen fertilizers at the farm scale; and (2) improve water quality and reduce GHG emissions (through control of the nitrogen cycle), thus further improving the sustainability of cellulosic biomass crops. Through field testing and model validation, Argonne is proposing and testing new productive landscape concepts that match productivity with sustainability at the watershed scale.

Selected Literature

Gopalakrishnan, G., M.C. Negri, M. Wang, M. Wu, S. Snyder, and L. LaFreniere (2009). Biofuels, land and water: a systems approach to sustainability. Environ. Sci, Technol. 2009, 43; 6094-6100.

Funding for this project comes from the US DOE EERE Office of the Biomass Program. The field study is kindly hosted by Argonne's EVS AGEM Section at the Murdock, NE USDA remediation site.



Argonne's EVS-AGEM 16-acre phytoremediation site at Murdock, NE is a conceptual model of a new approach to biomass production integrating resource recovery and marginal land use.

Specialized field techniques allow for the study of soil water.

CONTACT> M. Cristina Negri | 630 252-9662 | negri@anl.gov | Energy Systems Division | www.anl.gov