Errata: *U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry* August 31, 2011

The U.S. Department of Energy would like to correct formatting, values, and figures provided in the August 11, 2011, report, *U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry.* This document contains the corrected pages with the changes highlighted in yellow. Newly posted versions of the report may have corrections incorporated.

Specific changes to the report are listed by page number below:

- Page vii: Corrected formatting. “Cory Christensen, Ph.D.” should maintain independent line.
- Page 27: Corrected values. “$40 per dry ton” should change to “$80 per dry ton” to be consistent with Figure 3.7 on page 28.
- Page 52: Corrected values. “55 million dry tons” should be changed to “76 million dry tons.”
- Page 134: Corrected labels in text box. In Text Box 5.6, the horizontal label in the graphs should be changed from “$40/dry ton” to “$50/dry ton Baseline;” “$50/dry ton” to “+$5/dry ton Credit;” and “$60/dry ton” to “+$10/dry ton Credit.”
- Page 194: Corrected text. “Field Residues” should be “Secondary Field Residues.”

Workshop 2 – Herbaceous Energy Crops

Steve Thomas, Ph.D. – Project Officer, Golden Field Office, Department of Energy, Golden, Colorado (Workshop Facilitator)

Bill Belden – Consultant, Prairie Lands Biomass LLC, Ottumwa, Iowa

John Blanton Jr., Ph.D. – Research Programs Manager, Samuel Roberts Noble Foundation, Ardmore, Oklahoma

David Bransby, Ph.D. – Professor, Department of Agronomy and Soils, Auburn University, Auburn, Alabama

Cory Christensen, Ph.D. – Director of Product Management, Ceres Inc., Thousand Oaks, California

Fred Circle – President and CEO, FDC Enterprises, Columbus, Ohio

Ken Goddard – Extension Specialist, University of Tennessee, Knoxville, Tennessee

Neal Gutterson, Ph.D. – CEO, Mendel Biotechnology, Hayward, California

Stephen P. Long, Ph.D. – Professor of Crop Sciences, University of Illinois, Urbana, Illinois

Tom Lutgen, – President, Star Seed Company, Osborne, Kansas

Vance Owens, Ph.D. – Professor, South Dakota State University, Brookings, South Dakota

Ed Richard, Ph.D. – Supervisory Research Agronomist, USDA Agricultural Research Service, Houma, Louisiana

William Rooney, Ph.D. – Professor, Department of Soil and Crop Sciences, Texas A&M University, College Station, Texas

Workshop 3 – Woody Energy Crops

Bryce Stokes, Ph.D. – Senior Advisor, CNJV, Golden Field Office, Department of Energy, Golden, Colorado (Workshop Facilitator)

Bill Berguson – Director of Applied Forestry at the Natural Resources Research Institute (NRRI), University of Minnesota, Duluth, Minnesota

Starling Childs – Landowner, Consultant, EECOS, Norfolk, Connecticut

Mike Cunningham, Ph.D. – Director of Product Development, ArborGen, LLC, Tallahassee, Florida

Michele Curtis – Wood Supply Manager, Buckeye Cellulose/Proctor & Gamble, Perry, Florida

Howard Duzan, Ph.D. – Manager of Southern Timberlands R&D, Weyerhaeuser Company, Columbus, Mississippi

Thomas Fox, Ph.D. – Professor, Department of Forest Resources and Environmental Conservation, Virginia Tech, Blacksburg, Virginia

Robert Harrison, Ph.D. – Professor, University Estadual de Sao Paulo, Sao Paulo, Brazil

Alan A. Lucier, Ph.D. – Senior Vice President, National Council for Air and Stream Improvement Inc., Research Triangle Park, North Carolina

Mike Schmidt – Manager, Forestry Renewables, John Deere Construction & Forestry, Moline, Illinois

James Rakestraw, Ph.D. – Manager, Forest Research & Technology, International Paper Company, Bainbridge, Georgia

Robert Rummer, Ph.D. – Project Leader, Southern Research Station, USDA Forest Service, Auburn, Alabama

Timothy Tschaplinski, Ph.D. – Distinguished Scientist, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee

Timothy A. Volk, Ph.D. – Senior Research Associate, Forest & Natural Resources Management, Syracuse, New York

Ronald S. Zalesny Jr., Ph.D. – Geneticist, Northern Research Station, USDA Forest Service, Rhinelander, Wisconsin ton nationwide and are slightly higher in the West and slightly lower in the South due to differences in labor and fuel costs. Stumpage price is assumed to be zero for biomass from federal land because biomass removal is usually part of a fuels treatment or restoration activity. For privately owned timberland, stumpage price is assumed to begin at $4 per dry ton and increase to 90% of the pulpwood stumpage price when 100% of the available logging residue is used. The low entry price is based on a token payment in the likelihood that the biomass is only removed to meet other landowner objectives, such as reducing site preparation costs or fire risks. The higher prices are the result of demand increasing or supply decreasing to the point that biomass is almost competitive with pulpwood.

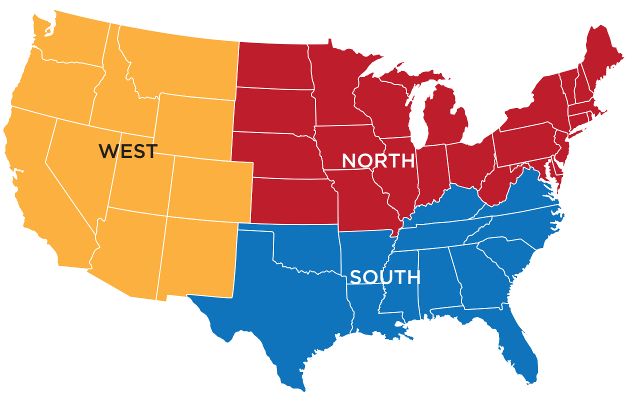


Table 3.2 Pulpwood Stumpage Prices by Region

	Delivered price ($/green ton)	Stumpage price ($/green ton)	Stumpage price ($/dry ton)
Hardwoods			
North	$32.00	$7.70	$15.40
South	$28.80	$6.70	$13.30
Softwoods			
North	$33.60	$10.40	$20.70
South	$29.00	$7.80	$15.70
West	$40.30	$13.80	$27.60

Source: RISI, 2008; Fight et al., 2006; Dykstra et al., 2009 (Includes all types of ownerships)

The supply curve based on logging residue estimates is shown in Figure 3.6 (thinning and composite supply curves shown in Figure 3.6 are discussed in subsequent sections). The logging residue supply curve is generally flat and shows 47 million dry tons per year potentially available at a roadside price of $40 per dry ton or less from all defined forestlands (Table 3.3 in Section 3.7). There is a 9% decrease in available tons per year generally across all prices when the federal lands are removed per EISA definitions. All logging residues are available at this price. State supplies at $80 per dry ton per year are graphically summarized in Figure 3.7. The largest supplies are where pulpwood and sawlog harvests are the greatest, namely the Southeast, Northwest, and Great Lakes. A more spatially explicit summary of logging residues supplies at $20 and $40 per dry ton is shown on the maps in Figure 3.8. Table 3.4 shows that at $60 per dry ton in 2030, about 50 million dry tons are available. These estimates are derived using USDA Forest Service Resource Planning Act (RPA) projections of timber harvests from forestland by region and estimates of logging residue as a percentage of timber product removals (Haynes et al., 2007).

Figure 3.5 Logging residues

(Courtesy of Barry Wynsma, USDA Forest Service)

4 AGRICULTURAL BIOMASS AND WASTE RESOURCES

This chapter provides estimates of quantities and farmgate prices (i.e., supply curves) for agricultural crop residue biomass, as well as residues and wastes generated mostly by food processing industries. Farmgate price is the price a buyer pays for crop residue at the farm, at a mill location in the case of processing residue, or at a landfill or feedlot in the case of waste resources. The agricultural resources considered in this assessment include:

- Crop residues from the major grain-producing crops
- Other crop residues
- Secondary agricultural processing residues
- Waste or tertiary resources (e.g., manures, waste fats, and greases).

For corn stover and other major grain residues, county-level supply curves are estimated using an agricultural policy simulation model. The chapter provides background on each of these resources and explains how estimates are made. The largest quantities are from crop residues. A number of factors are taken into account when estimating available crop residues: soil erosion and soil organic matter constraints, as well as the physical ability of machinery to harvest residues. Included in the price of these residues are the collection costs, a payment to the grower based on the nutrient value of the residue, and a profit. Estimates are made for a baseline and a high-yield scenario.

4.1 Cropland Resources (Corn Ethanol and Soybean Biodiesel)

These resources are accounted for in Chapter 2. The current total feedstocks for corn-based ethanol is 76 million dry tons per year (see Table 2.1). It is estimated that in 2017 the corn production for ethanol will meet the EISA mandate at 88 million dry tons and will be produced at that level through 2030. Soybean biodiesel feedstocks are estimated at 5 million dry tons per year, increasing to 18 million dry tons annually in 2017 and continuing at that level to 2030.

4.2 Agricultural Crop Residues

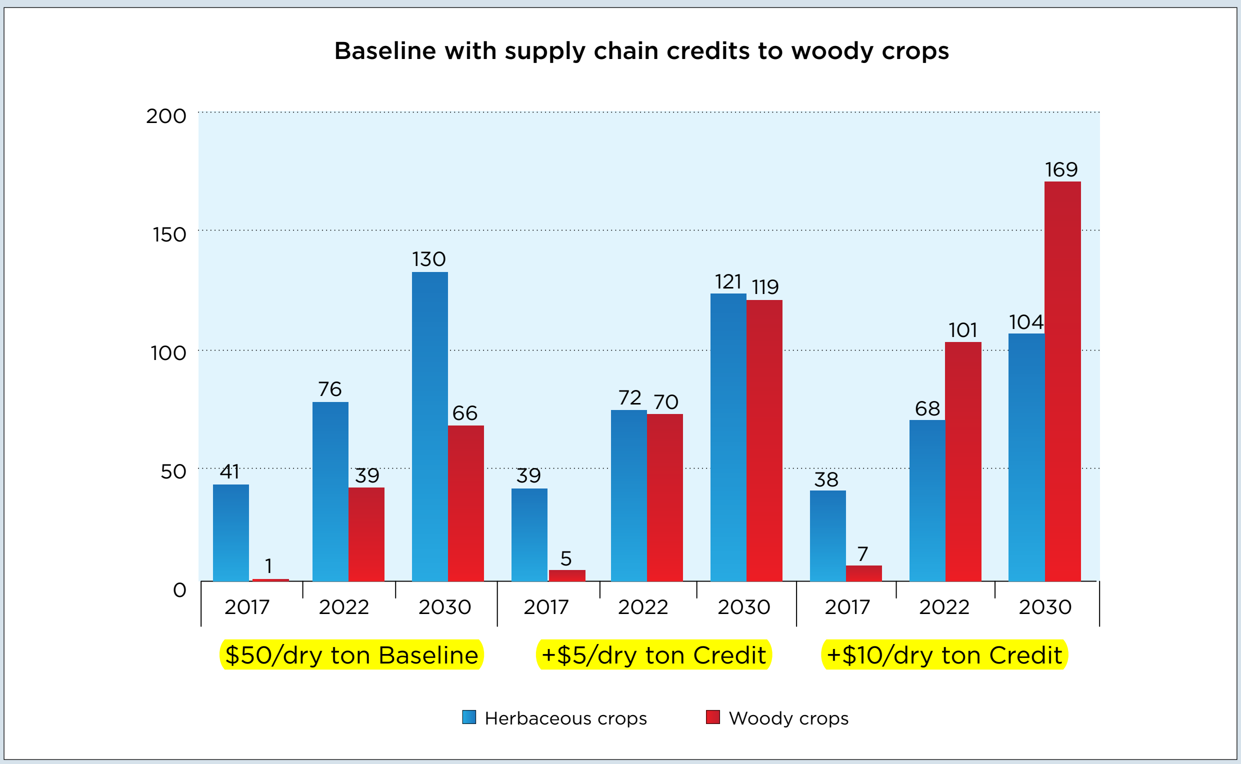
Crop residues are desirable feedstocks for bioenergy applications because of their low cost, immediate availability, and relatively concentrated location in the major grain growing regions. The most plentiful residues include stalks and leaves from corn (stover) and straw and stubble from other small grains, such as wheat, barley, oats, and sorghum (Figure 4.1). The 2005 *BTS* included a number of crop residue removal scenarios involving changes in crop yields, cropland tillage, and the efficiency of residue collection technology. In the 2005 report, the sustainable quantity of stover and straw residue was estimated at about 210 to slightly more than 320 million dry tons annually, depending on what was assumed about crop yield, tillage, and the fraction collected. If all crops are considered, then the crop residue potential is more than 400 million dry tons.[31] Corn stover, the largest single source of residue, was estimated between 170 and 256 million dry tons, depending on yield and tillage assumptions.

[31] The higher amount for the 2005 study included nearly 50 million dry tons of residues from forage-type soybeans. This potential is not included in this update.

TEXT BOX 5.6 | COMPETITIVENESS OF WOODY AND HERBACEOUS CROPS WHEN SUPPLY CHAIN ADVANTAGES ARE CONSIDERED

In addition to competing for land with conventional energy crops, energy crops also compete with each other. Farmgate analysis can distort the relative competiveness of energy crops when there are differences in feedstock logistics and supply chains. For example, woody crops have potentially less complex supply chains. In its simplest form, a woody crop can be harvested, chipped, and transported directly to the conversion facility. Further, woody crops can be stored on the stump, increasing volume, until needed at the conversion facility. Perennial grasses, annual energy crops, and crop residues have limited harvest and/or collection seasons and require storage between seasons. These herbaceous feedstocks also require more handling operations.

The figure below summarizes the effect of a credit given to woody crops to account for their potential supply chain advantages. The results show the baseline scenario at a farmgate price of $50 per dry ton and the same baseline with a $5 and $10 per dry ton credit given to woody crops. There were modest decreases in herbaceous crops and large increases in woody crops as the credit increased. Under the baseline at $50 per dry ton, woody crops are about one-third of total energy crop production in 2030. This percentage increases to 50%, with a $5 per dry ton credit and 65%, with a $10 per dry ton credit. Of course, this is a very simplistic comparison and a more thorough analysis of the entire feedstock supply and conversion chain is required. But the results do show that differences in assumed costs and assumptions among energy crops can have significant results in terms of the energy crop mix.



Appendix D: Data Sources

Appendix Table D.1. Data Sources

Feedstock	Sources and Notes
Forests	-
Fuelwood	EIA, AEO, 2010
Mill residues	USFS TPO, 2007
Pulp liquors	EIA, REA, 2007
Logging residues	USFS TPO, 2007
Thinnings (timberland)	USFS Inventory, 2010—further analysis/assumptions
Thinnings (other forestland)	USFS Inventory, 2010—further analysis/assumptions
Other removals	USFS TPO, 2007
Urban wood	EPA, 2007; McKeever, 1998 and 2004
Conventional (pulpwood)	2005 RPA; USFS Inventory, 2010—further analysis/assumptions
Agriculture	-
Corn starch ethanol	EISA
Biodiesel	EISA
Secondary Field Residues	USDA Agricultural Projections