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Research paper

A regional assessment of wood resource sustainability and potential economic impact of the wood pellet market in the U.S. South

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ABSTRACT

The ability to secure financing and local government support for construction of wood pellet facilities can be enhanced by articulating the economic benefits of these production facilities. This analysis explains how local economies can benefit from wood pellet manufacturing by expressing the economic multiplier effect of wood pellet plant operations in terms of employment, wages and salaries, and value-added in each of the 13 states in the U.S. South. Input-output analysis is conducted using the IMPLAN software and 2012 data. The analysis examines how direct effects (e.g., plant operation expenditures and employment) generate additional indirect effects (e.g., purchases by supporting industries and their employees) and induced effects (e.g., household spending by direct and indirect employees) that result in a total effect or cumulative benefit to the local economy. Moreover, this study also assesses wood fiber availability and development potential of wood pellet mills in each U.S. South state based on the annual pulpwood growth and removal trends. This information can be used to communicate the wider benefit to an economy that results from the establishment of a wood pellet facility.

1. Introduction

The South is often referred to as the “wood basket” of the United States because of its extensive timber supply, which has grown considerably to reach where the region stands today in terms of its wood production capacity [1]. Region wide timber production has doubled over past 50 years and currently accounts for 60% of total wood production in the United States [2]. While majority of land-owners value non-timber related benefits as their motivation for owning timberland, research suggests that large acreage owner-ships have propensity towards stumpage production [3]. Timber markets are among the primary factors that will reshape the future of forests and related industries in the South [4]. The emergence of wood-based bioenergy—a new consumer of timber products— has become the most important piece of the puzzle in recent years [4,5], as less is known about its impact on existing timber market dynamics.

Uncertainties do exist, in part, because limited efforts have been made to paint a big picture of how economic opportunities coming from wood-based bioenergy markets are likely to correlate with biomass supply potentials of this region (e.g. Refs. [6,7]). Nonetheless, wood pellet production is a growing industry in the southern United States because of its abundant fiber supply and relatively low shipping costs to Europe [8]. As a substitute for coal-based electricity production, use of wood pellets produced in the U.S. South has become an established strategy for carbon mitigation and greenhouse gas emissions, particularly in Europe and the United Kingdom [9–11]. As of May 2016, 56 wood pellet mills are currently under operation in the Southern United States, having a total production capacity of 10.21 million short tons per year [12]. In state of Georgia alone, nine wood pellet mills were constructed between 2007 and 2013, with several additional mills under development [13]. With the increased European market, wood pellet production brings economic opportunities to the U.S. South [14,15]. One approach to enhance potential growth is through demonstration of benefits of expansion to regional economies [16]. Information that details the benefits of wood pellet manufacturing facility operations can be used to bolster support for financing of facility construction and securing government incentives, tax ex-emptions, and other government support [16].

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To provide information that can be used to describe the potential economic benefits for a range of investments, this analysis reports multiplier values for a range of pellet plant production capacity sizes for each of the 13 states in the U.S. South region (Alabama, Arkansas, Georgia, Florida, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia). Input-output analysis is used to estimate the economic impact of annual operations of wood pellet plants for each state. Using input-output analysis allows for an explanation of how investment in a wood pellet facility generates additional economic activity within a defined economy (i.e. specific state). Besides an IMPLAN analysis, this study also assesses sustainable wood fibers availability and development potential of wood pellet mills in each state based on the annual growth and removal data obtained from the U.S. Forest Service Forest Inventory and Analysis (FIA) program. The following analysis indicates the potential number of wood pellet facilities and their economic impact values by state. The resulting economic impact values and associated multipliers can be used to communicate the wider benefit to an economy that results from the establishment of a wood pellet facility.

1.1. Status of current work

Economic assessment of the wood pellet industry is a relatively underexplored area of research as only a few studies in the southern United States addressed this topic. Joshi et al. [16] used an input-output modelling approach to estimate direct, indirect, and induced economic impacts associated with major wood-based bioenergy industries in Mississippi. The study results suggest that the operation of a wood pellet mill with 75,000 tons per year capacity will generate about 83 jobs and contribute to the local economy by an additional $12 million in terms of economic output. Of note, utilizing information from IMPLAN results, Joshi et al. [16] reported overall economic impacts coming from statewide woody biomass volumes available for additional use. Kabete et al. [17] analyzed the economic impacts related to wood pellet co-firing in portions of Alabama. They found that a moderate-sized facility with annual capacity of 50,000 tons is likely to generate $4.87 million in terms of total output, $2.27 million in value-added, and 36 total full- and part-time jobs. Value-added is the difference between total output and the cost of intermediate inputs and is a measure of the contribution to Gross Domestic Product of an industry or sector. The study suggested that an increase in annual capacity from 50,000 tons to 100,000 tons was likely to enhance overall economic output. Little et al. [18] estimated regional economic impacts associated with construction of a wood pellet facility having 1000 tons per day capacity in Pitt County, North Carolina. The study was based on the assumption that the entire production would be exported to the European market through the port of Wilmington, North Carolina. Analysis-by-parts method was used to estimate the indirect and induced economic contributions. Analysis-by-parts is a technique to create a customized economic activity when a predefined IMPLAN sector does not exist and this is achieved by allocating a spending pattern to a group of defined IMPLAN sectors (i.e., parts). The facility was projected to contribute to the local economy by generating 97 full- or part-time jobs, $69.8 million in economic output, and $16.2 million in terms of labor income.

Other studies reported direct jobs and other economic opportunities coming from the wood pellet industry in the United States. Spelter and Toth [14] reported on the status of North America's wood pellet sector and described potential economic contributions from the rapidly growing wood pellet market. The pellet industry was reported to have generated about 2300 employment opportunities in North America, of which almost one-third (710) were in the southern United States. The research also highlighted increased European interests in the North American wood pellet market. However, the study did not include an economic impact assessment using input-output modeling, so there were no reported economic multipliers to account for inter-industry linkages. Similarly, Mani et al. [19] provided an engineering-based economic analysis in which plant capacity, feedstock cost, and other costs of wood pellet manufacturing were estimated. While this study did not provide an accounting of total employment opportunities and other economic indicators associated with pellet mill operation, results revealed that any operation in a wood pellet facility having more than 10 tons per hour capacity would decrease the cost by $11 per ton. Pirranglia et al. [20] conducted a techno-economic analysis of the pellet industry in United States in which the focus was on production costs and related market trends. The authors identified that an average sized pellet mill with an annual capacity of 75,000 dry tons per year generates about 30 direct jobs to the local economy. These results were consistent with the findings by Lu and Rice [21], who revealed that the majority of pellet mills in the United States generate nearly 20 jobs.

Some important observations from the existing literature on wood pellet markets are worth noting. First, a handful of multi-county or state-specific studies have identified economic impacts coming from construction and operation of wood pellet industries in the southern United States. Second, none of the existing literature provided insights on the potential impact of wood pellet production on sustainability of the wood resource base in the entire southern United States. Third, existing efforts are confined to a state or select group of counties within a state (e.g. Mississippi, Alabama) with no assessment on the economics of wood pellets in a broader geographic extent, such as the southern United States. Finally, no previous study has examined the status of wood fibers uses and total availability of wood resources for potential development and sustainable operations of wood pellet mills in the entire U.S. South.

2. Methods

Using an input-output analysis, this study examines how direct effects (e.g., plant operation expenditures and employment) generate additional (i.e., multiplier effect) indirect effects (e.g., purchases by supporting industries and their employees) and induced effects (e.g., household spending by direct and indirect employees) that result in a total effect or cumulative benefit to the local economy.

Our work is theoretically grounded on the premises of an input-output model — a framework developed by Wassily Leontief to analyze macroeconomic impacts of production input and interdependence of industries within the economy (Miller and Blair 1985). The mathematical structure of an input-output model is set up with n linear equations each representing a sector having n unknowns.

In matrix form, this relationship can be written as:

$$AX + Y = X \quad (1)$$

In above equation, Y represents vector of final demand, X represents total output, and A represents a technical coefficient. Simplifying equation (1) provides a relationship: $X = (I\text{-}A)^{-1} Y$, which is often called a solution equation of input-output analysis. The matrix component $(I\text{-}A)^{-1}$ is called Leontief inverse matrix, which estimates an amount of direct and indirect output needed to meet the required level of a final demand [22,23].

Input-output analysis is conducted using IMPLAN software and 2012 data, which uses an input-output transaction table based on North American Industrial Classification System (NAICS). IMPLAN is a widely accepted non-survey-based computer software and modeling system originally developed by the U.S. Forest Service,