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# BioCentury Research Farm Update

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# BioCentury Research Farm Update

## **Abstract**

Since its dedication on September 22, 2009, the BioCentury Research Farm (BCRF) has promoted and supported advanced research in the areas of biomass production, harvest, transport, storage, preparation, processing, and analysis. In 2010, the BCRF's first full year of operation, many improvements were made and projects conducted. Projects focused on single pass and other advanced harvesting methods, biomass densification, logistics and effects of yearlong biomass storage, biomass preparation techniques, supplying material for external entity research, and pilot-scale production of value-added products. Several fermentations were completed in 2010. Multiple production runs of bio-oil and biochar also were successfully completed in 2010.

## **Keywords**

RFR A10124

## **Disciplines**

Agricultural Science | Agriculture

## BioCentury Research Farm Update

### RFR-A10124

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Since its dedication on September 22, 2009, the BioCentury Research Farm (BCRF) has promoted and supported advanced research in the areas of biomass production, harvest, transport, storage, preparation, processing, and analysis. In 2010, the BCRF's first full year of operation, many improvements were made and projects conducted. Projects focused on single pass and other advanced harvesting methods, biomass densification, logistics and effects of yearlong biomass storage, biomass preparation techniques, supplying material for external entity research, and pilot-scale production of value-added products. Several fermentations were completed in 2010. Multiple production runs of bio-oil and biochar also were successfully completed in 2010.

From its inception until the end of 2010, the BCRF has been well supported with private industry donations. The following companies contributed monetary and in-kind to Iowa State University for the BCRF:

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

Through these donations, the BCRF has increased its research and demonstration

capabilities in biomass harvesting, bulk storage, transport, preparation, demonstration, fermentation, and bio-oil production. Some of the donations included the construction of three large hoop barns, grinding equipment, control systems and software, fermenters and bioreactors, ancillary equipment, landscape enhancements, and unlimited use of several pieces of agricultural and industrial equipment.

In 2010, the BCRF completed the following upgrades and acquired the following new or used equipment:

- Concrete drives for freight delivery and unloading
- Completion of Slurrystore tank for wastewater storage until land application
- Installation of liquid nitrogen and liquid oxygen tanks
- Electrical service to the Biomass Preparation and Equipment Storage Buildings
- Biomass grinding lean-to addition
- Portable, modular offices
- Pyrolyzer and gasifier control room with storage mezzanine
- Multiple fermenters, bioreactors, mixing tanks, pumps, and ancillary equipment
- 20-gallon, high-pressure, glass-lined reactor
- Autoclave
- Pelletizer and tube filter
- Bale wrapper

The BCRF enjoyed a diversity of users in 2010. Iowa State University faculty and staff from agricultural and biosystems engineering, agricultural systems technology, agronomy, chemical engineering, forestry, food science, environmental engineering, horticulture, and mechanical engineering conducted research, teaching, and outreach at the BCRF. Private industry users such as Avello Bioenergy,

Frontline BioEnergy, and PowerStock, purchased services and/or rented space and equipment. ISU clubs, such as the Quarter-Scale Tractor Team and the College of Agriculture and Life Sciences (CALs) Student Council have used the facility for various projects, including staging for the 2010 Farm Progress Show and construction of the CALs Student Council VEISHEA float. A group of CALs students participated in assembling the all-terrain vehicle (ATV) prize for Successful Farming magazine's ATV Raffle. The ATV was upgraded at the BCRF and a Successful Farming reporter took photos of the ATV and developed an article for publication. By the end of December 2010, the BCRF had over 60 full- and part-time users and had projects associated with more than 90 percent of available space.

The BioCentury Research Farm saw a great deal of research project activity. The Harvest Storage and Transportation (HST) building supported multiple projects led by Drs. Matt Darr and Stuart Birrell of agricultural and biosystems engineering (ABE). Projects included densification and advanced harvesting techniques for the Sun Grant and other densification projects, single pass harvesting projects that baled stalks during the same pass as harvesting corn, and "clean stover" projects. The latter project brought ISU to the forefront of low-ash content stover collection, allowing ISU to be the sole source in the United States for such material on a large scale. Through association with the National Advanced Biofuels Consortium (NABC), this material has been prepared at the BCRF and distributed to several NABC members throughout the United States, including the National Renewable Energy and Pacific Northwest National Laboratories of the U.S. Department of Energy, member universities, and member companies.

Large-scale, longer-term storage tests were also conducted at the BCRF in two separate

projects. In a joint project with PowerStock and DDCE, 3,400 large square bales of stover were collected from across the Midwest and transported to the BCRF for storage and testing. Testing was also conducted on the biomass storage potential of bale wrapping.

Biomass preparation work was conducted in the Biomass Preparation Building in 2010. Many feedstocks were prepared to their desired size and moisture content as needed. Feedstocks prepared at the BCRF were:

- Corn stover
- Corncobs
- Eucalyptus wood chips
- Pine wood chips
- Red oak wood chips
- Switchgrass

Dr. Carl Bern, ABE, studied the effectiveness of drying trailers to remove moisture from biomass. Bern dried corn stover and corncobs, tracking energy use, drying rate, and uniformity of moisture reduction. In a second project, Bern also dried eucalyptus wood chips for Frontline BioEnergy, LLC, an Iowa start-up company.

Bench-scale testing in the area of torrefaction was completed by Darr with encouraging results. Construction of larger test equipment started in the latter half of 2010.

Construction of a pilot-scale fractionating pyrolysis unit by Dr. Robert Brown, distinguished professor of mechanical engineering, was completed in April 2010. From completion to the end of the year, 29 test runs of various durations were completed. Week-long, round-the-clock operational testing yielded excellent results on both reliability and bio-oil production. Feedstocks pyrolyzed during 2010 were red oak and corn stover. Resulting bio-oil and biochar outputs were analyzed and used in various projects, including a bioasphalt

mixture that was used to construct a bike trail at Waveland Park in Des Moines, IA.

Construction started on a new biomass fluidized-bed gasifier and gas clean-up system also led by Brown. This unit will be operational in early 2011.

Brown also led a project testing a new moving-bed granulated filter for use in high-temperature filtration. If successful, this technology could be used in conjunction with the pyrolyzer, gasifier, or other high-temperature filtration applications.

The majority of the fermentation equipment came on-line late in 2010. Four successful fermentations were performed in the newly installed 500-L fermenter. They included work for projects in the areas of fungal fermentation of corn thin stillage from ethanol production to produce feed products for swine and poultry, oleaginous yeast fermentation of biodiesel byproducts and cellulosic feedstocks, and encapsulation of omega-3 fat acids to improve milk quality. Installation of a new 1000-L fermenter commenced in the latter part of 2010 and will be brought on-line in early 2011.

A great deal of information dissemination and promotion was accomplished through tours, conferences, and symposiums. Since the dedication in September 2009 through the end of 2010, the BCRF hosted or supported more than 150 tours and conferences and more than 1,800 visitors. Through close cooperation with the Iowa State Research Farms, the Ames Visitor and Convention Bureau, the BioEconomy Institute, and the Iowa State Foundation, many public organizations, private companies, educational organizations, international organizations, and citizens of Iowa have visited the BCRF. Some of the notable events and visitors follow.

#### Conferences, Field Days, and Symposiums

- 2010 Farm Progress Show Tours
- 2010 U.S. Biochar Conference
- BioCycle Conference on Renewable Energy from Organics Recycling
- Biofuels: Science & Sustainability Tour
- TCS2010: Symposium on Thermal and Catalytic Sciences for Biofuels and Biobased Tour

#### Civic, Educational, Government, International, and Research Organizations

- Association of Private Farmers and Cooperatives of Russia delegation
- Biobased Industry Center
- Boone Kiwanis Club
- California Air Resources Board
- Central Iowa Farm Business Association
- Chinese delegation from agricultural institutes and universities
- Coe College
- Cornell College
- Dallas County 4-H
- French delegation
- German BioEnergy Delegation
- Iowa Corn Promotion Board I-LEAD
- Iowa Secretary of Agriculture Bill Northey
- Iowa state legislators
- Michigan State University
- National Academy of Science
- National Corn-to-Ethanol Research Center
- National Renewable Energy Laboratory
- Nong Lam University
- Pacific Northwest National Laboratory
- Professors from England
- Professors from Finland
- Rotarians from Sweden
- Senator Chuck Grassley
- Senator Tom Harkin's staff members
- Southeast Central Iowa AARP
- U.S. Congressional staff members
- U.S. Department of Agriculture
- U.S. Department of Energy
- U.S. Environmental Protection Agency
- U.S. EPA Director Margo Oge
- Ukrainian agricultural leaders

- University of Georgia
- University of Illinois
- University of Kentucky
- University of West Virginia
- University of Wisconsin
- Winterset High School students

Private Industry

- AGCO Corporation
- Alliant Energy
- Archer Daniels Midland Company
- Arvens Technology, Inc.
- BP p.l.c.
- Cargill, Inc.
- Conoco Phillips Company
- Crown Iron Works Company
- Deere and Company
- DuPont Danisco Cellulosic Ethanol
- E. I. DuPont de Nemours and Company
- Evolva Holding SA
- Genencor
- Insta-Pro International
- Metso Corporation
- Midland Power Cooperative
- Modular Genetics, Inc.
- Pioneer Hi-Bred International, Inc.
- POET, LLC
- PowerStock, LLC
- QTI, Inc.
- Royal DSM N.V.
- SunOpta Inc.
- Syngenta AG
- Tenaska Energy
- Toyota Motor Corporation
- Vermeer Corporation
- Virent Energy Systems, Inc.
- Wyffels Hybrids, Inc.

The BCRF has been featured in many publications. Articles have appeared in the Ames Tribune, Biofuels Digest, Successful Farming, and Wallaces Farmer. Biofuels Digest named Iowa State University its Institutional Research Facility of the Year for 2010. The publication cited the BioCentury Research Farm for its integrated research approach.