Supply and Social Cost Estimates for Biomass from Crop Residues in the United States*

PAUL W. GALLAGHER1, MARK DIKEMAN2, JOHN FRITZ3, ERIC WAILES4, WAYNE GAUTHIER5 and HOSEIN SHAPOURI6

1Economics Department, Iowa State University, Ames, Iowa 50011-1070, U.S.A. (E-mail: paulg@iastate.edu); 2Animal Science Department, Iowa State University; 3Agronomy Department Kansas State University, Manhattan, Kansas, U.S.A.; 4Agricultural Economics Department, University of Arkansas, Fayetteville, Arkansas, U.S.A.; 5Agricultural Economics Department, Louisiana State University, Baton Rouge, Louisiana, U.S.A.; 6Office of Energy Policy, U.S. Department of Agriculture, Washington, D.C., U.S.A.

Abstract. The components of social costs included in the supply analysis are cash outlays and opportunity costs associated with harvest and alternative residue uses, potential environmental damage that is avoided by excluding unsuitable land, and costs in moving residues from farms to processing plants. Regional estimates account for the growing conditions and crops of the main agricultural areas of the United States. Estimates include the main U.S. field crops with potential for residue harvest: corn, wheat, sorghum, oats, barley, rice and cane sugar. The potential contribution of residues to U.S. energy needs is discussed.

Key words: biomass supply, crop residues, renewable fuels, sustainable land use, United States agriculture

JEL classifications: Q42, Q21

1. Introduction

Industrial processes for converting biomass into fuel and chemicals now appear on the not-too-distant horizon (Committee on Biobased Industrial Products 2000). Further, some estimates suggest that the physical volume of crop residues compares favorably to other forms of potentially low-cost biomass in the U.S. (Spelman 1994). But there are concerns about competitiveness, sustainability and adequacy of the resource base for biofuels (California Energy Commission 1999). Further, the economic analysis of residue supply as a component of the resource base for the emerging biomass fuel industry is incomplete. Evaluation for public policy requires a resource supply curve that includes both private and social costs. The challenge is

that markets for crop residues do not exist because processing technology has not emerged in the marketplace. So observed supplies and market prices cannot provide the base for estimation. The residue supply analyses of this paper use productivity and opportunity cost calculations for private costs and exclusion criteria that ensure sustainable land use for internalized social costs. The estimates span major crops and agricultural regions of the United States, taking into account local variation in cost-determining factors such as residue yield, competition from alternative uses, and geographic density of residues. Further, residues are included in supply only if harvest avoids soil erosion, so social supply curves approximate farmers’ decisions under a government policy of sustainable land use.

Subsequent sections of the paper look at the residue supply curves for major United States crops. First, methodology is reviewed. Then cost and supply estimates are presented for the major crop producing regions of the United States. The results suggest that crop residues will provide a moderate amount of the U.S. fuel supply when biomass energy technologies are fully developed and adopted.

2. Methodology

Three components of marginal social costs are included in the supply analysis. First, the cash outlays and opportunity costs associated with harvest or farm use of residues are borne by farmers. Second, land is excluded when residue harvest could cause environmental damage; so the environmental cost of the included supply is negligible. Third, society incurs costs in moving residues from the farm to the processing plant.

2.1. Farm Supply

Entry-point supply estimation is useful at the farm level because producer participation in residue harvest is the main supply adjustment. Individual firms or local supply areas are sorted with low-cost producers first and high-cost producers last. The capacity that corresponds to a particular entry price is included in supply when costs are covered. Elsewhere, entry point supply analysis is used for analysis of the supply of transport services in international trade (Shimojo 1979); and producer participation decisions in Government agriculture programs (Hoag and Holloway 1991; Perry et al. 1989).

Two types of economic information are developed for each producer or local supply area. First, the height of the local supply function is identified with cost calculations. Second, a residue balance sheet identifies the output that is available at the cost threshold. Then firms or groups of firms with particular types of outputs are ordered from low-cost to high-cost and aggregated for regional estimates. All cost, output, and feed estimates are developed with county data since agronomic conditions are uniform at this level. Also, data from 1997 forms the baseline because the