Photo courtesy of Ed Richard, USDA-ARS

U.S. BILLION-TON UPDATE

Energy Crops*

Summary of Findings

The 2011 *Billion-Ton Update* estimates potential supplies of energy crops under different yield and feedstock farmgate prices. Perennial grasses, trees, and some annual crops can be grown specifically to supply large volumes of uniform, consistent-quality feedstocks for biofuel and biopower production. Growing these crops is a natural extension of current farm systems and offers additional profits to farmers and landowners. In this update, an agricultural policy simulation model (POLYSYS) was used to estimate potential supplies of energy crops at farmgate prices, ranging from $40 to $60 per dry ton. At the lowest simulated farmgate price ($40 per dry ton), energy crop production reaches 14 million dry tons by 2022 and 34 million dry tons by 2030. Higher simulated prices make energy crops much more competitive with commodity crops and pasture. At the highest simulated price of $60 per dry ton, 282 million dry tons of energy crops are potentially available by 2022, increasing to 400 million dry tons by 2030. These results are for the baseline scenario, which assumes an annual increase of 1% in yield due to learning or experience in planting energy crops and limited gains attained through breeding and selection of better varieties and clones. The high-yield scenario assumes energy crop productivity increases are modeled at three levels—2%, 3%, and 4% annually. These gains are assumed to be due not only to experience in planting energy crops, but also to more aggressive implementation of breeding and selection programs. Total potential energy crop supplies increase significantly from 400 million dry tons to 540 million dry tons at the 2% annual growth rate, to nearly 800 million dry tons at the 4% growth rate by 2030, assuming the $60 per dry ton simulated price.

Estimated energy crop supplies at selected years

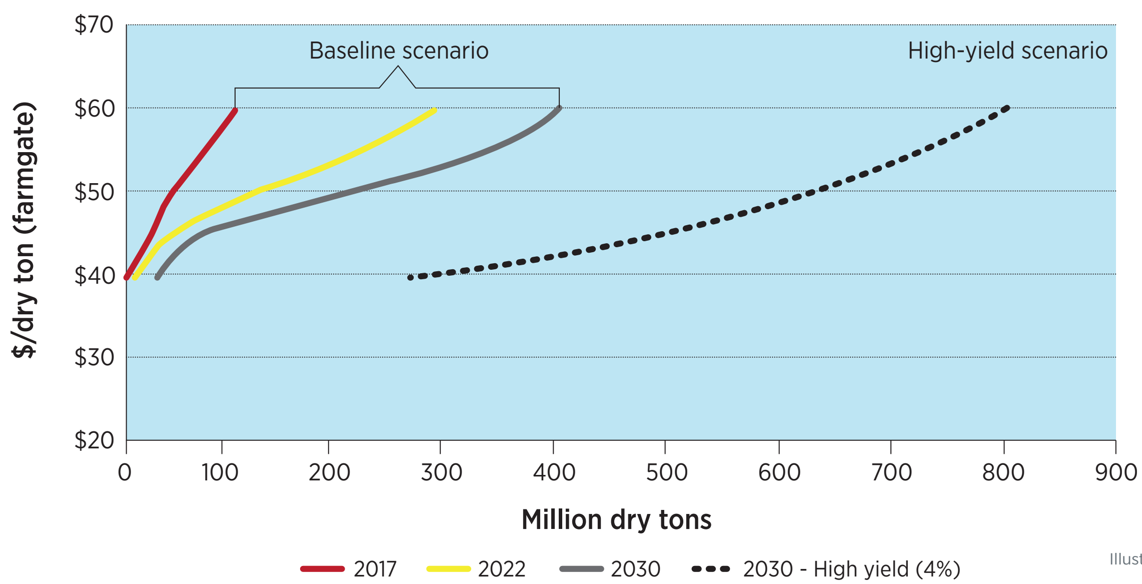

Illustration courtesy of BCS Inc.

*This fact sheet refers to the following document: U.S. Department of Energy. 2011. *U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry.* R.D. Perlack and B.J. Stokes (Leads), ORNL/TM-2011/224. Oak Ridge National Laboratory, Oak Ridge, TN. 227p. Download the full report at eere.energy.gov/biomass/pdfs/billion_ton_update.pdf. View the report, explore its data, and discover additional resources at bioenergykdf.net.

Additional Information

The report, *Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply* (published in 2005 and generally referred to as the *Billion-Ton Study*) included scenarios that assumed a relatively large shift of land into the production of energy crops. It was reasoned that energy crops could displace as many as 40 to 60 million acres of cropland and pasture and produce 150 to nearly 380 million dry tons of biomass sustainably, provided average annual yields of 5 to 8 dry tons per acre could be attained. Demands for food, feed, and exports would still be met under these scenarios because of projected yield growth and other technological advances in U.S. agriculture.

Implicit in the 2005 *Billion-Ton Study* was an assumption that energy crops are economically competitive and offer risk-adjusted net returns at least as high as what could be earned from growing conventional agricultural crops or from existing uses of the land. In this update, POLYSYS was used to assess the economic competitiveness of energy crop production and determine how much cropland and pastureland could possibly shift to energy crops. Land-use change can include acreage changes among commodity crops and conversion of pastureland to energy crops, provided forage can be made up through pasture intensification. At the highest simulated farmgate price of $60 per dry ton, 22 to 30 million acres of cropland and 40 to 50 million acres of pasture shift into energy crop production, depending on the baseline or high-yield scenario.

Beginning in the late 1970s, numerous woody and perennial grass crops were evaluated in species trials on a wide range of soil types across the United States. One key outcome of this research was the development of crop management prescriptions for perennial grasses and woody crops. Some highlights of this research (i.e., crop biology and adaptation, agronomics, production costs and yields, and requirements for sustainability) are presented in the report update for representative energy crops deemed to have high potential. These crops include three perennial grasses, an annual energy crop (i.e., high-yield sorghum), and four woody crops, managed either as a single rotation (i.e., harvest before replanting) or managed as a multi-rotation (i.e., coppicing) crop.

Each of these crop classes must compete for land with existing uses and with each other. Energy crops must offer higher net returns to displace crops on cropland. For pastureland, energy crop returns must be greater than the rental value of the pastureland, plus additional intensification costs to make up for lost forage. In assessing the relative profitability of energy crops, the most important data relate to crop yield. In this assessment, assumed energy crop yields (baseline) vary considerably across the United States, ranging from 2.0 to 9.5 dry tons per acre for perennial grasses, 3.5 to 6.0 dry tons per acre for woody crops, and 6.0 to 9.0 dry tons per acre for annual energy crops. These baseline yields for perennial grasses and woody crops are well within observed test plot yields. Production costs assumed for energy crops are based on minimal tillage and recommended fertilizer and herbicide applications. In addition, production costs generally assume use of best management practices for establishment, cultivation, and harvesting.

Baseline vs. High-yield Scenarios

The baseline assumes a continuation of the U.S. Department of Agriculture 10-year forecast for the major food and forage crops and extends to 2030. The average annual corn yield increase is assumed to be slightly more than 1% over the 20-year simulation period. The baseline also assumes continued trends toward no-till and reduced cultivation and an annual increase of 1% in energy crop yields. The 1% change in annual yield reflects learning or experience in planting energy crops and limited gains from breeding and selection of better varieties. The high-yield scenario is more closely aligned to the assumptions in the 2005 *BTS*. This scenario assumes higher corn yields and a much larger fraction of crop acres in reduced and no-till cultivation. Under high yield, the projected increase in corn yield averages almost 2% annually over the 20-year simulation period. The energy crop productivity increases are modeled at three levels: 2%, 3%, and 4% annually. These gains are due not only to experience in planting energy crops but also to more aggressive implementation of breeding and selection programs.

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