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The Origin of the USDA Regional Biomass Research Centers

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Abstract The U.S. Department of Agriculture (USDA) Regional Biomass Research Centers (RBRC) were created to contribute to the planning, research, and development of entire long-term sustainable biofuel production supply chains based on agricultural and forest-based feedstocks. The intent of the centers is to provide a catalyst that links feedstock genetic development, sustainable production and management, logistics, conversion, co-product production, distribution, and market demand suited to the available economic, social, and natural resources within different regions. The centers provide a coordinated, region-based research focus designed with relatively short-term deliverables to help accelerate the commercial production of biomass and other biofuel feedstocks. The centers provide a leadership structure for coordinating biomass research across the country, providing a national perspective that complements other USDA agency efforts designed to help US rural communities participate in the emerging biofuels and biobased products economy. Through coordination with the RBRC, USDA research and service agency programs and resources have been leveraged with the U.S. Department of Energy (DOE) and other federal department, university, and private industry efforts to help accelerate commercial advancement of advanced biofuel production to promote rural economic opportunities and achieve transportation biofuel policy goals.

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Abbreviations

USDA	U.S. Department of Agriculture
DOE	U.S. Department of Energy
EPA	Environmental Protection Agency
ARS	Agricultural Research Service
FS R&D	Forest Service Research and Development
DoD	Department of Defense
RBRC	Regional Biomass Research Centers

Background on the Regional Biomass Research Centers

The Energy Independence and Security Act[1] established a goal of 36 billion gallons of biofuels by 2022 to power our cars, trucks, jets, ships, and tractors. Towards achieving this end, the corn grain ethanol industry showed remarkable growth, seeing an increase from less than 1 billion gallons produced in 1992, to more than 14 billion in 2014.[2] In 2009, the USA produced almost 11 billion gallons of ethanol and was on target for achieving the Congressional mandate of 15 billion gallons blended into the transportation fuel stream by 2022. However, the country was not on track to achieve the

[1] Library of Congress, Bill Text, 110th Congress (2007–2008) H.R.6. ENR, The Energy Independence and Security Act of 2007. https://www.gpo.gov/fdsys/pkg/PLAW110publ140/html/PLAW-110publ140.htm verified: January 28, 2016.

[2] Renewable Fuels Association, Annual US fuel ethanol production, http://www.ethanolrfa.org/resources/industry/statistics/ verified: January 19, 2016.

additional 21 billion gallons of advanced biofuels that needed to be produced from cellulose, lipid seed crops, and other biomass sources than grain starch. Investments had been made in publicly funded research and development projects before 2009, but little progress had been achieved towards meeting the legislated targets for advanced biofuels. In response, President Obama appointed Agriculture Secretary Tom Vilsack to lead an Interagency Working Group that included the Energy Secretary Stephen Chu and U.S. Environmental Protection Agency (EPA) Administrator Lisa Jackson, with the charge to develop a plan to get the country on schedule for meeting the advanced biofuels mandates.[3]

During the summer of 2009, the Chief of Staff of the U.S. Department of Agriculture (USDA) Research, Education, and Economic mission area convened a committee of USDA agency technical experts to explore scenarios for achieving the mandates. In September 2009, work was begun to develop a research plan to help accelerate development of advanced, third-generation, or drop-in biofuels—biofuels that are similar to petroleum-based fuels and therefore compatible with existing infrastructure and engines. A briefing paper was drafted that outlined a whole-government approach to support the existing corn starch-based biofuels industry, but also focus research efforts to help create and rapidly deploy new technologies to establish an advanced biofuels industry.

The plan prescribed a government-wide effort that used a business-oriented approach focused on complete supply chains. Each government agency had responsibility for those component parts of the supply chain covered by their expertise and policies. Attention was also focused on coordinating agency efforts among the various government programs and investments with expectations that their products would help advance commercial biofuel production. The plan identified that not only support for research was needed, but also demonstration and commercialization projects, as well as education and workforce development efforts to help ensure an emerging industry would be sustainable. The plan also recognized that dependable supplies of feedstocks would need to be made available in ways that minimized transaction costs across entire supply chains, and so help bring down the cost points of the biofuels. It was also the vision of the plan that advanced biofuels could be used as a vehicle to create new wealth for farmers, forest landowners, and rural communities.

Once developed, the research initiative titled *Growing America's Fuel* was championed by the Agriculture Secretary and the White House announced the initiative February 3, 2010 as the Biofuel Interagency Working Group's first report.[4]

Based on the adoption of *Growing America's Fuel*, the roles and responsibilities across USDA, DOE, EPA, and other federal agencies for achieving national biofuel targets were clearly defined. Within USDA, science and technology research and other development resources were strategically identified and directed to help accelerate short-term progress towards the production of commercially available biomass feedstocks. Specific research leadership responsibility for the USDA included the development of improved varieties of dedicated biomass crops and purpose-grown wood species, and sustainable biomass production/management and harvest within existing agricultural and forest systems.

The initiative was also used as the basis for establishing new kinds of partnerships with other non-research USDA agencies such as Rural Development, the Natural Resources Conservation Service, and the Farm Service Agency, as well as with non-agricultural agencies and industries including the Department of Navy (Navy), Federal Aviation Administration (FAA), and the commercial aviation transportation industry represented by Airlines for America and the Commercial Aviation Alternative Fuels Initiative (CAAFI). Multiple official agreements have been established between departments to coordinate efforts including memorandums of understanding for USDA with Navy and FAA. Resulting efforts include the USDA's *Farm to Fly* Initiative with Airlines for America and Boeing Corporation, and the Navy-DOE-USDA Title III Defense Production Act *Advanced Drop-In Biofuels Production Project* to help cost-share the building of commercial aviation biofuel refineries.

Specifically towards the need for dependable feedstock supplies of agricultural and forest-based biomass, *Growing America's Fuel* specified that the USDA create five Regional Biomass Research Centers (RBRC). The regional focus of the centers recognized the diverse nature of the growing environments, different kinds of adapted feedstocks that could be produced across the country, and the opportunity for involvement of many rural areas that could benefit economically from an emerging biobased fuel economy. With the myriad of possible feedstocks that could be developed, USDA focused on five classes of feedstocks and sustainable systems for their production: perennial grasses such as switchgrass, *Miscanthus*, and mixed native grasses; energy cane, a biomass form of sugarcane; biomass sorghum; oil seed crops, including canola and camelina; and woody biomass from fast-growing trees and wood residues. The Agriculture Secretary announced the centers as a part of a major renewable energy

[3] President's May 5, 2009 memorandum forming the Bioenergy Interagency Working Groups with high-level USDA, DOE, and EPA participation. https://www.whitehouse.gov/the-press-office/president-obama-announces-steps-support-sustainable-energy-options verified: January 28, 2016.

[4] To read the full report, go to the White House link at: https://www.whitehouse.gov/sites/default/files/rss_viewer/growing_americas_fuels.PDF verified: January 27, 2016.

policy speech at the National Press Club on October 21, 2010.[5]

The USDA National Institute of Food and Agriculture (NIFA) also translated the key features of the initiative in its development of the Agriculture and Food Research Initiative *Bioenergy Consolidated Agricultural Projects* program, as well as the joint USDA-DOE *9008 Biomass Research and Development Initiative* grant program. The resulting NIFA awards were the largest research grants ever funded by the USDA.

It was understood that the RBRC would depend upon the collective contributions of USDA research and action agency programs and require robust partnerships with other federal and state agencies, land grant and other universities, industries and investors, non-government organizations and foundations, Tribes, and international entities. Because of the coordinated approach towards developing sustainable advanced biofuel supply chains, a community of practice developed among staff members of the principal departments and agencies where expertise was shared and results were used to achieve goals with reduced conflicts. Examples included the interpretation of what constitutes a non-food crop for aviation fuel production and its use by the commercial air transportation industry and Department of Defense (DoD) service branches; the development of life cycle analyses based on the most suitable data for considering feedstocks for conversion technology pathways under the Energy Independence and Security Act; identifying the risks of utilizing potentially invasive species as biofuel feedstocks; and contribute to the creation of a national strategic plan for aviation biofuel production. These kinds of efforts were accomplished through work among agency program staff in Washington, DC with RBRC regional coordinators and researchers across the national network.

Key Features of the Regional Biomass Research Centers

The USDA research agencies had not before attempted a national multiple-location, interdisciplinary research effort of this scale. Within the USDA, it was necessary to develop a leadership plan for the five RBRC. A hub-and-spoke network was designed to coordinate Forest Service Research and Development (FS R&D) and Agricultural Research Service (ARS) biomass/biofuel research activities, with the centers organized into five regional research networks (Fig. 1). The centers are coordinated networks of existing scientists and facilities linked by the newly formed relationships, not new buildings or restricted to single locations. Their intent was to provide the critical mass needed to develop high-performance interdisciplinary and multi-institutional teams to help guide and execute biomass research across the government and be competitive in pursuing extramural support from grant programs and funded partnerships.

The ARS and FS R&D share leadership responsibilities for the Southeastern (with hubs at Tifton, GA, Auburn, AL, and Temple, TX) and Northwestern (Pendleton and Corvallis, OR hubs) Centers; ARS solely leads the Western Regional Center (Maricopa, AZ) and Central-East (Lincoln, NE) Centers; and FS solely leads the Northern-East Regional Center (Madison, WI). Geopolitical state boundaries were assigned to each region, independent of the two agencies' management areas. While ecogeographic regions may have been a better representation of the service areas for the centers, crop and forest ecoregions do not necessarily coincide. There have been more than 100 researchers involved nationwide. The initial base ARS annual contribution to the centers in personnel and operations was $60 million, with FS R&D contributing another $13 million. All funding came from existing agency resources.

The regional biomass research centers are managed with the purpose of accelerating the commercial deployment of feedstock production and management systems across different growing environments. Because of the diverse nature of biomass feedstocks that can be grown across different regional environments, a multifunctional landscape approach was used. Emphasis was placed on dedicated energy crops and purpose-grown wood, as well as incorporating biomass production and harvest into existing agricultural and forest management systems. The integrated production, management, and logistics systems are being designed with advanced biofuels refinery requirements and the production of value-added co-products in mind.

Another key feature of the RBRC is the need to address upfront the economic, environmental, and social uncertainties that a new production sector would bring to existing land uses and markets, and incorporate these concepts to help design sustainable supply chains suited to different regions across the country. Multiple objective assessments of technology and system impacts are are made, and optimal implementation options identified. Science-based research results will be used to inform customers, stakeholders, and policymakers; help build public understanding; and contribute to understanding and reducing risks for the creation of new markets, investments, and credit—now and in the future. Forest management and agricultural production research are done in appropriate cooperation with biophysical and economic modeling teams, and coordinated with national analysis efforts conducted by the USDA Economic Research Service, FS R&D, ARS,

[5] To see the USDA press release, go to the link at: http://www.usda.gov/wps/portal/usda/usdamediafb?contentid=2010/10/0545.xml&printable=true&contentidonly=true verified: January 27, 2016.

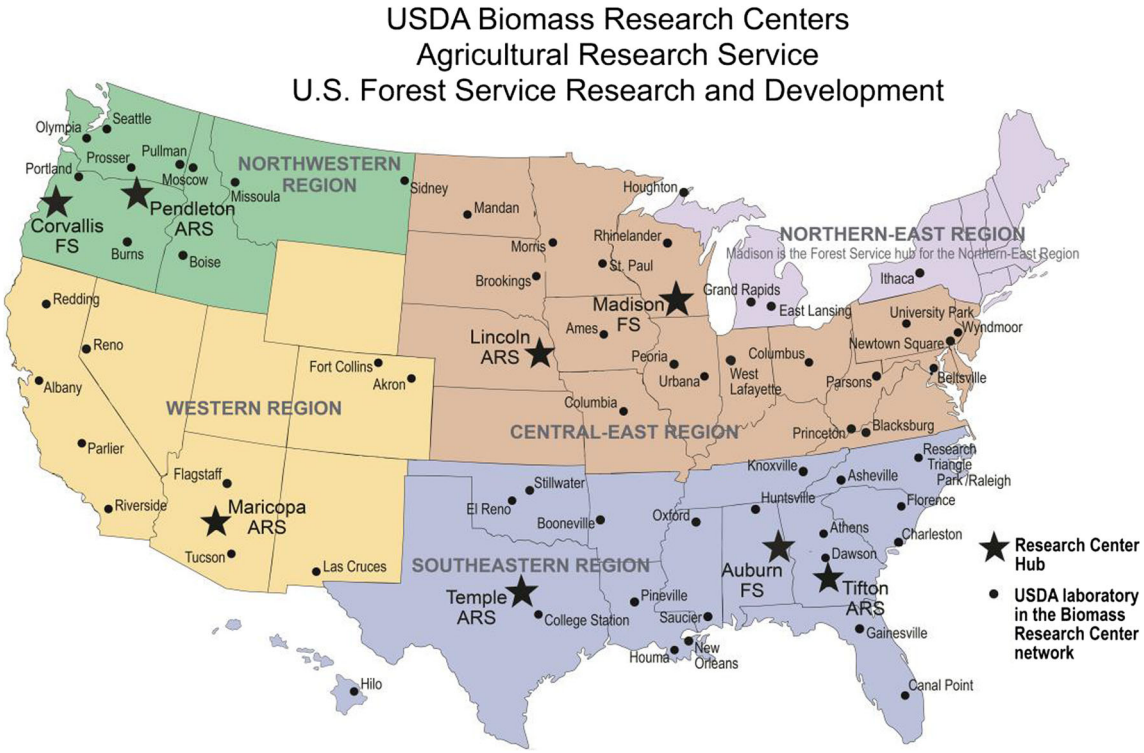

Fig. 1 Map showing the five regional networks of ARS and FS R&D locations contributing to the USDA Biomass Research Centers

National Agricultural Statistics Service, Natural Resources Conservation Service, the Office of Energy Policy and New Uses, and other federal agencies.

By focusing on specific regional feedstocks, a framework is provided to allow for superior genetic varieties to be developed that can meet emerging and future biomass needs. The development of feedstock varieties and the systems to produce them will be done with consideration for production and management efficiency, sustainable resource management and utilization, greenhouse gas emissions reductions, species invasiveness and biological diversity, gene escape, conversion efficiency, and value-added co-product development and manufacture. Close coordination with USDA researchers and collaboration with other agencies should help plan for and advance the long-term needs for highly efficient and productive biomass crops in the future. Commercialization and collaboration with university and private companies have been encouraged.

Researchers through the centers utilize USDA natural resources databases, data frameworks, and data management systems, and collaborate with FS R&D and ARS long-term watershed, carbon flux and greenhouse gas, and agricultural and forest systems research networks. Documented methods and spatial displays help provide adequate context for measured data. Collaborations with the National Agricultural Library, DOE sponsored national laboratories and other federal, state, and local agencies, universities, and private companies are encouraged and ongoing.

Research Accomplishments During the First 5 years

The diverse ecogeographic and social landscapes of North America are reflected in the examples of research from the USDA RBRC presented in this issue of BioEnergy Research. Utilization of wood, the most available and long-standing source of biomass, is presented by Anderson and Mitchell who outline the forest operations and biomass logistic considerations and advances in harvest and processing technology, transportation systems, scheduling and planning, feedstock quality, biomass conversion processes, and environmental impacts, including greenhouse gas emissions. Rudie et al. summarize recent Forest Service biomass utilization research including direct combustion, fuel pellets, and conversion of forest biomass to ethanol, both as stand-alone biorefinery processes, and as an addition to the traditional wood pulping processes.

Mitchell et al. address the advancements of herbaceous feedstocks for the eastern half of the USA including switchgrass and the utilization of corn stover from existing commodity production. Oil seed crop development and challenges to incorporation into the arid western US wheat belt systems are presented by Long et al. The opportunities and physical energy balance limitations for utilizing animal manures is presented by Ro, as well as ways to blend manure with consumer wastes to provide more economic solutions. A review of RBRC and other research into the utilization of biochar as a larger strategy to capture and sequester carbon in combination with

enhancing growth performance of bioenergy and other crops is given by Novak et al.

Fundamental discovery of genes in dedicated herbaceous biomass crops that facilitate the production of advanced biofuels and other biobased products is given by Anderson and his colleagues. Such close coupling of plant sciences with the development of physical biomass collection and conversion technology strategies is given by Orts and McMahan that account for crop yield and crop quality.

The recognition for the need to ensure the development of advanced biofuel production systems is done in a context of sustainable development. Zalesny et al. address environmental technologies of woody crop production systems and how RBRC collective efforts are being used to develop systems and tools that can help to mitigate ecological degradation and thereby sustain healthy ecosystems across the rural to urban continuum. Scott and Page-Dumroese report on ways many biomass energy operations provide opportunities to ameliorate or amend forest soils to sustain or improve their productive capacity. Zalesny et al. also report the efforts being done to document the ecosystem services that are provided by short-term woody biomass as a renewable biomass source, not only for carbon, but also as a way to protect soil resources and wildlife habitat.

Conclusion

To help make feedstocks more readily available to support an emerging advanced biofuels and bioproducts industry, the USDA envisioned the creation of the Regional Biomass Research Centers. The five regional centers are a network of ARS and FS R&D facilities and scientists working in a coordinated and collaborative way with other agencies and partners to help accelerate the development and dependable availability of regionally adapted biomass crops and special grown woody biomass. The costs of feedstock inputs will continue to greatly affect the price points of advanced biofuels, so efficient supply chains will only be developed by integrating across all supply chain components. The establishment of sustainable advanced biofuel supply chains will require that component participants are productive, profitable, and make their contributions in ways that provide for good stewardship of natural and human resources. From developing new biomass sources such as purpose-grown woody species and switchgrass, to the sustainable utilization of available biomass resources such as corn stover and woody residues, to incorporation of lipid producing oil seed crops into existing food production systems to enhance overall system performance, to the development of new conversion technologies that produce fuels and other value-added products, these actions are seen as necessary to not only achieve goals for producing renewable materials, but also as a means to bring economic development to rural areas across America.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no competing interests.