ISU’s Bioeconomy Initiative

Robert C. Brown
Department of Mechanical Engineering
Office of Biorenewables Programs
Iowa State University
Iowa’s Efforts to Build a Bioeconomy

- **2002**: ISU establishes Office of Biorenewables Programs
- **2003**: Iowa Vision & Roadmap for a Bioeconomy released
- **2004**: BIOWA Development Association founded, Iowa establishes Biosciences Alliance of Iowa (BAI)
- **2005**: ISU offers grad degrees in Biorenewable Resources and Technology
- **2006**: BAI provides funds to support Bioeconomy Initiative, Cargill, Farm Bureau announce major gifts to ISU Bioeconomy Initiative
Office of Biorenewables Programs (OBP)

**Centers and Institutes:**
- Ames Laboratory Biorenewable Resources Consortium
- Biosafety Institute for Genetically Modified Agricultural Products
- Center for Agricultural & Rural Development
- Center for Catalysis
- Center for Crops Utilization Research
- Center for Designer Crops
- Center for Industrial Research & Service
- Center for Sustainable Environmental Technologies
- Center for Plant Breeding
- Center for Plant Genomics
- Center for Plant Transformation
- Institute for Food Safety & Security
- Institute of Science & Society
- Leopold Center for Sustainable Agriculture
- NSF-IMI CoSMIC International Materials Institute

**Academic Departments:**
- Agricultural & Biosystems Engineering -
  Agricultural Economics -
  Agronomy -
  Biochemistry, Biophysics & Molecular Biology -
  Chemical & Biological Engineering -
  Chemistry -
  Civil, Construction, & Environmental Engineering
  Community & Regional Planning -
  Economics -
  Food Science & Human Nutrition -
  Genetics, Development & Cell Biology -
  Industrial & Manufacturing Systems Engineering
  Logistics Operations & Management Information Systems
  Materials Science & Engineering -
  Mechanical Engineering -
  Natural Resource Ecology & Management -
Research / Discovery

• Over 60 faculty and scientific staff involved in R&D activities
• Research activities currently organized around five technology platforms
• Incremental ISU funding helped leverage over $38 million in extramural funding over the last four years
Research Platforms at ISU

- Oleochemicals
- Carbohydrates
- Corn-to-Alcohols
- Biocomposites
- Thermochemical
- Cross-cutting
Platform Teams: Integrated Approaches to Research

Nutrient Recycling Between Production and Processing Systems

- Fibrous Biomass
  - Pretreatment
  - Conditioning
- Enzymatic Hydrolysis
- Sugar Fermentation
- Beer Slurry
- Ethanol
- De-water
- Gasification
- Ammonia Recovery
- Fischer-Tropsch Synthesis, Electric Power Generation
- K, P-Rich Ash

Systems Integration
- R. Anex

Agroecology
- M. Liebman

Fermentation
- A. Pometto

Biomass Pretreatment
- R. Raman

Nutrient Recovery
- R. C. Brown

Perennial Agriculture
- K. J. Moore
ISU Advances in Biorenewables

**PLANT SCIENCE**
- Genetically engineered plants that produce polymers
- Maize breeding for improved cellulose conversion
- Elucidation of carbon flux in soybean metabolism
- Modification of lignocellulose synthesis to simplify fractionation of biomass

**PRODUCTION**
- New crops and cropping systems for improved biomass yield
- Integrated wet storage and biological pre-treatment of stover
- Feedstock supply systems for large-scale bioenergy production
- Green mulching systems to reduce soil loss under cultivation of biomass crops
- Agronomic systems that sequester carbon from the atmosphere
- Recycling of nutrients between biorefineries and fields

**PROCESSING**
- Determination of substrate/cellulase structures
- Conversion of glycerol into 1,3 propanediol
- Catalysts that hydrolyze oligosaccharides to fermentable sugars
- Sonification to increase starch conversion rates
- Isoamylase conversion of starch to increase yield of fermentable sugars and ethanol
- Enzyme-assisted, water-based process to recover oil from soybeans
- Heterogeneous catalysts to convert soybeans to biodiesel
- Thermochemical alternatives to enzymatic hydrolysis

**UTILIZATION**
- Soybean oil with superior cold-tolerance and tribological characteristics for fuels
- Plastics from vegetable oils with shape-memory and noise-dampening properties
- Soy protein-based adhesives and plant-derived biocomposite materials
- Analysis of changing markets as a result of biofuels production
Learning: ISU Program

• Established the Biorenewable Resources and Technology graduate program
  – Ph.D. and M.S. degrees offered (plus Ph.D. minor)
  – 24 students currently enrolled
• Textbook published April 2003 by Blackwell Publishing
• Offering fundamentals course through Engineering Distance Education
• www.biorenew.iastate.edu (follow the Graduate Program link)
Engagement/Outreach

• Assisted in development of Iowa Vision and Roadmap
• Helped found the industry-led BIOWA Development Association
• Co-sponsor of an annual industry outlook conference
• Managing Federal Biobased Products Preferred Procurement Program
Program Development
DOE GTL Bioenergy Center

• Focus on basic research in plant science and microbial science
• Up to $125 million over 10 years for each of two center
• Proposal due in February
• Teamed with Venter Institute, UC San Diego, and Battelle Institute
Center for Biorenewable Chemicals
*NSF Engineering Research Center*

- Focus is application of engineering science to develop combined biocatalyst/chemical catalyst systems
- Up to $20 million from NSF to support center
Sloan Center for Biobased Products Industry

Goal: interdisciplinary research and education programs in support of biobased industries

- economic analysis
- marketing
- policy
- infrastructure
- workforce
Transforming Agriculture to be Feedstock Ready…

…by establishing a New Century Farm

Research: biomass cropping, biofuel processing, the logistics of biomass supply, and recycling nutrients back to the land

Teaching: Laboratory and extension resource for training future scientists, producers, and extension experts

Extension: Demonstrate the economic, social and environmental viability of bioenergy production to producers, publics, and policy makers

“The New Century Farm (NCF) would be the first integrated, sustainable biofuel feedstock production farm in the USA.”
ABE/OBP Complex

- Houses Agricultural and Biosystems Engineering Department
- Headquarters for the campus-wide Bioeconomy Initiative
- Contiguous office and laboratory space for biorenewables research, education, and outreach
- 166,000 ft² building
Join the Bioeconomy Initiative

By becoming an affiliate of the Office of Biorenewables Programs

http://www.biorenew.iastate.edu/who-we-are/join-obp.html