2016 Billion-Ton Report Frequently Asked Questions

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This document provides answers to frequently asked questions from public presentations, webinars, and personal communication via billionton@ornl.gov following the July release of the *2016 Billion-Ton Report* (DOE, 2016).

General Questions

How were these biomass feedstocks determined, and what is the land basis of production?

In this report, the term biomass generally refers to raw material that is harvested, collected, and transported in field or forest to the roadside or landing, similar to Perlack et. al (2005) and DOE (2011). For urban and industrial waste resources, the biomass is assumed to be available in developed areas. Throughout the history of the Billion-Ton reports, major biomass sources have included underutilized biomass from primary agricultural and forestry operations, energy crops from agricultural land, as well as biomass from secondary resources such as municipal solid waste, crop processing residues, and animal manures, among many others. These feedstocks were identified by the Bioenergy Technologies Office (BETO) of the U.S. Department of Energy to have significant potential to expand renewable bioenergy production. In the *2016 Billion-Ton Report (BT16)*, a subset of feedstocks are modeled from the farmgate/roadside to the reactor throat (e.g. "delivered feedstocks").

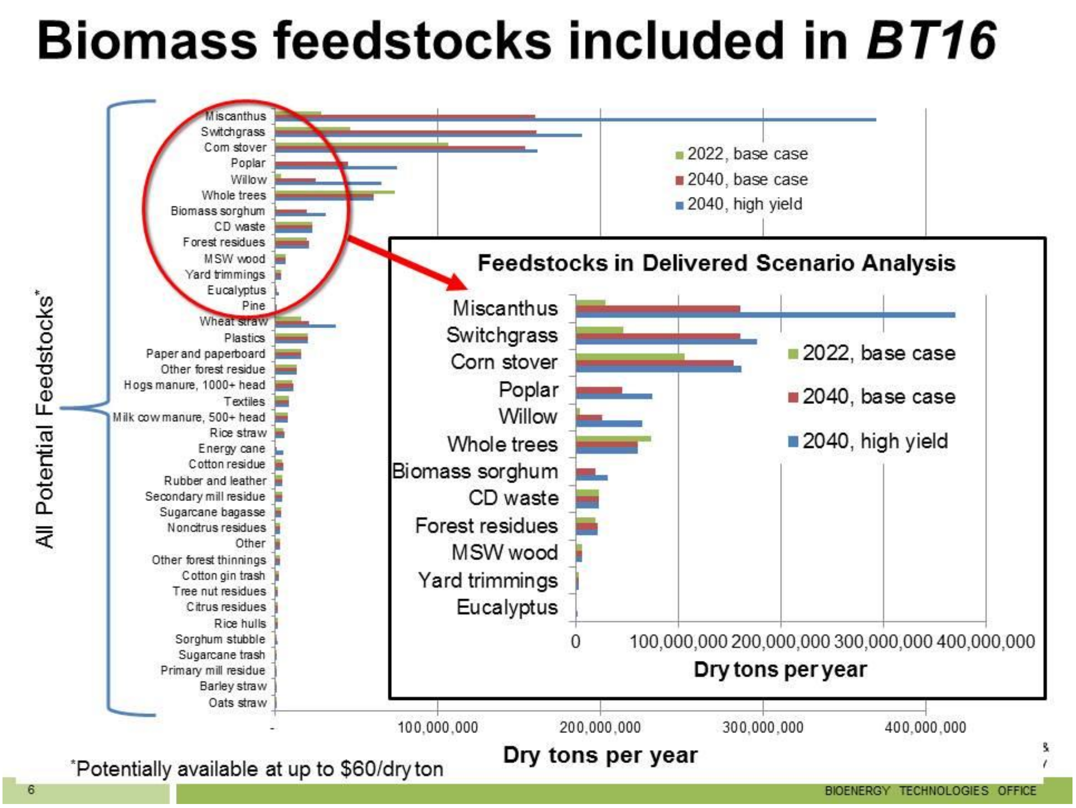

Figure 1: Feedstocks included in report and subset examined in delivered analysis

The land base assumed in this report includes primary agricultural land (land in major crops as measured by NASS annual crop surveys and hay and pasture as reported in the 2012 U.S. Department of Agriculture [USDA] Census of Agriculture) and timberland (including plantations and private and industrial forests). Land is restricted to non-protected areas and may or may not be included in conservation easements based upon the reporting of use by the landowner. Forest resources are measured including all private and federal land only. The assessment covers the lower 48 states due to accessibility and availability of data and assumptions applicable to major crops, hay, and timberland.

What does a supply analysis mean?

The resource assessment in the *2016 Billion-Ton Report* includes the following assumptions: biomass beyond currently used (described as "potential") is simulated as policy and end-use agnostic (e.g., may be available for a variety of biomass users including biofuels, biopower, and bioproducts), avoids double counting of currently used, and follows an economic approach with supply and cost curves of farmgate/forest landing biomass and delivered feedstock. The disclaimer, printed within the front cover of the *2016 Billion-Ton Report,* expands these principals to describe the scope of the report.

Measures were taken to ensure no double counting of biomass. The first of these is the movement away from the *EIA-Annual Energy Outlook* (*EIA-AEO*) projections toward surveys of production (see monthly biodiesel report [DOE-EIA, 2015], among others). The reason for this is that the *EIA-AEO* includes projections of increased use of biomass for energy, and it was identified in the research for Chapter 2 that forestry supply curves from previous Billion-Ton analyses were used in the bioenergy simulations for stationary power forecasts. Beyond 2014, it is assumed that currently used biomass reflects market clearing conditions where supply and demand intersect. A simplifying assumption is made that the level of currently consumed biomass (approximately 365 million tons per year) is flat throughout the projection period and that future quantity supplied equals demand such that consumption remains flat. This prevents the reporting of total biomass potential to be confounded by increases in demand and double counting of the forestry and other biomass consumption.

After publication of this report, a number of advancements have been made in the marketplace that upgrade low-valued biomass to biofuels and biochemicals. The ability to predict these advancements is impossible and outside the scope of this report; however, the analysis of this potential, is useful, and falls within the scope of conversion technology assessment and evaluation of the use of biomass.

The projection of biomass is not intended to be a forecast or prediction of potential biomass. It is intended as a guide to identify characteristics and traits of biomass supply chains that may be available in the future. With the application of additional assumptions, it can be useful as a set of data points among many others that guide the sustainable development of biomass supply. Within any particular region there may be market dynamics, such as land tenure and availability, labor conditions, competing agricultural markets, etc. that may act to promote or discourage biomass development. Further, the ability to inventory and categorize all uses of biomass at a regional level for animal bedding, landscaping, and ornamental uses, among many others, is nearly impossible and extremely cost prohibitive.

How is sustainability addressed in Volume 1?

Sustainability is broadly defined as the ability to meet the needs of today without jeopardizing the ability to continue to meet those needs in the future. With respect to the Billion-Ton analysis, this includes the modeling and assumptions supporting agricultural and forestry biomass for energy.

The resource assessment includes a number of criteria to appropriately measure the cost and availability of biomass according to sustainable production guidelines. These include both biophysical exclusion criteria (i.e., appropriate land identification for energy crops, exclusion of steep and sensitive forestlands, sustainable retention of agricultural and forestry residues), market exclusion criteria (i.e., high-valued irrigated cropland and pastureland), costing of bioenergy crop production to include best management practices (i.e., including nutrient replacement at mass-balance rate), among others.

In both agriculture and forestry, the constraints were developed through a combination of solicited input, discussions with experts and stakeholders, published information, and expert opinion. The sustainability constraints for agriculture were developed through stakeholder and contributor input from multiple workshops: the 2009 High Yield scenario workshops (DOE, 2009) and 5 regional mapping workshop of the Sun Grant Regional Feedstock Partnership (publications in review). Assumptions on agricultural residue removal were developed through work at Idaho National Laboratory, and are summarized in two reports (Muth et. al, 2012; Muth and Bryden, 2012).

The approach is reported in the *2011 Billion Ton Update (BT2)* (see section 4.3, DOE, 2011). Exclusion of energy crop production with irrigation and irrigated cropland allowed to convert to energy crops is a program priority developed by BETO. No residue removal from soybeans was developed based on feedback from the *2005 Billion-Ton Report* and this constraint was added to the 2011 update. Assumptions on forestry residue removal were developed through a literature review and are reported in Section 3.1.1 of the 2011 update and used in *BT16*. All other assumptions were developed through an experts workshop in December 2007 that were used in the 2011 update and again in *BT16*, or through additional discussions with authors and outside experts as needed for *BT16*.

It should be noted that the supplies reflect a high-level perspective based upon regional conditions. While the underlying data may be developed at fine scale (grid-level), the results are aggregated to the county-level and may not be appropriate as best management practice recommendation. Biomass suppliers and growers should consult agronomists, foresters, and other specialists to develop suitable field and forest-level biomass harvest management plans to ensure long-term site productivity.

What's the difference between base case and high-yield? Is this consistent throughout the report?

There are three general types of scenarios developed for the agricultural resources in the *2016 Billion-Ton Report*: agricultural baseline, the base case, and the high yield.

The agricultural baseline reflects the 10-year, national-level USDA long-term forecast and an extension to 2040. A number of assumptions are made to disaggregate national production to county-level production of the baseline. First, acreage of production is distributed to the county-level based on a 4-

year average of cropping history. Second, costs are estimated to generate net returns of traditional crops. Finally, a weighting procedure is calculated to adjust the county-level yields such that production and acreage match the USDA baseline forecast. The extrapolation of the USDA Baseline is based upon the 3-year average of the crop yield (supply module), food and industrial demand variables food demand, and export demand.

How was stakeholder input incorporated into the report?

Since the publication of the original 2005 study, the authors have received significant stakeholder input – both solicited and unsolicited. One example is a stakeholder workshop held to review the 2011 update after publication (see ORNL-CBES, 2011). There have been additional opportunities to garner feedback from many presentations and through the KDF website.

In addition to the numerous contributors involved in the 1.5 year process of data and scenario development work, an expert peer review was conducted in December 2015 with over 40 representatives from industry, academia, and government involved in the biomass supply chain and bioenergy sector.

Three areas of significant involvement and input from stakeholders are in the development of corn and energy crop production parameters and yield expectations, assumptions concerning energy crop production on pastureland, and whole-tree harvest for biomass. A series of workshops conducted in 2009 laid the underpinning of the high-yield assumptions for corn and energy crops. These yield improvement values include a mix of future biomass crop breeding and enhanced management practices input (DOE 2009).

One criticism of our results has been the assumption that pastureland is eligible for energy crops through management intensive grazing. In the *BT2*, the assumption was that 1 acre of pastureland could be intensified to double grass yield such that total livestock herd can be maintained on 0.5 acre of grazing land. The intensification assumption included additional costs to the livestock producer through additional fencing, building of troughs, and labor to rotate cattle periodically (represented in budgets as a one-time and annual cost throughout energy crop rotation). In this sense, the pecuniary externality born to livestock producers is paid by the energy crop grower, and the cost to grow energy crops on pastureland is increased by around $5-10/dry ton (discounted). In the 2016 report, a more conservative assumption on the yield gains through intensification is made such that it takes 1.5 acres of land to achieve a loss of 1 acre of forage. It is noted that the initial assumptions on pastureland productivity are incredibly conservative and new insight on national-scale estimates is scarce. A set of workshops were conducted in 2013-2014 to develop the maps of potential yield for energy crops, including annual and perennial herbaceous crops and woody crops, through the Sun Grant Regional Feedstock Partnership. A summary of those efforts is available on the National Sun Grant Initiative website. Those results have improved the measurement of pastureland yield, and this is included in the analysis.

In forestry, one criticism has been the cutting of green trees. There are not enough logging residues to meet any high demand, and cutting trees is part of active forest management to produce economic and ecological benefits. Also, there is generally criticism of clearcut harvest of biomass for energy instead of just thinning. Both are included as a practical approach that mimics current and future wood supply.

Specific Questions

I want to interact with the data referenced in the report. Where can I go, and do I need a login?

All data from the report is available at the Bioenergy KDF. The landing page is located at http://www.bioenergykdf.net/billionton. No user account is needed for the interactive data visualizations or the data download tool.

Is irrigation used in the production of biomass in the analysis?

Conventional agricultural grain crops that produce residues are irrigated and included in the biomass supply analysis. The production of such crops is determined from the USDA Long Term Forecasts that assume no weather anomalies or water shortages for irrigation. In practice, there is some limited irrigation of short-rotation woody crops in the Pacific Northwest. However, in the model used to generate energy crop yields, all production is assumed to be rain-fed.

Irrigation is often used for successful establishment of annual and perennial energy crops and may be a recommended practice where water is available and landowners own privileges, especially in western regions. Of the 110 in-network field trials, only one trial was irrigated to establish energy crops in the Sun Grant Partnership. This trial was for energy cane in College Station, Texas; however, the data estimate was not included in the national yield regression equations. Several other trials in the historical yield database also reflected irrigation in establishment and maintenance years within energy crop stand lengths, but were withdrawn because they had no effect on estimating the spatial gradient of precipitation. While irrigation did promote successful establishment in this one case, and could be recommended in other cases, the condition of non-irrigated production was applied to all other crops and field trial data used in the final yield maps. Thus, the final yield maps and underlying energy crop yield assumptions reflect rain-fed production only.

Why are forestry supplies lower in the 2016 report compared to the 2011 report?

The long-term supply of forestry resources in the 2016 report is 103-97 million dry tons, compared to 97-102 in the 2011 report.

A noticeable change is that the *BT16* projections are anchored to the 2012 Resource Planning Act which, like the USDA Baseline forecast for agricultural simulations, ensure the meeting of conventional wood uses over energy uses. Wood use scenarios were used to develop demand curves, whereas supply curves were derived from the demand curves that bounded supply to demand.

Why is double cropping not included in the *BT16* report?

Double cropping, or planting two successive crops in one calendar year, may be a biomass supply strategy that can significantly increase supply estimates and can be accomplished with little additional investment. It may be possible to employ these practices to produce additional forage to agricultural systems to produce biomass for energy and forage where land is limited. But double cropping and other management alternatives were not assessed in the *BT16* report.

The current analysis does not include double cropping due to time constraints, but has been requested for consideration in analysis. The POLYSYS model, in its current form, does not model crop rotations explicitly, rather it assumes each year represents a 3-year average. So, there is an opportunity to consider these alternative scenarios. However, many regional biomass strategies are difficult to capture nationwide, but can be examined with the land allocation from the output.

How was the assumption behind the management intensive grazing developed?

Management intensive grazing (or rotational grazing) is assumed in the base case scenario for pastureland production as described above. The energy crop producer has to pay for these efforts (the pecuniary externality of lost land, thereby increasing feeding costs land rates, is "internalized" by the energy crop producer). In reality, many more things are at play. The MIG assumption seeks to minimize the negative externalities to the cattle industry by allowing stocking rates to be maintained on less land. In reality, the relationships are much more complex. A farmer may actually substitute away from grazing to supplemental feed if land is reduced.

The 1:1.5 ratio assumes that intensified pasture can produce 66% more biomass per acre than a non-rotational system. The estimates of pasture productivity are distributed widely:

- 17% increase, "The Benefits of Management Intensive Grazing" University of Illinois Extension, May 2004 http://livestocktrail.illinois.edu/pasturenet/paperDisplay.cfm?ContentID=6614
- 100% increase, Intensive Grazing increases beef production, George et al. California Agriculture, Volume 43, Number 5, available at https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&ved=0CDYQFjAE&url=https%3A%2F%2Fucanr.edu%2Frepositoryfiles%2Fca4305p16-68528.pdf&ei=P5Y2VaW6KcbtsAWfnoHgCg&usg=AFQjCNFcE57bKbg7S0mOtzLYiYdDdaGnHg&sig2=72YCS9vFzGVWZzLquUHCPg&bvm=bv.91071109,d.b2w&cad=rja
- 78% increase, "Intensive Grazing" from The New Farm, May/June 1991 http://www.mcivershappyacres.net/intensive_grazing.html
- 50% increase, "Mob grazing increases efficiency and profitability of livestock production" South Dakota State University, 2012, http://mysare.sare.org/sare_project/LNC11-338/

How are energy crops modeled when land is assumed fixed?

The amount of land available for all agricultural production is constrained to a fixed amount that is presently available for crop production (including pasture). In the USDA Baseline and the extended baseline, less agricultural land is needed in the future from what is under production today due to yield increases exceeding demand increases. This amounts to approximately 10 million acres additional acres that are idled, and this is held constant across all price and technology scenarios.

The increase of energy crops on cropland does not come without some observed impacts to existing markets. From the USDA Baseline, the price of corn is $3.40/bushel in 2015 and $3.70 in 2025 (end of baseline period, and stays flat until 2040). With energy crops included in the base case scenario, the price of corn increases to $3.79/bushel in 2025 and $4.03 in 2040. The total domestic use, however, decreases only 3% in 2040 in the base case relative to the extended baseline (from 16.214 million bushels down from 16.755 million bushels for feed, food, ethanol, exports, and other industrial use). The model allows for substitution among inputs to satisfy this decreased consumption so that the impact is minimized.

What changes were made in the waste analysis?

For this analysis, the nationwide estimate of waste is expanded to include a broader characterization of organic wastes beyond woody wastes and construction and demolition debris currently landfilled that may be diverted from landfills to new uses for energy. Biogas was added using EPA data using reasonable assumptions of production and capture.

Citations

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Muth, D., McCorckle, D, Koch, J, Bryden K. Modeling Sustainable Agricultural Residue Removal at the Subfield Scale. Agronomy Journal (104:970–981 (2012)). https://bioenergy.inl.gov/Journal%20Articles/Modeling%20Sustainable%20Agricultural%20Residue%20Removal%20at%20the%20Subfield%20Scale.pdf

Oak Ridge National Laboratory- Center for Bioenergy Sustainability, 2011. U.S. Billion-Ton Study: What can be learned from Bioenergy Sustainability? http://web.ornl.gov/sci/ees/cbes/workshops/BT2%20Bioenergy%20Sustainability%20Workshop%20Report%20%20FINAL.pdf (Accessed October 5, 2016). 17p.

Perlack, R. D., Wright, L. L., Turhollow, A. F., Graham, R. L., Stokes, B. J., & Erbach, D. C. 2005. Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasability of a Billion-Ton Annual Supply. No. ORNL/TM-2005/66. ORNL, 2005.

U. S. Department of Energy, 2009. High Yield Scenario Workshops. https://bioenergy.inl.gov/SitePages/High-Yield%20Scenario%20Workshop.aspx

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