Agricultural Residues and Biomass Energy Crops

There are many opportunities to leverage agricultural resources on existing lands without interfering with production of food, feed, fiber, or forest products. In the recently developed advanced biomass feedstock commercialization vision, estimates of potentially available biomass supply from agriculture are built upon the U.S. Department of Agriculture's (USDA's) *Long-Term Forecast*, ensuring that existing product demands are met before biomass crops are planted.

Dedicated biomass energy crops and agricultural crop residues are abundant, diverse, and widely distributed across the United States. These potential biomass supplies can play an important role in a national biofuels commercialization strategy.

Summary

The *2016 Billion-Ton Report*: *Advancing Domestic Resources for a Thriving Bioeconomy* summarizes the most recent estimates of potential biomass supply that could be available for biorefining in the future. Along with assessing biomass resources from forests, municipal solid wastes, urban wood waste, and algae, the report includes an evaluation of biomass supply potentially available through production on agricultural land.

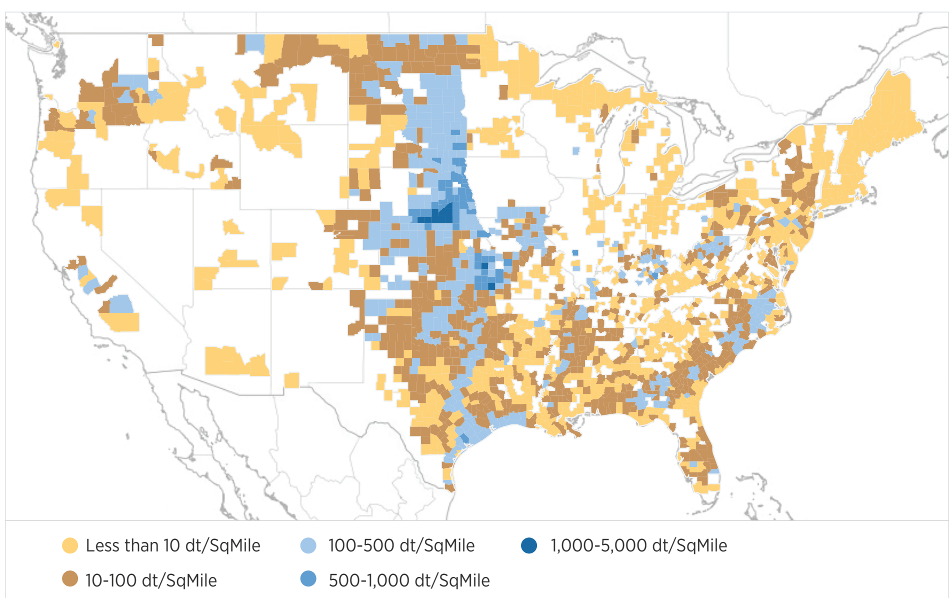
Crop residues require no additional cultivation or dedicated land and are considered potentially available in the near term. Residues quantified in the *2016 Billion-Ton Report* include those from the production of corn stover, wheat straw, oat straw, barley straw, and sorghum stubble.

Over the past 5 years, biomass research has developed a better understanding of the management of dedicated energy crop options, which is reflected in the *2016 Billion-Ton Report*. Energy crops included in the analysis of agricultural biomass resources include herbaceous varieties—switchgrass, miscanthus, biomass sorghum, and energy cane—as well as short-rotation woody crops—willow, eucalyptus, poplar, and pine. These crops are expected to enter into production in 2019. In addition to advancing the commercialization of biofuels, perennial energy crops also have the potential to benefit farm incomes and the environment, complementing the production of conventional crops.

Approach

For this analysis, the research team used POLYSYS (Policy Analysis System), which is a modeling framework that serves as a policy simulation model of the U.S. agricultural sector. POLYSYS was developed to simulate changes in economic policy, agricultural management, and natural resource conditions, as well as to estimate how agricultural producers may respond to new agricultural market opportunities, such as new demand for biomass, while considering the impact on other non-energy crops.

For this analysis, the data in POLYSYS is anchored in a USDA-published baseline of yield, acreage, and price projections for the agriculture sector, which are extended from the USDA 10-year baseline projection period through 2040. There are two scenarios used throughout the analysis: a base-case scenario that includes a 1% annual yield increase, and a high-yield scenario that includes a 3% annual yield increase. Biomass markets are introduced at specified farmgate prices (e.g., <$40, <$60, <$80 per dry ton). Each simulation of a different price represents an independent model simulation.



Production of residues and energy crops at an offered farmgate price of $40 in 2040 under a base-case scenario

Agricultural residue modeling assumptions include above-ground biomass residue produced before implementing sustainability, operational, and economic constraints, and these assumptions are calculated in POLYSYS based on a 1:1 harvest index. Sustainable constraints are most apparent in crop residues; various crop residues provide important environmental benefits, including wind and water erosion protection, the maintenance of soil organic carbon, and soil nutrient recycling, so not all crop residues may be used for biomass.

A sensitivity analysis confirmed that the price offered for biomass resources from agricultural lands has the largest effect on total available supplies. Pastureland intensification, or the displacement of pasture to energy crops, is also found to have a positive impact on the long-term economic viability of energy crops—especially miscanthus and switchgrass. Regarding operational efficiency, the reference case assumes a 50% efficiency in the year 2022, increasing to 90% efficiency in 2040. Finally, varying the energy crop input costs by +/- 10% of feedstock production estimates was found to have the greatest effect on miscanthus and switchgrass, with a base-case impact on woody crops and energy sorghum.

The *2016 Billion-Ton Report* builds on the 2011 *U.S. Billion-Ton Update* by adding updated input data, model enhancements, and new feedstocks. Additionally, the 2016 report includes reconciliation between current and projected operational technology, minor corrections in the modeling framework, and revised technological assumptions.

All energy crop yields are empirically modeled. Data from more than 110 field trials, in addition to soil maps and climate maps, were used by the Sun Grant Regional Feedstock Partnership in coordination with the Oregon State University PRISM modeling group to estimate county-specific, per-acre yields. The crop yield estimates also incorporate biweekly climate variables.

Both the 2011 and 2016 *Billion-Ton* reports analyze the potential biomass feedstock availability at specified farmgate prices. In addition to a baseline scenario that establishes initial and future crop supply and demand, the 2016 report expands the number of scenarios and market simulations to include supplies at specified prices and prices at specified production targets. Modeling these additional scenarios enables supply estimates based on the national market offering constant prices, as well as a national supply target, respectively.

UPDATED AGRICULTURAL BIOMASS FEEDSTOCKS

- Crop residues
- Biomass sorghum
- Energy cane
- Poplar
- Willow
- Eucalyptus
- Pine
- Switchgrass

The Path Forward

Both the *2016 Billion-Ton Report* and the 2011 *U.S. Billion-Ton Update* conclude that crop residues will comprise the majority of new agricultural biomass resources in the near term, while herbaceous energy crops will contribute the bulk of agricultural resources in the long term. Existing agricultural biomass resources, such as sugar cane bagasse, waste byproducts, corn grain, oils, fats, and greases, are analyzed in chapter 2, "Biomass Consumed in the Current Bioeconomy," in volume 1 of the 2016 report.

The Bioenergy Technologies Office's Feedstock Supply and Logistics program is implementing a strategy to achieve the vision of a thriving and sustainable bioeconomy through the development of efficient and sustainable biomass feedstock supply systems. The U.S. bioenergy industry relies on many factors, including a reliable, adequate supply of high-quality biomass that is available at a cost that enables meeting business profitability targets. With this in mind, the Feedstock Supply and Logistics program is working with a variety of collaborators to support the development of a logistics system concept that integrates time-sensitive feedstock collection, storage, and delivery operations into efficient, year-round supply systems that sustainably deliver consistently high-quality, infrastructure-compatible feedstocks to the variety of biorefineries served.

This fact sheet refers to the following documents

U.S. Department of Energy. 2016. *2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy.* M. H. Langholtz, B. J. Stokes, and L. M. Eaton (Leads), ORNL/TM-2016/160. Oak Ridge National Laboratory, Oak Ridge, TN. 448p.

Download and view the report, explore its data, and discover additional resources at www.bioenergykdf.net.

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DOE/EE-1441 • June 2016