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BIOMASS ELECTRIC POWER PLANTS: LAND USE IMPACTS FOR FORESTRY AND AGRICULTURE

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Abstract: Sharply increasing timber prices in Minnesota reflect an imbalance in the ageclass distribution of the cover types that are most important to the forest industry. This paper examines the potential contributions that short-rotation forest crops grown on marginal agricultural lands can make in producing biomass for wood-base power plants and in supplying wood to the forest industry. A large-scale regional scheduling model was used to allocate forest and agricultural lands in order to minimize wood production costs for forest industry as well as power plant uses. Alternative potential sites for a wood-based power plant were examined in terms of wood production costs and of transportation implications. Preliminary recommendations as to the most appropriate agricultural lands and sites for power plants are made. The higher productivity of agricultural lands leads to reduced harvesting of forest lands. The associated indirect environmental benefits and the direct environmental benefits from putting agricultural lands under tree cover are the subject of additional research.

Keywords: Wood energy, short-rotation forestry, agricultural tree production, timber supply costs, harvest scheduling

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Introduction

Increasing demand for wood has put upward pressure on timber prices over the past few years. Plans for one or more wood-burning power plants are adding to this demand and pressure on timber prices. Management intensification in selected locations close to major forest industry centers can reduce price pressures by growing wood more efficiently and help mitigate the increasing constraints imposed on forest managers especially of public forests. Although the sustainable harvest level of forest lands in Minnesota could be increased through intensive management, at issue are the relative cost of such intensification and the priority that timber production should receive. Some of the public argues that relatively few undisturbed forested acres remain in Minnesota and that many of those acres should be preserved. Arguments are also being made that more forested acres should be managed using longer rotations and less intensive management. With increased wood demands from the forest industry, there are more pressures than ever on forest resources.

In Minnesota, almost two million acres of marginal agricultural lands have been idled under Federal Conservation Reserve Program (CRP) contracts (Taff 1993). Many of these contracts began to expire in 1996 with nearly 80 percent expiring by the end of 1998. Some of these lands may be a potential source of wood. Marginal agricultural lands can support fast growing hybrid tree species such as poplar which have average annual growth rates that are ten times those of native hardwoods grown naturally on the same site (Strong and Hansen1993). The conversion of a portion of these lands to intensively managed short rotation tree crop production may be a viable alternative. However, the identification of locations where such conversion to forest crops is attractive for a farmer depends on the interaction of complex market forces, land characteristics, and government policies. Forest industries in Minnesota due to increasing supply pressures and associated price increases for raw materials are in a strong position to compete with potential wood-based powerplants for the wood coming from intensively managed plantations on agricultural lands.

Inclusion of CRP lands in the forest resource base can mean significant savings in public expenditures currently incurred in order to make contract payments. The modeling of timber supply with traditional forest lands and agricultural lands as well as the addition of new demand centers in the form of wood-based powerplants is adding to the complexity of resource management decisions. Policy decisions concerning subsidies for marginal farm lands, transportation issues, carbon credits, renewable energy and management of public forest lands require an understanding of the economic and environmental impacts of different location-specific wood demand scenarios.

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Background

Forest land occupies 16.7 million acres of Minnesota, roughly 31 percent of the state. In 1990, Minnesota's wood industry employed nearly 59 thousand people with gross sales of $6.2 billion. Statewide harvest levels have increased from 2.3 million cords in 1980 to 4.9 million cords in 1995. Growth of the forest products industry has been accompanied by increasing demands for preserving old-growth forests, for maintaining biological diversity, and for considering forest management impacts on the tourism industry. It is not surprising that there has been substantial concern about the ability of the forest resource to sustain an expanding forest industry. Over $800,000 of State funds were invested in the first-ever Minnesota Generic Environmental Impact Study (GEIS) to address the impacts of increased timber harvesting in Minnesota (Jaakko Pöyry 1992). This study identified severe physical shortfalls for aspen, the most important species for the industry, within 1-2 decades even under current forest industry demands. The study also illustrated that additional constraints on timber management for environmental reasons will further exacerbate the supply shortages. The shortages in industrial requirements of aspen products can be overcome in a number of ways. Forest industries can either import the balance of their aspen requirements from other states or use substitutes for aspen from sources within the state. Importing aspen can be an increasingly expensive operation because of transportation costs. It will also result in additional pressures on the forest resources of the exporting states. The use of aspen substitutes such as hybrid poplar from locations within Minnesota will require forest industries to invest in the modification or purchase of new compatible processing equipment.

In the following we will describe some results of a research project that examined how timber supplies in Minnesota could be sustained and what role agricultural lands might play in supporting the forest industry and an emerging wood-based power plant industry. The associated project "Identifying Potential Sites for Energy Production from Woody Biomass" was funded by the Consortium for Plant Biotechnology Research (CPBR) and the Minnesota Center for Transportation Studies (CTS).

Model Description

A management scheduling model(Hoganson and Rose 1984, 1989) was used to allocate forest and agricultural lands by choosing among numerous management options. These options were developed using the prescription writer RxWrite (McDill and Rose 1991), a set of software programs compatible with the scheduling model. The prescription writer simulates harvesting and different types of thinnings. RxWrite utilizes all stand-level inventory data including individual tree records. Tree growth over time was simulated using the Stand and Tree Evaluation and Modeling System (STEMS) which was developed by the USDA Forest Service (Belcher et al. 1982). The model was used to simulate sets of specified management options for a given stand or group of stands. The output from these simulations was converted into input files for use by the scheduling model version used in this study, DTRAN, which recognizes alternative market location (Hoganson and Kapple 1991). Timber products demand in six forest markets were modeled for ten 10-year planning periods. Six aggregated forest product markets were considered in this study, located in Brainerd, Bemidji, Cook, Duluth, Grand Rapids, and International Falls. These locations represent the concentration of major forest industries in Minnesota. The timber product requirements were similar to those modeled in the Minnesota GEIS medium scenario (Jaakko Pöyry 1992). These demands reflect the future raw material requirements of the existing forest industries as well as those projected to 1997. Forest management options representing traditional and environmentally restricted management practices were used, along with hybrid poplar production on agricultural lands.

Information about the commercial forest land of about 13 million acres for this research was taken from the latest North Central Forest Inventory and Analysis (NCFIA) project conducted by the USDA Forest Experiment Stations. The farm land data set for this study of about 1.8 million acres of land enrolled in Minnesota was obtained from the Minnesota Department of Agriculture (MDA). Acreage reported as highly erodible was excluded from any further analysis. These exclusions reduced the agricultural land base considered for tree production to 438,364 acres, about 26 percent of the original database. Annual cash rental rates were used to determine the land owner's opportunity cost of growing hybrid poplar.

Yield estimates for hybrid poplar were derived from a network of research plantations which were established in a five state region of the north central U.S during the 1980s (Hansen et al. 1994). Yield rates were modeled as a function of land capability classes and subclasses, rainfall, and soil types.

Estimates of variable production costs for hybrid poplar production were obtained from the Natural Resources Research Institute (Berguson 1994) based on actual cost data associated with a network of plantations in Minnesota and Wisconsin.

The harvest cost model was specifically designed for the forest harvest conditions encountered in Minnesota (Jaakko Pöyry 1992). It accounted for factors such as clear-cut or thinning, average tree size, volume per acre, off road distance, and total volume harvested.. Harvesting cost estimates for hybrid poplar were based on data by the Oak Ridge National Laboratories (ORNL) for the Great Lakes region (Walsh 1994). Transportation costs were generated using actual road distances between analysis areas and the market locations.

The most direct output of the scheduling model are the estimated shadow prices for products at various levels of production over time. Differences in production costs between different management scenarios measure the trade-offs of changing forest product demands and management constraints.

Key Findings

Detailed findings can be reviewed in a number of publications describing this research project (Rose and Husain 1998a, 1998b; Husain and Rose 1998a, b). Shadow prices for major species were significantly higher in the restricted runs than in the unrestricted runs because of the reduced forest acreage and because of higher costs of restricted management alternatives. This difference in shadow prices is one measure of the cost of imposing environmental restrictions on forest management. The inclusion of agricultural lands for wood production helped meet timber product demands, particularly in those planning periods where not enough timber was available from forest lands.

Inclusion of intensively managed CRP lands can result in significant shifts in the traditional forest land use and can help meet the ever increasing demand for timber (Rose and Husain 1998a, 1998b; Husain and Rose 1998a, b) . Land use decisions and policies affecting these decisions in the agriculture and forestry sectors have significant impacts on rural highways as well as the cost of transporting wood. Transportation costs make up a significant portion of delivered timber costs. Cost differences impact competitiveness and locational advantages for individual producers . Siting decisions for new powerplants have important impacts. Two powerplant sites examined in the study, Alexandria and Granite Falls, appear to be poor choices. Short-rotation hybrid poplar grown in the model on Conservation Reserve Program (CRP) agricultural lands almost exclusively is being transported to forest industrial production centers far away from the wood production sites. This is a direct result of the ability of the forest industry to compete for this wood fiber which is a good substitute for a scarce aspen resource. On the other hand, wood fuel needs by the identified powerplants are met from forest lands, mostly the relatively abundant northern hardwood covertype, and wood is transported a fair distance from the wood production to the consumption centers in Alexandria and Granite Falls. This results in more pressure on roads than necessary under better siting decisions for powerplants and for wood production. Fuelwood energy costs were shown to be in a range that makes wood an attractive renewable energy alternative. The study also identified supply bottlenecks in terms of where and when they can be expected to occur and identified locations where management intensification might have the greatest benefits in terms of reduced road impacts, transportation costs, and income opportunities for rural farmers. Wood production opportunities for agricultural lands in specific townships were identified by the study.

In addition to direct economic benefits to farmers and the wood using industries, these tree plantations on agricultural lands are expected to generate two types of environmental benefits. One, are environmental benefits associated with tree versus an agricultural cover crop on the selected agricultural sites, the second are the environmental benefits of harvesting fewer forest acres because of the increased wood production potential of intensive short-rotation systems. Agricultural lands utilized to grow wood in intensive, short-rotation crop systems can at the same time protect soil resources, provide wildlife habitat, and help reduce the pressure on forest resources especially where critical and fragile ecosystems are involved such as in the riparian zones, more erodible soils and in certain locations where public demand for non-timber services are strong.

While that study answered a number of questions, it also raised several additional issues. These questions are being currently addressed in a second year of funding from CPBR and CTS. One was the need for examination of questions surrounding the use of industrial wood residues in power generation. The use of industrial wood residue can have great significance in power plant siting decisions. Many forest industries are co-generating power, but are faced with excess supplies of wood residues. The emergence of increasing environmental restrictions on timber harvesting and the pending deregulation of the power industry are adding a new dimension and complexity to questions of power plant siting and timber management investments. A re-examination of the power plant siting decision has potentially great ramifications for impacts on rural road from trucking traffic, transportation and wood production costs, environmental impacts of timber harvesting and investment opportunities for farmers in Minnesota. We are currently examining three other powerplant sites in northern Minnesota, Bemidji, International Falls and Brainerd. Preliminary results suggest substantial reduction in timber production and transportation costs for some of these new power plant sites. Better land use policies and decisions which can reduce the impacts on rural roads, and transportation costs and which can improve the environment and the income potential for farmers will be formulated from this research.

Summary

Ongoing research on agricultural land-use has examined the economic issues associated with producing wood for forest industries and power plants from forest versus agricultural lands and have identified the opportunities and trade-offs for producing wood on marginal agricultural lands. Conversion of marginal agricultural lands to the growing of intensively managed tree crops has the potential to reduce timber costs, to contribute to rural economic development.

Siting decisions should not only be based on the wood production costs and the potential for rural economic development. An additional key factor is to make site selection in such a way that the environmental benefits of growing trees on agricultural lands are maximized. One of the key contributions of intensive wood production on marginal agricultural lands is the potentially large reduction in the harvest acreage needed to supply the industries' demand for wood. Certain agricultural lands can be efficiently utilized to grow additional wood in intensive, short-rotation crop systems while at the same time protecting soil resources, providing wildlife habitat, and by helping reduce the pressure on forest resources. This is especially important where fragile ecosystems are involved such as in the riparian zones. This provides opportunities for improving the environmental conditions of large forest areas without impacting on the ability to supply wood fiber. Additional environmental benefits are expected from the conversion of agricultural lands from annual to wood crops.

To maximize direct environmental benefits we need to understand which aspects of a specific agricultural land accounts for any environmental benefits. They could be related to specific physical properties of a site and equally important to the landscape, e.g., river basin, in which this site occurs. In order to maximize indirect environmental benefits associated with reduced need for harvest acreage, we need to understand the environmental benefits associated with not harvesting specific forest lands. These benefits as in the case of agricultural lands are related to specific physical properties of a site as well as the landscape in which the site occurs.

The development of guidelines for the assignment of marginal agricultural lands to their best use in terms of economic and environmental considerations will help farmers as well as government policy makers make better resource decisions that will generate economic benefits to farmers and economic and environmental benefits to the state. This research is also useful to decision makers in state agencies for developing land use policies and incentive programs. Environmental trade-off analyses are considerably more complex than the siting decisions related to minimizing wood production and transportation costs. However, the development of government policies in the form of regulations and/or incentives for growing trees on agricultural and forest lands requires an understanding of both the economic and environmental benefits associated with regional decisions on how agricultural and forest lands are to be managed in the future.

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