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New Report on Logging Utilization in Idaho

Logging utilization studies describe how trees are harvested in commercial operations and account for how the various tree parts are used. This information helps land managers evaluate their logging operations and can reveal utilization trends over time and within various regions.

Logging utilization data is particularly valuable to NARA researchers because it provides a basis used to estimate the amount of forest residues available after harvesting operations. The biomass projections based on this data are shown on maps used in supply chain analyses, and the data is incorporated into biomass projection models and life cycle analyses being developed by NARA researchers.

Recently, a report titled *Logging Utilization in Idaho: Current and Past Trends* was published. A majority of the authors are with the Bureau of Business and Economic Research (BBER) based at the University of Montana (a NARA affiliate organization), and NARA partially funded the work.

View *Logging Utilization in Idaho: Current and Past Trends*

Report covers logging utilization in 2008 and 2011

Data for this report was obtained during the 2008 and 2011 harvest-seasons and provides a snapshot of utilization over a dynamic period for the logging industry. The previous utilization study for this region was conducted in 1990.

This study looked at active logging sites in Idaho where live green trees were harvested for conversion into wood products. Logging sites were selected at random, and 815 trees were sampled from 33 active logging sites spread across 10 Idaho counties.

The specific objectives for this report are to:
1. characterize Idaho's timber harvest by tree species and diameter (dbh);
2. characterize Idaho timber harvest operations by felling, yarding, and merchandising methods;
3. compute current Idaho logging utilization factors to express: a) volumes of growing-stock (bole wood) logging residue generated per thousand cubic feet (mcf) of mill-delivered volume, b) proportions of mill-delivered volume coming from growing-stock vs. non-growing stock portions of harvested trees, and c) total removals (i.e., timber product and logging residue) from growing stock.

Residue highlights

Two opposing trends are affecting the amount of residues available after harvest. On one hand, the volume of forest logging residues has decreased between 1990 and 2011 due to technical advancements in harvesting and milling operations. Seventy-two percent fewer residuals remained after harvest in 2011 than in 1965. In 2011, 1,011 cubic feet (cf) of timber volume from growing stock was harvested for every million cubic feet (mcf) delivered to the mill. Of the 1,011 cf, 987 cf was used and 24 cf was left in the forest or at the landing as forest residue.

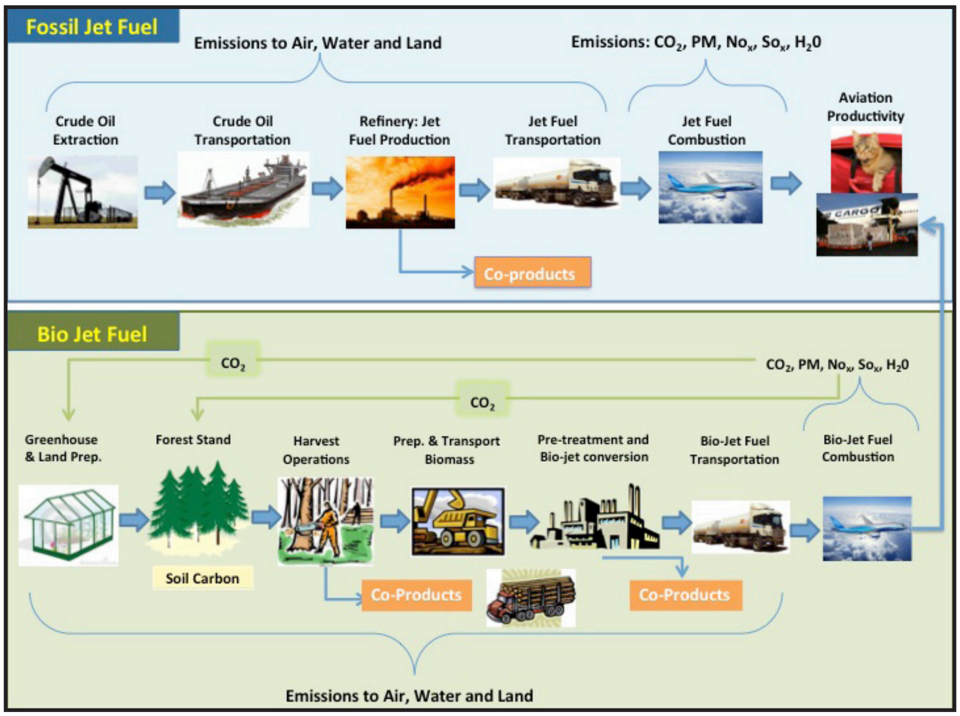
Counter to the decreasing trend of improved utilization and less residues is that the average diameter of trees harvested in 2011 was smaller than in 1990. During this study, roughly one-half of the mill-delivered volume, growing-stock removals, and growing-stock logging residues came from trees with a diameter at breast height (dbh) less than 16 inches. Smaller diameter trees tend to produce a larger proportion of un-used residues compared to larger diameter trees.

Grand fir, Douglas-fir, western larch and western redcedar accounted for 82% of the total mill delivered volume and 87% of the growing-stock logging residue. Of these species, western redcedar showed the lowest proportion of residue per delivered volume with western larch providing the highest proportion of residue volume.

Additional resources from BBER

BBER is conducting logging utilization fieldwork throughout the NARA four-state region (ID, WA, OR, MT). To date, they have sampled 97 logging sites and over two thousand trees. They are also developing a four-state site-level model that will predict the ratio of logging bole wood residue volume to mill delivered volume as a function of readily available covariates, such as logging systems employed.

BBER offers a number of other analyses and tools useful to the logging industry. For instance, the public can access timber harvest volumes by county, forest industry outlooks, capacity studies and forest economic data from the BBER website.



Comparing the LCA's of fossil-based jet fuel to biojet fuel from forest residuals. The image is from Environmental assessments of woody biomass based jet-fuel.

Assessing the Environmental Impact of Forest Residual-Based Biojet Fuel

Replacing fossil fuel-based products with bio-based products are good for the environment…right? How do we know? A technique used to answer this question is a life cycle assessment (LCA), which assess the overall environmental impacts associated with a product or activity throughout its life cycle. LCAs can be used to compare the environmental impact of one product to another, and standards are adopted to ensure that the assessments are complete and relevant.

NARA is conducting a life cycle assessment of forest residual-based biojet fuel. The LCA-based global warming potential (GWP) impact assessment has economic implications for the overall feasibility of the project. A 60% reduction in GWP potential associated with NARA biojet fuel, as compared to fossil based jet fuel, ensures that the forest residual-based biojet fuel meets the greenhouse gas reduction target specified in the US Energy Independence Act and is a necessary step to qualify for renewable identification numbers (RINs) and for public procurement eligibility.

Review a report on the renewable fuel standards, RINs, and how they relate to NARA here.

In a recent newsletter published by the Center for International Trade in Forest Products (Cintrafor), NARA researchers at the University of Washington provide the framework and preliminary findings for an LCA on producing woody biomass-based biojet fuel.

Read *Environmental assessments of woody biomass based jet-fuel* here.

Key Findings

The paper describes the overall scope of the LCA and lists the assumptions, benchmarks and scenarios used to evaluate the environmental implications of producing biofuels in the NARA sub-region of western Montana, northern Idaho and eastern Washington (previously titled the Western Montana Corridor (WMC)). Listed below are key findings and assumptions expressed in the paper.

• Sixty one percent of the above ground biomass harvested from a mature forest in the WMC region consists of sawlogs and pulp logs; 39% is considered forest residuals (branches and tops). Approximately 58% of those forest residuals are available for use as feedstock while the remaining residuals are left on the forest floor or at the landing site.

• Hauling forest residuals over forest roads from the landing to a secondary landing where the residuals are ground to chips produced significantly more smog and CO2 than harvesting and chipping activities and chip transport on paved roads to a depot or conversion facility. The use of a roll-off containers verses a dump truck to transport residuals on forest roads greatly reduced CO2 emissions.

• The avoided environmental impacts derived from using forest residuals to produce biojet fuel rather than burning them in slash piles result in a 62.2% reduction of the global warming potential. After accounting for the avoided emissions from slash pile burning, Harvesting, processing and hauling feedstock from the harvest site to a conversion facility produces approximately 15% of the total CO2 emissions generated in using forest residuals to make biojet fuel. The remaining 85% emissions are generated at the biorefinery.

• The assessment assumes that 6.857 kg of bone dried woody biomass produces 1 kg of iso-paraffinic kerosene (jet fuel).

• Depending on the transportation scenario used, 56% to 70% less CO2 and 35% to 89% less smog are produced when forest residuals are used to produce biojet fuel rather than jet fuel made from petroleum.

More LCA Refinement

The LCA is a work in progress as more data becomes available. Since this paper's publication, a preferred pretreatment protocol has been chosen, and harvesting and logistical information has been updated for the west side of the Cascades. The NARA research project will conclude in the summer of 2016, and a more complete and refined LCA will be available then.

NARA just concluded its third annual meeting in September at Seattle. At this meeting, the LCA lead researcher Indroneil Ganguly presented an update, which can be viewed on NARA's YouTube page.

> View Indroneil's talk "Life Cycle Assessment of Biomass Scenarios"

Unpressed (left) and hot-pressed (right) pretreated lodgepole pine samples. Images taken at USDA Forest Products Laboratory.

Packaging Pretreated Wood Material for Transport

There are multiple ways to envision a supply chain that uses forest residuals to make a variety of chemical products. One option would have all of the wood residuals transported to a single integrated biorefinery where the pretreatment, hydrolysis, fermentation and conversion steps would occur at a single facility.

Other options would consider a distributed depot strategy where conversion processes occur at multiple facilities. NARA is evaluating the economics, logistics and environmental sustainability of multiple supply chain scenarios that include a depot strategy. A depot strategy can provide economic and logistical advantages through use of existing facilities, improved transportation efficiency and by extending the range of biomass availability.

> Learn more about potential biorefinery and depot locations in the NARA region here.

One potential depot scenario would have forest residuals pretreated and densified into pellets or mats at one facility and the downstream possessing occurring at a different location, presumably a centrally located biorefinery. The densification process would shrink and dry the pretreated material and make it more cost efficient for transport. It is unknown, however, whether the process of making pellets or mats from pretreated material would change the wood chemistry in a way that negatively affects downstream processes used to produce simple sugars and isobutanol.

To address this question, NARA researchers from the USDA Forest Products Lab and Washington State University recently published a paper that evaluates how pressing sulfite-based pretreated wood chips into mats affects downstream sugar and alcohol yields.

Obtain a copy of *Effect of Hot-Pressing Temperature on the Subsequent Enzymatic Saccharification and Fermentation Performance of SPORL Pretreated Forest Biomass* here.

Testing sugar yield from hot-pressed pretreated samples

A hot-press protocol, typically used to make plywood and particle board, was used to densify the pretreated residuals into mats. Multiple hot-pressed samples were made from pretreated lodgepole pine and poplar wood chips under a range of pressing temperatures from room temperature to 177°C. Turns out that when higher temperatures were used, the hot-pressed samples were less susceptible to enzyme hydrolysis. The heat changed the wood structure in a way that made it more difficult for the cellulase enzymes to penetrate the material and access the cellulose fibers. The most dramatic reduction in cellulase accessibility occurred with temperatures above 110°C. The increased temperature, however, did not apparently affect the cellulase's ability to perform its function of cleaving off simple sugars once it did penetrate to the cellulose fibers. When the cellulase enzyme was allowed to incubate with the 110°C pressed pretreated residuals for 72 hours, there was no difference in sugar yield between the 110°C pressed and unpressed pretreated wood chips. These results suggest that a longer hydrolysis time can compensate for reduced cellulase accessibility to cellulose due to the 110°C temperature.

Testing hot-pressing effects on ethanol yield

The unpressed and pressed (110°C) poplar and lodgepole pine pretreated chips were hydrolyzed using cellulase enzymes, and the resulting sugar broth was fermented using yeast. Yeast fermentation converts the simple sugars into ethanol. The ethanol yield for the pressed pretreated poplar samples was similar to the unpressed pretreated sample. To account for the similarity, the authors suggest that the cellulase enzymes continued working during fermentation to make up for the reduced sugar yield due to the 110°C pressing. The ethanol yields were not similar, however, for the pressed and unpressed pretreated lodgepole pine samples. In this case, the pressed chips produced an ethanol yield 45% below the unpressed samples, and apparently, cellulase activity during fermentation did not compensate for the lack of accessibility induced by hot-pressing.

The results suggest that a hot-pressing temperature of 110°C is suitable for poplar pretreated material with little decrease in alcohol yield compared to unpressed samples. For lodgepole pine samples, however, the hot-pressing temperature should be below 110°C to avoid dramatic reductions in alcohol yields. Further studies are underway to optimize the process design and evaluate the economics associated with hot-pressing wood residuals.

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