

BioCentury Research Farm Update

RFR-A17122

Andrew Suby, manager

Introduction

The BCRF had a diversity of users in 2017. Iowa State University (ISU) faculty and staff from the Departments of Agricultural and Biosystems Engineering (ABE); Agronomy; Biochemistry; Chemical and Biological Engineering (CBE); Civil, Construction, and Environmental Engineering (CCEE); Mechanical Engineering (ME); and Food Science and Human Nutrition (FSHN), as well as the Bioeconomy Institute (BEI), Center for Crops Utilization Research (CCUR), College of Agriculture and Life Sciences (CALs), and Extension and Outreach conducted research, teaching, and/or outreach at the BCRF. Private industry users included ARGO, Chevron, Deere and Company, DuPont Cellulosic Ethanol, Phillips 66, and many others. By the end of 2017, the BCRF had more than 85 full- and part-time users with projects in all available space.

Research, Education, and Equipment

A great deal of project activity occurred in the following areas:

- Algae research and production methods
- Biochemical research
- Biomass feedstock logistics research
- Biomass preparation
- Biopolymer research
- Thermochemical research that included biomass gasification, pyrolysis, and solvent liquefaction processes
- Educational support
- Infrastructure and Equipment
- Grants, appropriations, donations, and awards

Algae. Various production systems, including flat panel bioreactors, a raceway pond system, a novel revolving algal biofilm (RAB) system, and various lab-scale reactors located in the BCRF Algae Facility are being used to grow algae. The major focus for these algal growth systems is removal of nutrients (nitrogen and phosphorus) and toxic metals from municipal and industrial wastewaters. In 2017, Gross-Wen Technologies (GWT) received three Small Business Innovation Research (SBIR) grants for a combined total of \$800,000 and won the 2017 Pappajohn Iowa Entrepreneurial Venture Competition.

Biomass feedstock logistics. Multiple projects continued in this area with the most notable ones related to the DuPont Cellulosic Ethanol (DCE) and POET-DSM Advanced Biofuels research led by Matt Darr and Stuart Birrell, ABE.

For the DCE project, work continued in the area of corn stover bale collection and quality assessment, and bale processing at the inlet of the plant. The BCRF received numerous bales for observation, stack testing, ash and moisture content sampling, and other attribute testing. Other feedstock storage studies began to determine best storage practices for warm season grasses.

Biomass preparation. The BCRF prepared biomass feedstocks for several internal and external clients (e.g., universities, national laboratories). The farm's biomass preparation lab was used to fine grind, screen, and size the feedstocks. Various hammermills were used to provide biomass material from 200 microns up to 3,175 microns. Particle size distributions were performed and moisture contents and bulk densities were determined. From inception to the end of 2017, over 100 tons of material had been processed at the BCRF.

Biopolymer research. The Bio-Polymer Processing Facility was completed and dedicated in 2015. The project was led by Eric Cochran, CBE, and Chris Williams, CCEE, in collaboration with Argo Genesis Chemical, LLC, an affiliated company of Seneca Petroleum, in Crestwood, Illinois.

In the first quarter of 2017, the first production run of biopolymers was completed. Work is continuing both at the facility and on campus to make a more complex biopolymer.

Thermochemical. Robert Brown's, ME, fast pyrolysis unit located at the BCRF was used for bio-oil production from red oak and corn stover for internal and external projects. This work explored possible uses for individual fractions, including a path to fermentable sugars and generation of pilot-plant data for system scale up. Further progress was made in increased throughput using autothermal pyrolytic processes, sustainable corn stover processing, and alternative collection stage design.

Work related to pyrolysis-based modular energy production systems began in 2017 as part of the Rapid Advancement in Process Intensification Development Institute (RAPID) Distributed Biorefinery program. Work in this area will continue in 2018.

The solvent liquefaction pilot plant (collaborative project between BEI and Chevron) became fully operational in late 2015. Work continued on a battery of tests through summer 2017. Lysle Whitmer, BEI, gave an overview of BEI's pilot-scale testing of Chevron's solvent liquefaction process (located at the BCRF) at the 2017 Department of Energy Project Peer Review sessions. More testing is planned for the first quarter of 2018.

Educational support. The BCRF hosted many ISU class tours. In 2017, over 190 students

from the departments of ABE, Agronomy, FSHN, and Biology visited. The BCRF also supported several capstone projects including an analysis of the BCRF greenhouse HVAC system (ME 415) and a wastewater monitoring system (ABE 415).

Infrastructure and equipment. The DuPont soil separator was delivered to the BCRF in 2016. The system was reassembled and cleaned up in 2017. Electrical connections, control panel, and commissioning will occur in 2018.

Major repairs to the main airhandler unit in the Processing Building were completed in 2017, and included removal of a damaged heat recovery heat exchanger and rerouting of the supply and exhaust air flows. The new configuration allows a much more distributed airflow across the geothermal heat pump heat exchanger. A dock was added near the truck scale to allow larger agricultural equipment to be loaded on site.

Grants, appropriations, donations, and awards. In September 2017, CCUR and the BCRF were recognized with the Iowa State University Award for Achievement in Economic Development in Iowa.

Outreach, Visitors, and Tours

Information dissemination and promotion was accomplished through tours, conferences, and symposia. Tours were provided for 73 groups with approximately 1,642 visitors in 2017. Since the dedication in 2009, BCRF has hosted 860 tours with 14,715 visitors.

The 2017 tours included visits by the Association for the Advancement of Industrial Crops; Association of Education and Research Greenhouse Curators; British Consulate-General; Cedar Valley Alliance; Cultivation Corridor; Hebei Province (China); Idaho National Lab; International Farmers Aid Association; Iowa Corn Growers Association;

Iowa Economic Development Authority; Iowa Innovation Corporation; ISUEO County Services unit; LAMPS Advisory Board; National Institute of Agriculture Technology; Jilin Academy of Agricultural Sciences; Oak Ridge National Lab; Republic of Kazakhstan; Queensland Australia State Department and Trade Office; Synthesis Venture Fund Partners; U.S. congressional aides and federal agency staff; Mark Brodziski (Deputy Administrator of the USDA, Energy Programs); and Charles Cleland (leader of the USDA NIFA SBIR program).

Several companies and other organizations also visited including the following:

- BioForge Laboratory
- BioPro Power
- Deere and Company
- DuPont
- Easy Energy Systems
- Flint Hills
- Grain Processing Corporation
- Griffith Foods
- Monsanto
- Origin Technologies
- People's Bank Agriculture
- PHYCO2
- Renewable Energy Group
- Roeslein
- Synthesis Venture Fund Partners
- Valent BioSciences
- Vermeer Corporation
- Zions Ag Finance

The BCRF also gave numerous tours to students and teachers from K-12 schools as well as the following groups and workshops:

- Ames High School students
- ASABE Midwest Regional Rally
- CBiRC Summer Academy
- FFA students
- Waukeee APEX students

Tours were given for students, researchers, instructors, and professors from Abraham Baldwin Agricultural College, Dordt College, Furman University, Iowa Central, Penn State University, Southern University of Illinois at Edwardsville, University of South Dakota, and foreign universities in Malaysia, Nigeria, and the United Kingdom.

In August, the BCRF participated in the Iowa Renewable Fuels Biofuels: Science and Sustainability Tour group of approximately 48 congressional aides and federal agency staffers.

The BCRF was an exhibitor at the 2017 Iowa Renewable Fuels Summit and Trade Show on January 31 in Altoona, Iowa. Many attendees visited the exhibit and were able to see samples of materials produced at the BCRF including algae, ground feedstocks, bio-oil, biochar, and torrefied corn stover pellets.