Iowa State University

Department of Industrial and Manufacturing Systems Engineering

Spring 2012 Seminar

An Economic Analysis of the Future U.S. Biofuel Industry, Facility Location, and Supply Chain Network

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Abstract

The Renewable Fuel Standard (RFS) mandates blending 36 billion gallons of renewable biofuels with conventional transportation fuels by 2022, of which 16 billion gallons must be derived from celullosic biomass. This will intensify the competition between traditional food/feed crops and biofuel feedstocks on limited agricultural lands. We determine the agricultural supply response and economic equilibrium in the commodity markets considering the interaction between multiple production activities. Because of the spatial heterogeneity in the costs and yields of biomass and food/feed crops, supply responses are modeled in a regionally disaggregated framework. Feedstock production depends also on the locations of biorefineries which currently do not exist (except a few demonstrative facilities). Conversely, the locations of future cellulosic biorefineries would depend on the spatial distribution of biomass supply. Therefore a facility location component is incorporated in the equilibrium analysis. This leads to a dynamic, nonlinear mixed integer programming (MINLP) model. With a large number of supply units and potential processing locations involved, the problem cannot be solved directly using MINLP solvers. We use a sequential two-stage solution procedure with feedbacks where the MINLP model is decomposed into a price endogenous agricultural sector model that solves the supply response and equilibrium in agricultural product markets, and a dynamic linear mixed-integer programming (MIP) model that solves the optimum facility location and delivery network. Due to the large number of binary variables involved, computational difficulty was encountered when solving the MIP model as well. We employ a backward progression technique to obtain an approximate solution of the problem. Using a reasonably small test case we demonstrate that this procedure is computationally convenient and produces almost optimal solutions. We apply this method to the full scale problem where nearly 3,000 U.S. counties are considered both as spatial supply units and potential refinery locations. Empirical results show that biofuel mandates will lead to a significant increase in commodity prices, the optimum refinery locations would be in the regions that have comparative advantage in producing biofuel feedstocks, and incorporating the biofuel refinery locations in land use decisions makes a substantial difference in the regional distribution of biomass production.

About the Speaker

Hayri Önal received bis BS and MS in Mathematics and PhD in Operations Research, all from the Middle East Technical University (METU), Ankara, Turkey. He served as a faculty member in the Department of Mathematics and Department of Industrial Engineering of METU before joining the University of Illinois at Urbana-Champaign in 1989. Currently he is a professor in the Department of Agricultural and Consumer Economics. He teaches mathematics for economists, applied mathematical programming, and dynamic simulation courses. His current research focuses on conservation reserve design, spatial optimization, land use allocation, economic analysis of biofuels, and agricultural policy analysis.