Land Use Implications of Biofuel Crop Production

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What are the land use implications of aviation biofuels from the most promising biofuel crops (in the US and Globally)?

In order to address this question, one must ask the question how much biofuel. The impacts will differ from virtually no national impacts if only a small number of facilities are planned to significant impacts to address proposed national objectives. Dr. Daniel De La Torre Ugarte and I have conducted numerous analyses incorporating different goals during the past 3 years. We have looked at the impacts of producing 60 billion gallons by 2030, 18 billion gallons of corn ethanol by 2015,81 billion gallons by 2025, and just recently completed an EISA analysis. We have developed energy bio-feedstock supply curves to the Department of Energy for their NEMS modeling system. We have found different land use impacts with each of these analyses. We have not, however, extended these to a global view. Our domestic comments are limited to those land use impacts resulting from meeting the EISA requirements.

An analytical tool called POLYSYS, developed at the University of Tennessee, is used to estimate changes in land management, crop production, farm income, and commodity prices, and determining the energy and carbon dynamics associated with these changes. The POLYSYS model is a variant of an equilibrium displacement model that is capable of estimating annual changes in land use, environmental quality, prices, income, and government payments as a result of a policy scenario and was developed to simulate changes in economic policy, agricultural management, and natural resource conditions and to estimate the resulting impacts from these changes on the US agricultural sector (De La Torre Ugarte et al, 1998,2003,2006,2007; De La Torre Ugarte and Ray, 2000; Ray et al, 1998).

At its core, POL YSYS is a system of interdependent modules that simulate (a) crop supply for the continental US, (b) national crop demands and prices, (c) national livestock supply and demand, and (d) agricultural income. Variables that drive these modules include planted and harvested areas, production inputs, yields, exports, production costs, demand by use, farm prices, government program outlays, and net realized incomes. Among the issues analyzed with POL YSYS are the potential effects of farm bill changes, bioenergy supply, EI Nino events, elimination of CRP, erosion benefits of alternative management plans, and free trade agreements.

The POLYSYS model currently incorporates switchgrass, crop and forest residues as eligible feedstocks. However it is important to note that switchgrass can be seen as a generic dedicated energy crop, which would be representing the land use requirements, implicit in the use of other energy crops for which data is not readily available. The use of switchgrass as a model crop representing other energy crops, could underestimate the production potential of feedstock that has a superior yield/cost relationship in a particular geographic area when compared to switchgrass, and consequently could underestimate the potential of specific regions of the country as candidate locations for potential bio energy projects. Although SRWC are not directly included because lack of updated cost and yield data, results from previous POLYSYS studies (De La Torre Ugarte et ai, 2003) indicate that SRWC may have a comparative advantage in the Pacific Northwest and in the Northeast.

To meet EISA, ethanol comes from a multitude of feedstocks such as corn, corn stover, wheat straw, and dedicated energy crops. The analysis we did focused on the impacts to net farm income; farm prices; government payments; land use shifts; and environmental implications as well as direct, indirect, and induced economic impacts as a result of changes in the aforementioned variables.

To model this, POLYSYS was used to estimate the quantity and price of feedstock nece ssary to achieve the EISA targets through 2023. Figure 1 illustrates the resulting contribution of the above-mentioned feedstock to achieve the EISA goals. One can observe the significant contribution that crop residues would make in the short term, while the contribution of dedicated energy crops would be essential to achieve the targets beyond 2016. When accounting for the contribution for forest residues, it would be expected that residues would make a significant portion of the feedstock supply and influence a reduction in feedstock prices.

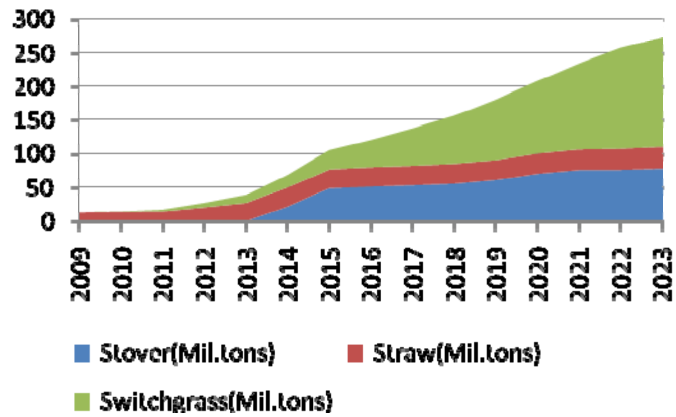

Figure 1. Feedstock Participation in Achieving EISA Target (Million of dry tons)

This scenario does cause some land shifts. Wheat and soybeans are the most impacted, while corn, because of the increased revenues from the collection of stover is able to increase its acreage. The acreage of hay shows some minor reduction. As shown in the Table handout, there is expected to be an increase in the total land under cropping. This increase indicates how many acres of cropland in pasture have left pasture to a higher value use. All of these changes are in response to the increase in the plantings of energy dedicated crops, which by 2023 reach over 30 million acres. The actual transition in acreage is that acreage currently in hay shifts to dedicated energy crop production. As a result, the cropland remaining in pasture will be planted in hay or used more intensively. The extent of the impacts of the shift of pasture in cropland to switchgrass will depend on the ability of farmers/ranchers to increase the forage productivity of the more than 350 million acres in pastureland. Increased forage productivity could be achieved by fertilization, and/or by increasing the management intensity of pastures. By the year 2023, 11 million acres in cropland pasture shift into a higher use; about 2 million make up for the loss of hay acreage and the other 9 million shift to dedicated energy crop production.

Implementing EISA could result in a mixed environmental picture. A decline in soil carbon is estimated ranging from 3.4 percent to as high as 22.6 percent primarily due to utilization of acreages for crop residue removal and conversion of previous hayland and pasture to bioenergy crops. As a result of increased demand for cellulose, both land use and a movement occurs toward reduced and no tillage production practices. These changes bring about a reduction in erosion as cellulosic ethanol increases. Nearly 40 million tons of gross soil erosion are saved annually. If there 160 tons of soil in an inch of top soil, then an estimated 243,000 inches of topsoil are saved each year.