Harvesting Forest Biomass as a Sustainable Fuel Source

In order to curb the threat of climate change and reliance on fossil fuels, The United States enacted new policies that utilize renewable energy. One such policy, the Energy Policy Act of 2005, created the Renewable Fuel Standard program (RFS)**.** The RFS required that up to 36 billion gallons a year of renewable fuel be mixed into transportation fuels by 2022 and offers financial incentives to encourage the production of biofuel material (Adusumilli & Leidner, 2014). According to the RFS, sources of renewable fuels include agricultural crop residues, animal manure, and forest biomass (Adusumilli & Leidner, 2014). Forest biomass includes wood from thinning, residue left over from logging operations, and byproducts from mills. Though forest biomass is considered a renewable fuel source, there is evidence to suggest it is not a sustainable one.

To be considered a renewable fuel within the RFS, the source material should produce fewer emissions throughout its lifecycle than fossil fuels (Adusumilli & Leidner, 2014). The lifecycle of a fuel consists of its harvesting, transportation, processing, storage, and use. Forest biomass is generally considered carbon neutral because carbon released when burning the fuel will be reabsorbed by new vegetation (Weldemichael & Assefa, 2016). A study comparing the emissions saved by creating and burning wood pellets from forest biomass instead of burning coal shows an eighty three percent reduction in greenhouse gas emissions (Röder, Whittaker, & Thornley, 2015). However, when analyzing the entire life cycle of bio fuels, the emissions savings can drastically decrease. Logging operations use a substantial amount of fossil fuels to operate the equipment and vehicles used to harvest and transport material (Proto, Bacenetti, Macrì, & Zimbalatti, 2017). Additionally, the amount of methane released while storing dried pellets can push the life cycle emissions past those of using coal in just four months. Fossil fuels

are often used in the drying process while creating biofuels, which will further negate the emissions savings (Röder et al., 2015). Once these lifecycle considerations are taken into account, the difference in greenhouse gas emissions produced by using woody biomass instead of coal may not be as substantial as originally thought.

The collecting of woody biomass does seem to have positive impacts when looking past emissions. Due to the advancements in fire suppression, many forests have increased their fuel loading, leading to higher intensity wildfires. This overcrowding has also made forests more susceptible to disease and pest infestations, causing many trees to become un-merchantable for timber production (Mayfield, Foster, Smith, Gan, & Fox, 2006). Thinning for the purpose of collecting biomass can aid in restoring forest resilience and return fuel loads to normal (Polagye, Hodgson, & Malte, 2007). Having a healthy, functioning forest has implications for the economies that rely on harvesting them. With the downturn of the pulpwood market and mill closures, many rural communities have been struggling economically and the collection of biomass can create jobs (Mayfield et al., 2006). Collecting forest biomass after thinning and logging creates new jobs in harvesting and energy production. Additionally, sites usually need to be prepared for replanting after logging operations. This involves removing the slash (leaves, twigs, branches, and stumps) either by burning or disposing of it in a landfill. Harvesting the material instead for biofuels can help the landowner recover some of the costs involved in site preparation (Gan & Smith, 2007). However, a study done to determine the economic value of harvesting biofuel after thinning operations shows that the recovery of material alone will not cover all of the costs of the operation (Polagye et al., 2007). While harvesting biomass may not be economically feasible on its own, the government aims to subsidize it in order to grow the biofuel industry and meet its fossil fuel reduction goals. To supplement this cost difference, the

USDA offers a Biomass Crop Assistance Program (BCAP) to give incentives for delivering woody biomass products to biomass conversion facilities. To qualify, the material must come from treatments in fuel reduction, such as thinning, or infestation removal, not merchantable wood products (United States Department of Agriculture, 2015).

There are also ways in which removing woody biomass can damage forest health. Plant residue is important for soil nutrient balance, fertility, soil carbon pools, and productivity (Lal, 2009). Removing this material can have detrimental effects on the soil. A study in Finland analyzing the contribution of logging slash to soil activity found that whole tree harvest, which leaves less slash, decreases tree growth over time. This may be from decreased nutrient availability from the removal of biomass (B. Adamczyk, S. Adamczyk, Kukkola, Tamminen, & Smolander, 2015). The study found that leaving logging residue on site increased enzyme activities, the rate of nitrogen mineralization, and the amount of carbon and nitrogen found in soil microbial biomass. The needles were shown to provide nutrients that help in the upkeep of soil properties and aid in decomposition and soil enzyme activity. Since needles decompose at a rate of five to ten years they offer these benefits at a faster rate than larger woody debris, which can take decades to decompose (Adamczyk et al., 2015). Tree litter is a vital part of a forest ecosystem and removing it can have long term detrimental effects. The ability of a forest to retain nutrients reduces the reliance on fertilizers for future production (Lal, 2009). It also provides a layer that protects against erosion from rain and other forces. Increased erosion and fertilizer use can have negative effects on water quality, as runoff will end up in waterways (Adusumilli & Leidner, 2014). Tree litter also increases soil fauna activity which leads to improved soil structure and increased macroporosity resulting in higher water retention (Lal, 2009). Without maintaining these residues, there is a cycle of soil and ecosystem degradation that

relies on additional management in order to function properly.

Wildlife and other plant species also rely on the material that would be harvested for bioenergy. Downed woody debris is important to the forest ecosystem for nutrient retention, water dynamics, and wildlife habitat (Grodsky et al., 2016). In forests of the south eastern United States, wintering birds are known to use downed wood, as it is a good source of food from seeds and insects and provides perches and cover. However, findings show that removing this material had little effect on the birds once vegetation began to regrow. Downed wood is important in a young forest, but birds relied more on the structure of the changing vegetation once it reached heights above the wood (Grodsky et al., 2016). In contrast, small mammals of the Olympic Peninsula in Washington rely heavily on coarse woody debris (CWD) for shelter, food, and cover from predators (Carey & Johnson, 1995). It was found that forests that had been managed for timber had reduced CWD compared to old growth forests. Trees that would normally die and fall on their own were removed before they could accumulate on the forest floor for wildlife to use. If wood is collected for energy by thinning or whole tree harvesting, it impacts small mammals that rely on such structures (Carey & Johnson, 1995). Similarly, a study in Sweden looked at changes in biodiversity in old growth forests against managed forests, specifically if the removal of biomass for energy would affect species of conservation interest (Jong & Dahlberg, 2017). It was determined that while removing logging slash did negatively affect biodiversity, it was mostly among generalist species, not specialists. Removing stumps and CWD would have a greater impact on species diversity as a whole, including rare species. As slash decomposes quickly, it is only available for a short while and is used mainly by generalist, opportunists, and rodents. In contrast, stumps and CWD take much longer to decompose and therefore have a lasting effect on the diversity of all species (Jong & Dahlberg, 2017). Therefore, it is important to

limit the amount and type of material removed in biofuel collections to minimize the effect on species that are reliant on these residues.

Considering forest biomass a sustainable fuel source in terms of emissions alone is only looking at part of the equation. The ecological damage and inability to support itself economically without government assistance suggests that it is not a sustainable resource. When the entire life cycle of the fuel is considered, even the reduction in emissions may not be worth the other costs as a long term strategy. The RFS program should take into account these factors when determining fuel renewability so that the Energy Policy Act can have implications beyond simply achieving reduced greenhouse gas emissions.

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