NARA
Northwest Advanced Renewables Alliance

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On-site grinding of forest residuals. Photo from John Sessions, Oregon State University

Lowering the cost of hauling forest residuals

Ok, so you have piles of forest residuals generated after harvest and a biofuel conversion facility offering a set price per ton upon delivery. How do you process and transport this biomass in the most efficient and cost effective manner possible?

NARA researchers from Oregon State University, Rene Zamora, John Sessions, Glen Murphy and Kevin Boston are designing simulation models to help answer this question and improve cost estimation and decision making at the operational level. They recently published a paper in the Forest Products Journal that describes a simulation model and its application to improve processing and transportation costs in three case scenarios involving real operations.

> Read their paper *Economic Impact of Truck-machine Interference in Forest Biomass Recovery Operations on Steep Terrain*

Gathering Information

To develop a simulation model, the team visited 21 different forest biomass recovery operations in Oregon and Washington. These operations all involved transporting forest residuals in steep terrain to a bioenergy facility and represented a broad range of scenarios likely faced by an operation manager. The data recorded from these visits include the number and type of trucks and grinders used; road characteristics; and transport, loading and unloading times. This information along with all the costs (labor, fuel, equipment, maintenance) associated with the transport and processing were used as "inputs" to the modeling software.

Comparing Model Simulations to Real Scenarios

In the study, three case scenarios, based on actual operations and representing different road characteristics and grinder/truck locations, were designed. In each case, "grinder position and loading time, trailer capacity, number of trucks, inter-arrival time between the trucks, average truck speed (paved, gravel, dirt), turning around time, positioning time, backing-up time (if needed), time to put the tarp over the load (usually after the trucks leave the local area), and unloading time at the bioenergy facility" were determined and used as an input for the model.

For each case, model outcomes were then compared to actual recovery operations. In all three case scenarios, the simulated operations were modified for number of trucks used and grinder locations to see if costs improved over actual costs. The cost to transport and process a bone-dry-ton (BDT) of residual biomass improved over actual costs in all case scenarios ranging from 3.85% (Case 2) to 29.7% (Case 1) improvement.

The grinder utilization rate (actual time the grinder is filling a truck) ranged from 60% in Case 1 where the roads were most constricting to 81% in Case 3 where a loop road was used. Grinder productivity was affected by the amount of trucks used in the operation and the road characteristics.

Model Use Can Lower Feedstock Costs

When fully developed, this simulation model should benefit NARA stakeholders and help determine and improve costs associated with different road configurations, number and type of trucks, and grinder utilization rates. As described in the initial techno-economic analysis developed by NARA, the largest single

cost center in the entire analysis is the feedstock cost, which in turn is dominated by grinding and transport costs. The simulation models being developed at Oregon State University will serve as an important tool to make forest residual products, such as bio-jet fuel, cost competitive.

View NARA's strategic analysis that addresses the techno-economic report

Registration Open and Speakers Set for PNW Biofuels Conference

NARA and six other collaborators are taking an active role to prepare this biofuels and co-products conference sponsored by the USDA and Washington State University Extension.

Conference Website

Conference Agenda and Speakers

Through their efforts, an engaging agenda has been set that addresses all aspects of creating a wood-based biofuels and co-products industry here in the Pacific Northwest. The opening afternoon will feature speakers who provide a big picture perspective from major stakeholders (Commissioner Peter Goldmark, Washington Department of Natural Resources; Carol Sim, Alaska Airlines; Chris Cassidy, USDA Rural Development; and Barbara Bramble, National Wildlife Federation) followed by regional updates from three USDA AFRI-CAP programs (NARA, AHB and BANR) and Canadian counterparts. The afternoon will conclude with a reception and poster session.

Day two gets into the details and offers three tracks covering 1) feedstock processing and transport , 2) economic, social and environmental impacts, and 3) pretreatment and conversion technologies. Each track will feature 7-8 speakers and will run concurrently in separate rooms. These tracks will be followed by presentations from NARA and AHB researchers describing key aspects of the projects and how they impact Pacific Northwest stakeholders.

Day three will focus on opportunities to generate co-products from all stages of the supply chain.

Conference Agenda

List of Conference Speakers

Conference Background

It has been just over two years since the USDA invested $80 million to facilitate the development of a sustainable wood to biofuels and co-products industry in the northwest United States. This investment created the Northwest Advanced Renewables Alliance (NARA) and Advanced Hardwood Biofuels Northwest (AHB): two projects with multiple partners focused on softwood and hardwood feedstocks respectively.

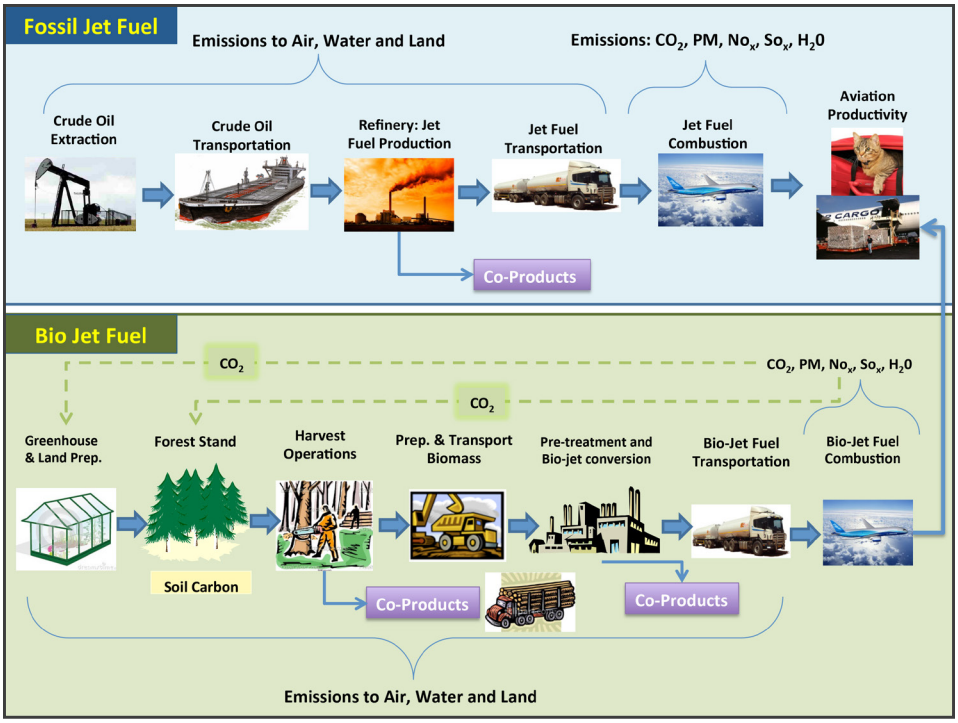
These projects are proceeding amidst efforts from other northwest-based organizations (state government, research labs, industry, non-governmental organizations) who also contribute to developing wood biomass as a resource for fuel and novel products.

With so much activity devoted to wood-based biofuels and co-product development in the Northwest, this conference will provide a timely opportunity for the region to assess developments and form strategic partnerships.

"Northwest stakeholders will come away from this conference with a clear understanding of what is needed to develop a supply chain for this industry and the role that they could play in making it a success", says Peter Moulton of Washington Department of Commerce and conference steering committee member. "In addition, there are many outside the northwest United States with similar challenges to developing feedstocks, fuels, supply chains and products who we hope to attract to share our ideas and learn from their experience."

Registration is Open

We encourage anyone interested in wood-based biofuel and co-product development to attend this conference. Registration costs are low at $195.00 per person; students can register for $100.00. Fees cover reception, breakfasts and lunches.



Supply chain and CO2 flow for fossil jet fuel and bio-jet fuel. Infographic courtesy of Indroneil Ganguly.

Forest Residuals to Biojet Fuel: Environmental Impacts and Sustainability

Typically when trees are harvested for lumber and pulp, the limbs and branches (commonly termed "forest residuals") are left on the forest floor or collected in slash piles and burned. If these forest residuals were used instead to produce products such as biojet fuel, what effect would that have on our environment and how can we manage the resource to ensure environmental sustainability?

NARA (Northwest Advanced Renewables Alliance) is currently providing research to help answer this question. NARA is one of seven coordinated agricultural projects (CAPS) within the sustainable energy challenge area funded by the USDA National Institute of Food and Agriculture (NIFA) Agriculture and Food Research Initiative (AFRI). It is tasked with facilitating the development of a Pacific Northwest industry that uses forest residues to make chemical products such as biojet fuel.

This industry is anticipated to provide numerous benefits to society. As biofuels displace fossil fuels, U.S. energy independence is strengthened and net carbon emissions to the atmosphere are potentially reduced. A novel use for forest residuals can stimulate rural economic development and provide new ways to approach forest management that reduce fuel loads and improve forest health. And unlike corn-based ethanol that can create a financial stress on food markets, products such as bio-jet fuel, derived from forest residuals, do not compete with food production.

There are, of course, legitimate concerns to how this industry will affect forest ecosystems, water and air quality. The NARA project funds research to investigate these concerns and provide research-based analyses and conclusions so that regional stakeholders and society can make informed decisions. The purpose of this article is to describe the research within NARA that evaluates the potential impacts of forest residual harvest on forest ecosystems and the environment.

How are Forest Soils Affected?

Forest vegetation and soil microbes need nutrients in the soil for healthy growth. When forest residuals decay, they can release stored nutrients back to the soil. NARA is funding research that develops effective models and methods to ensure that soil nutrient pools remain sustainable in working forests when limited forest residuals are removed.

Initially, NARA researchers measured the amount of carbon and nitrogen in soils at Douglas-fir plantation sites throughout the Pacific Northwest. Their measurements, when compared to the harvest history and soil type, provide a rough prediction tool to measure a site's capacity to retain productive nutrient levels when residuals are removed.

Review of NARA publication on predicting nitrogen depletion risk

NARA research posters on soil carbon

For a more detailed understanding of how removing forest residual can affect soil nutrient levels, NARA researchers have established long-term experiments at numerous sites in the Pacific Northwest. At one experimental site located on Weyerhaeuser land near Springfield Oregon, seeding growth and soil nutrient content will be measured over years from multiple plots subjected to various levels of forest residual harvest. Over time, these results will provide a clearer picture to how forest residual removal affect soil nutrient levels.

NARA research poster on NARA Long Term Soil Productivity Site

NARA research poster on soil carbon #1

NARA research poster on soil carbon #2

How is Water Quality and Retention Affected?

There is a need to investigate forest residual harvesting impacts on water movement, retention and quality at scales ranging from field scale to regional scale.

At the field scale level, water runoff, nutrient export, sediment erosion and microbial populations will be examined under various residual harvest options. These experiments are being conducted at the Springfield Oregon Long Term Productivity Site.

Based on this data, predictive models will be developed to determine water quality, quantity, and the effects on stream channels under various residual harvest scenarios at a regional scale. These models should provide a real impact to how residual harvest is managed so that water resources are protected.

NARA research poster on soil erosion

What is the Effect on Wildlife?

A large body of experimental work is available that describes how wildlife interacts with downed woody material and snags. This existing information will be used to generate regional models designed to estimate the potential impact of forest residual removal on vertebrate abundance. In summer 2014, NARA researchers will produce a more detailed study that examines the relationship between white-crowned sparrow fledglings and forest residual slash piles. Casual observation suggests that fledglings are using slash as cover between the times that they leave the nest and gain the ability to fly. Data derived from this research combined with earlier studies will be used to model bird responses to forest biomass use.

NARA research poster on impacts to biodiversity

How Would this Industry Affect the Atmosphere?

NARA is comparing the amount of greenhouse gas emissions, ozone depletion, and smog that would occur when bio-jet fuel, using forest residuals as feedstock, is produced compared to jet fuel production from petroleum. The results from this assessment, called a comparative Life Cycle Assessment (LCA), are not only critical to determine environmental sustainability of the process, but also important to determine whether the products derived from forest residuals qualify as "renewable" under the Renewable Fuels Standard (RFS). Qualifying under these guidelines is critical to the economic success of the process.

Varied treatments at NARA's Long Term Productivity Site. Left image: no residual removal after harvest. Right image: full residual removal after harvest. Photos courtesy of Michael Barber.

The LCA traces the environmental impacts at all stages of development from forest residual extraction and transportation through to the finished product.

There is more work to be done to verify all the inputs and outputs of the process, but preliminary results show that producing jet fuel from forest residuals reduces global warming potential, measured in kilograms of CO_2 emissions, by over 60% and ozone depletion by nearly 90% when compared to jet fuel production from petroleum. Contributing significantly to these results is that the practice of burning forest residuals in slash piles would be reduced, thus reducing the amount of smoke, ash and CO_2 emitted to the air.

NARA research poster on air impacts

NARA research poster on LCA #1

NARA research poster on LCA #2

Private and Public Lands

The supply chains being developed are influenced by the sustainable availability of forest residuals. Currently, the forest residuals considered are located on private, tribal and state lands. Due to access limitations and policy, the forest residuals from federal lands are not being considered in the analysis.

One area of public debate over federal forest management is forest fire mitigation. To provide science-based information for this debate, NARA researchers are working with regional forest managers to develop models and experiments that determine the impact of forest thinning on forest fire intensity. If these management prescriptions are implemented, a market for the residuals may help alleviate the cost of thinning programs.

NARA research poster on fire reduction treatments

Plenty of Work to Do

Generating biojet fuel and co-products from forest residuals places a new dynamic on forest practices and environmental impacts. The research funded by NARA will provide tools and analysis useful to determine these impacts. Now is the time to identify environmental concerns and opportunities associated with this emerging industry. Included in NARA's outreach efforts, we will participate in the Public Interest Environmental Law Conference (PIEIC) in Eugene, Oregon this February. In addition, NARA is sponsoring a "Northwest Wood-Based Biofuels + Co-Products Conference" in Seattle April 28-30. This conference will feature speakers who will address the environmental issues surrounding woody biomass utilization for biofuels and value-added co-products.

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