A Comparison of Empirical and Theoretical Eucalyptus Yields in Brazil

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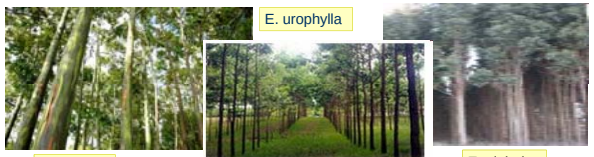
Introduction & Background

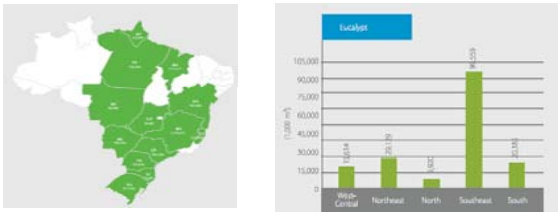
This project is part of an overarching effort to estimate the feedstock potential of eucalyptus species for biofuel production in Brazil. The primary focus of the project is to review the literature on empirically estimated eucalyptus productivity in Brazil and compare these to theoretical estimates. This serves two important purposes for biofuel feedstock analysis. First, the comparison demonstrates the potential error from estimating feedstock potential based on theoretical yield calculations. Second, the data derived from the literature will provide insights into the determinants of eucalyptus yield in Brazil. This information will be useful in the development of methods for projecting realistic estimates of eucalyptus feedstock potential in Brazil.

There are over 700 species of eucalyptus that are mostly native to Australia - about 20 of these species are grown outside Australia. Eucalyptus is one of the most widely grown hardwoods in the world. Several eucalyptus species are potentially low cost sources of woody feedstock for biofuel production because of their rapid growth and adaptability to a wide range of climates. For pulp production and increasingly for solid wood, E. grandis, E. urophylla and their hybrids are the most favored in tropical and subtropical regions with E. globulus favored in temperate regions.[5]



Eucalyptus Production & Use in Brazil

Eucalyptus plantation area in Brazil was estimated at 4.3 million hectares in 2008 compared with about 1.9 million hectares for pine and 0.5 million hectares for other forests. Eucalyptus plantation area in Brazil has been growing rapidly with an average annual growth rate of 7.4% between 2004 and 2008. The most highly productive regions of Brazil are in the states of Minas Gerais, Sao Paulo, Rio Grande do Sul, and Esprito Santo. [1]



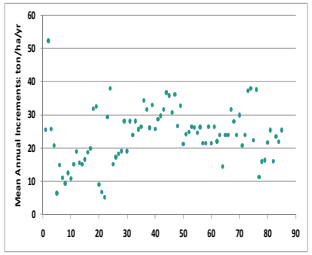
The annual roundwood production from planted forests in Brazil totaled 166.8 million m³ in 2007, out of which 111.5 million m³ (64.0%) was industrial roundwood, with the remaining being fuelwood (22.7%), and charcoal (13.4%).[1]

Roundwood production from eucalyptus, is concentrated (57.0%) in the Southeast, followed by the Northeast and South regions. These planted forests are mainly associated with the pulp and paper, the charcoal-based pig iron and steel, and reconstituted wood panel industries in these regions.

Methods

This project conducted a review of the literature to compile empirical data on eucalyptus yield measurements under various conditions in Brazil. Comparative graphical analysis was used to evaluate the relative role of various determinants of eucalyptus yield. Finally, the empirical data were compared against yields estimated from a theoretical model.

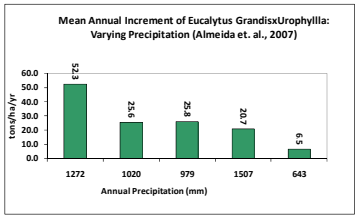
Measured Eucalyptus Productivity Levels: Four studies[2,4,5]



1. Measured productivity levels vary from 6 to 53 ton/ha/yr.
2. Most estimates fall in the 20 – 30 ton/ha/yr range.
3. Determinants of eucalyptus productivity identified in the literature include: water availability (precipitation & irrigation), fertilization, temperature, altitude, soil characteristics, and management practices, such as weeding.[6,7,8]

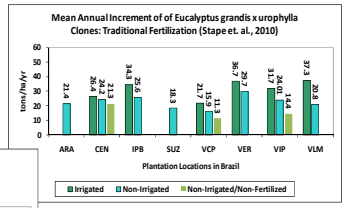
Determinants of Productivity: Precipitation

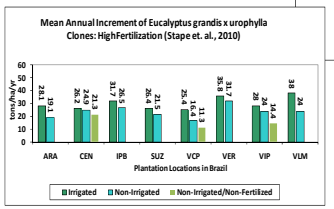
1. Water availability is a major determinant of eucalyptus productivity.
2. Low water availability in areas otherwise suitable for eucalyptus may require irrigation given the large influence of water on productivity



Determinants of Productivity: Irrigation & Fertilization

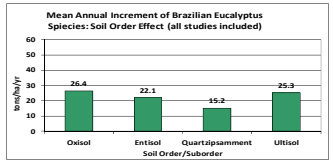
Irrigated plantations are shown to be uniformly more productive vs. non-irrigated plantations.





Fertilized plantations are also more productive than non-fertilized ones, but high fertilization seems to contribute little additional productivity

Determinants of Productivity: Soil Characteristics

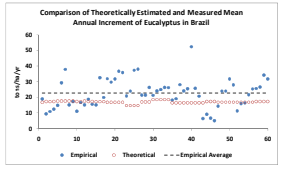


Oxisols are highly weathered soils of tropical and subtropical regions. Oxisols characteristically occur on land surfaces that have been stable for a long time. They have low natural fertility as well as a low capacity to retain additions of lime and fertilizer.

Ultisols are soils in humid areas. They are typically acidic soils in which most nutrients are concentrated in the upper few inches. They have a moderately low capacity to retain additions of lime and fertilizer.

Entisols occur in areas of recently deposited parent materials or in areas where erosion or deposition rates are faster than the rate of soil development; such as dunes, steep slopes and flood planes. Quartzipsamment is a sub-order of entisols.

Results & Discussion: Comparison to Theoretical Estimates[10]



Theoretical estimates of productivity tend to show small variations for a number of reasons:

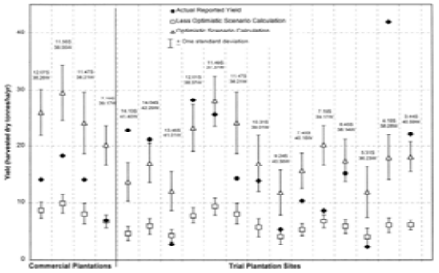
1. The calculations often incorporate only few climatic, soil and species data.

2. Variables, such as temperature and precipitation, used in theoretical calculations are generally long-term averages that do not match actual site conditions.

3. Plant data used for the simulations may not match the typical genetically modified species in actual plantations. Theoretical estimates appear to be useful only as a gauge of average productivity values. However, substantial differences between theoretical and empirical averages suggest that the former is still not very reliable.

Schneider et al (2001) reported substantial differences between estimated and measured yields in a previous study of Northeastern Brazil.

The range of the two evaluated scenarios around the empirical estimates were as large as 30 ton/ha/year.



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