

Center for Advanced Bioenergy and Bioproducts Innovation: Sustainability Theme

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<https://cabbi.bio/>

Project Goals:

CABBI aims to provide improved technologies for advanced biofuels using high yielding perennials and producing value-added products from plant-produced feedstocks or substrates and an integrated economic and environmental framework for determining feedstock supply and its sustainability. Research conducted by the Sustainability Theme of the Center seeks to improve our mechanistic understanding of ecosystem processes related to carbon, nitrogen, and water cycling to enable predictions of ecosystem service production by different feedstocks grown across many geographic regions and under variable climate. It will combine ecological and economic modeling together with big data capabilities to determine the land available for feedstock production and examine the economic viability and resilience of biomass production from the farm scale to the economywide bioproducts, and biofuels under climate- and market-induced volatility under existing and future policy scenarios.

Abstract:

The University of Illinois and 17 partner institutions are establishing the Center for Advanced Bioenergy and Bioproducts Innovation (CABBI) for the development of transformative technologies for the economic and sustainable production of fuels and chemicals from plants. This major interdisciplinary research effort is designed to accelerate biofuel and bioproduct development while retaining the flexibility to assimilate new disruptive technologies whatever their source. CABBI is founded on the “plants as factories” paradigm, in which biofuels, bioproducts, and foundation molecules for conversion are synthesized directly in plant stems. CABBI will be built around three highly interconnected DOE priority research areas: Feedstock Development, Conversion, and Sustainability. These three themes each play an essential interconnected role into developing an overall solution to providing sustainable energy solutions for our future.

The Sustainability Theme provides an integrative framework for CABBI by assessing the environmental and economic outcomes from feedstock production and conversion to biofuels and bioproducts. The Sustainability Theme will include five major areas of investigation and implementation – Experimentation, Ecosystem Modeling, Big Data Analysis, Refinery-scale Techno-economic Analysis, and Integrated Economic Analysis. A multi-disciplinary team of investigators will improve mechanistic understanding of the links between traits of feedstocks and the ecosystem services they provide and analyze the characteristics of refinery-scale processes that determine the economic viability and environmental outcomes associated with different combinations of biofuels and bioproducts and quantify the ecological and economic implications of large scale energy crop production. It will provide insights on where, when, and how crops are planted and managed as well as the economics and energy inputs of different

conversion processes which will ultimately influence the impact of an emerging bioeconomy on the environment. The Sustainability Theme is grounded in state-of-the-art empirical measurements of how different crops and agronomic practices affect carbon, nitrogen, and water cycles, with a focus on soil microbe-plant interactions, and extends these data in space and time through process-based modeling. A unique feature of the Sustainability Theme is the ability to integrate ecological, biophysical, and economic models to holistically evaluate sustainability. The Sustainability Theme's research will prioritize minimizing competition with food production and using deep-rooted, low input bioenergy crops to improve marginal lands. Two globally-recognized process-based models, DayCent and AgroIBIS, that have been at the forefront of bioenergy crop modeling will be used to simulate the effects of climate and environmental change on carbon and nutrient cycling in terrestrial ecosystems, employing a similar approach to simulating below ground processes and contrasting approaches to simulating C assimilation. Economic and biophysical models will be integrated to develop a multi-scale, spatially explicit capability to determine the land available to optimize feedstock productivity across a mix of feedstock types, and its potential to lead to a range of improved environmental outcomes. CABBI research will examine the economic viability and resilience of biomass production from the farm scale to the economywide scale to meet local, regional and national demands for biopower, bioproducts, and biofuels under climate- and market-induced volatility under existing and future policy scenarios.