

2013

BioCentury Research Farm Update

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Recommended Citation

Suby, Andrew A., "BioCentury Research Farm Update" (2013). *Iowa State Research Farm Progress Reports*. 1887.
http://lib.dr.iastate.edu/farms_reports/1887

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Abstract

The BioCentury Research Farm (BCRF) again had a diversity of users in 2012. Iowa State University faculty and staff from the Departments of Agricultural and Biosystems Engineering (ABE); Agronomy; Biochemistry, Biophysics and Molecular Biology; Civil, Construction and Environmental Engineering (CCEE); and Food Science and Human Nutrition, as well as the Bioeconomy Institute (BEI), Center for Crops Utilization Research (CCUR), Center for Sustainable Environmental Technologies (CSET), College of Agriculture and Life Sciences (CALs), and Extension and Outreach conducted research, teaching, and/or outreach at the BCRF. Private industry users of the BCRF included AGCO, Avello Bioenergy, Deere & Company, Direvo Industrial Biotechnology, DuPont Cellulosic Ethanol, Frontline Bioenergy, Phillips 66, and Virant, Inc. By the end of 2012, the BCRF had over 86 full- and part-time users with projects in more than 90 percent of available space.

Keywords

RFRA12128

Disciplines

Agricultural Science | Agriculture

BioCentury Research Farm Update

RFR-A12128

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Introduction

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Research, Upgrades, and Equipment

A great deal of research project activity occurred at the BCRF in 2012. In the biomass storage and pretreatment building, biomass was processed and sent to companies, research facilities, and universities including DuPont Cellulosic Ethanol, JELD-WEN, Phillips 66, National Renewable Energy Laboratory, Pacific Northwest National Laboratory, Virent, and Washington State University. Wood products, low ash content corn stover, sugarcane bagasse, and switchgrass were ground using the stationary hammermill and pilot-scale hammermill. A fine particle biomass preparation lab was constructed in the

biomass storage and pretreatment building. The lab was used for fine grinding, sieving, size distribution, pelletizing, milling, and briquetting. A drying and grinding control room was also installed to provide workers a climate-controlled, dust-free environment to oversee the drying and grinding of biomass feedstocks. It features a computer interface that can operate the entire system of conveyor belts, surge hoppers, hammermills, and a dryer. Large windows and a camera monitoring setup allow workers to observe the system while it is running. The Iowa State Plant Sciences Institute provided the funding for the control room.

Also in the biomass storage and pretreatment building, work continues on the completion of a new biomass drying and grinding system. The system will use equipment donated by Vermeer Corporation and components purchased by CSET. The Iowa Economic Development Authority funded the purchase of the remaining equipment to finish the system.

A “super stack” of corn stover bales was built at the BCRF. The stack consisted of 700 large square bales, each weighing over 1,000 pounds. The purpose of this experiment was to test stack designs for industrial corn stover storage. In addition to the “super stack,” the baled stover was analyzed for long-term storage testing using hoop structures, under tarps, and without protection. This is part of a research project led by Matt Darr, assistant professor, ISU ABE, and was done in cooperation with DuPont Cellulosic Ethanol.

A pilot-scale rotary steam-tube drying system for drying distillers dry grains with solubles (DDGS) was installed at the BCRF. The rotary dryer is the first dryer of this size built in the United States and was custom built by

ICM, Inc., a manufacturer of ethanol plant equipment, based on their commercial-scale rotary dryer. The system can handle DDGS from the 500- and 1,000-liter fermenters. A research project by Hans van Leeuwen, professor, ISU CCEE, used the rotary dryer to produce MycoMeal, a dried fungal biomass product currently being used in pig nutrition trials conducted by ISU animal science faculty.

A distillation column and evaporator, purchased from Vendome Copper & Brass Works, Inc., were installed in the biomass processing facility's biochemical processing train. The distillation column and evaporator handle beer and thin stillage from the fermenters and distills and evaporates batches of those sizes independently. The distillation column is capable of vacuum distillation when product quality is sensitive to heat and atmospheric pressure distillation. The equipment can process beer from cellulosic crops as well as grain. The new equipment completes a system that can be used for ethanol research at the BCRF, which also includes 500- and 1,000-liter fermenters. The Iowa Economic Development Authority granted the funds to purchase the distillation column and evaporator.

A large project was started with international company Direvo Industrial Biotechnology GmbH from Cologne, Germany that used the distillation column, evaporator, and rotary steam-tube dryer system. Direvo collaborated with CCUR and BCRF to test a new enzyme technology that could improve the nutritional value of DDGS, offering a cost effective alternative to corn and soybean meal in the livestock feeding industry. DDGS was produced for initial animal feeding trials and later for scale-up trials to test the effects of the enzyme treatment during ethanol production. Also in the Biochemical Processing Train, DuPont used the 500-liter fermenter to

determine scale-up feasibility on a research project involving bacterial fermentation.

In the thermochemical train, a gas cleaning system was added. The cleaning system is downstream of the gasifier and removes contaminants. The CSET operates the cleaning system and gasifier.

A fuel trailer with a capacity of 990 gallons was purchased to store ethanol produced at the BCRF. This addition enhances the BCRF ethanol research capabilities. The CALS Ag Experiment Station provided the funding for the fuel trailer.

An algal production facility was completed at BCRF. The facility is a 720 square-ft greenhouse accommodating two raceway pond systems, four flat panel photobioreactors, and one custom-made revolving photobioreactor. It features a geothermal heating and cooling system, which enables the greenhouse to be used year-round while minimizing energy consumption. The total production capacity will be 50-100 kilograms of dry algae biomass per year. Researchers will use the various production systems to quickly grow algal biomass for various research purposes including the production of renewable fuels, food, or feed. Zhiyou Wen, associate professor, ISU Food Science and Human Nutrition, and BCRF affiliate, is the professor-in-charge of the greenhouse. The Grow Iowa Values Fund, Iowa NSF Experimental Program to Stimulate Competitive Research, College of Agriculture and Life Sciences, and Bioeconomy Institute provided funding for the algal production facility. Midwest Builders LLC of Logan, Iowa, and Mid America Drilling Corporation of Oakland, Iowa, donated a significant amount of labor and some supplies for this project.

Grants and Donations

From its inception in 2009 through 2012, BCRF has been well supported with private industry donations. To date, the following companies contributed monetary and/or in-kind support to Iowa State for use at BCRF:

- AGCO Corporation
- Centocor, Inc. (Johnson & Johnson)
- Country Landscapes, Inc.
- Crown Iron Works Company
- Deere & Company
- DemoDozer, Inc.
- DuPont Cellulosic Ethanol (DCE)
- Pioneer Hi-Bred International, Inc.
- Rockwell Automation, Inc.
- University of Northern Iowa National Ag-Based Lubricants Center
- Vermeer Corporation

Through these donations, BCRF has increased its capabilities in biomass harvesting, bulk storage, transport, preparation, fermentation, and production of bio-oil, syngas, and other products. These donations included construction of three large hoop sheds, grinding and sieving equipment, control systems and software, fermenters and bioreactors, other ancillary equipment, landscape enhancements, and unlimited use of several pieces of agricultural and industrial equipment.

Visitors and Tours

Information dissemination and promotion was accomplished through tours, conferences, and symposiums. Tours were provided for 103 groups with approximately 2,180 visitors in 2012. Since the dedication in 2009, the BCRF has hosted 387 tours with 5,533 visitors. Tours included visits by ISU President Steven Leath; Biomass Products & Technology Magazine; several companies including Cargill, Cellencor, Clariant, Phillips 66, Pioneer, Bepex International, Kiverdi, Petrobas; international visitors, and others. The Farm Progress Show brought 320 visitors to the BCRF in August.

Approximately 200 people attended the New Technology Expo held September 12 at the BCRF. Attendees included 45 state agriculture departments and members of a regional Gulf of Mexico Hypoxia Task Force. The expo activities included field equipment demonstrations, research posters and presentations, an educational trade show, and self-guided tours of the BCRF. The expo was hosted by the National Association of State Departments of Agriculture, the Mississippi River Gulf of Mexico Watershed Nutrient Task Force, the Soil and Water Conservation Society, and Iowa State University.

Through close cooperation with the Iowa State Research Farms, the Ames Convention and Visitors Bureau, the BEI, and the Iowa State Foundation, many public organizations, private companies, educational organizations, international organizations, and citizens of Iowa have visited the BCRF.