



BIOENERGY PROJECTS
In the
CROP CONVERSION SCIENCE & ENGINEERING RESEARCH UNIT
Eastern Regional Research Center, ARS, USDA
Wyndmoor, PA 19038

Primary Contact: Kevin Hicks, Research Leader, kevin.hicks@ars.usda.gov

Major Bioenergy Research Themes:

- Thermochemical Conversion of Biomass to Fuels and CoProducts
- Process Engineering Advances in Fuel Ethanol Production
- Economic Analysis of Biofuels Products and Processes
- Ethanol CoProducts
- Enzymatic Processes to Lower Cost and Increase Net Energy of Ethanol

Current Research Projects and Objectives:

1. Project 1935-41000-069-00D -- *Aqueous Enzymatic Extraction of Corn Oil and Value-Added CoProducts from Corn Germ Produced in New Generation Dry-Grind Ethanol Processes.* Robert A. Moreau, robert.moreau@ars.usda.gov, 215-233-6428

Objective: Develop new environmentally safe aqueous/enzymatic processes to extract the edible oil from corn germ (obtained from new-generation dry-grind corn-to-ethanol plants) and develop processes to fractionate the de-oiled germ into value-added protein and carbohydrate coproducts, to improve the overall economics of making fuel ethanol in new-generation plants.

Feedstocks: Corn, corn germ, corn ethanol byproducts

Accomplishments:

- Patented processes for developing nutraceutical oils and fiber coproducts from ethanol byproducts
- Developed processes for removing 80% of corn oil from corn germ with enzymes
- Developed processes to extract corn oil containing high levels of lutein and zeaxanthin, nutraceuticals critical for preventing macular degeneration

2. Project 1935-41000-070-00D -- *Enzyme-Based Technologies for Milling Grains and Producing Biobased Products and Fuels.* David B. Johnston, david.johnston@ars.usda.gov, 214-836-3756

Objective: The objective of this research project is to develop new, cost effective, alternative methods and engineering processes for corn processing and fractionation using enzymes, immobilized enzymes and other environmentally sustainable processes that maximize the yields of products and co-products (starch, protein, ethanol, oil, and fiber) and increase co-product market diversity and value while eliminating hazardous processing aids, such as sulfites.

Accomplishments:

- Patented and licensed new enzymatic corn wet milling process and demonstrated at commercial plant scale
- Patented new enzymatic dry grind fuel ethanol process
- Developed economic and process models for corn wet milling and distributed nationwide
- Developed new processes to make corn fiber gum emulsifiers

Feedstocks: Corn, corn milling and ethanol byproducts

3. Project 1935-41000-072-00D -- *Economic Competitiveness of Renewable Fuels Derived from Grains and Related Biomass Processes.* Kevin B. Hicks, kevin.hicks@ars.usda.gov, 215-233-6579

Objective: Lower the cost of fuel ethanol production from corn and barley through improved fractionation techniques, including a new 'ammoniation' process. Develop more efficient processes for converting hulled and hullless barley to fuel ethanol and improved, beta-glucan-free, feed coproducts. Assist in creation of a new hullless barley-to-ethanol industry in corn deficient regions, particularly the Mid Atlantic States and the North Western U.S. Develop improved processes to convert low valued crop-related biomass, byproducts and energy crops being researched in the ARS energy crop program into renewable hydrogen or liquid fuels and conduct economic feasibility studies for integrating this technology into co-located dry grind ethanol plants. Develop small-scale thermo-chemical technologies that economically, efficiently, and sustainably produce hydrogen and coproducts from agricultural materials.

Accomplishments:

- Developed economic and process models for fuel ethanol processes now being used by researchers and industry all around the world.
- In collaboration with Virginia Tech, developed new hullless energy barley cultivars
- In collaboration with ADM, developed new milling technology to upgrade feed value of corn stover and other high-fiber feedstocks
- In collaboration with Genencor, developed two new processes for producing ethanol from barley, the EDGE and Stargen™ processes.
- Developed dry fractionation processes to improve economics for the barley fuel ethanol process
- Developed process to isolate barley oil and discovered it contains highest levels of tocotrienol nutraceuticals than any natural oil
- Built first ARS thermochemical pyrolysis reactor and demonstrated production of pyrolytic oil and syn gas from switchgrass, alfalfa stems, blue grass straw, and energy crops
- Determined potential of switchgrass and other energy crops as feedstock for thermochemical (pyrolysis and gasification) conversion to fuels and chemicals

Feedstocks: Corn, barley, other small grains, crop residues, energy crops

Unique Capabilities: **Pilot Plants** for fermentation, grain milling, and thermochemical research; **Aspen Plus and SuperPro Designer simulation software** for process and economic analysis; state-of-the-art **microscopic analysis and proteomics facilities**; state of the art **milling, carbohydrate, lipid, and coproducts** research laboratories.