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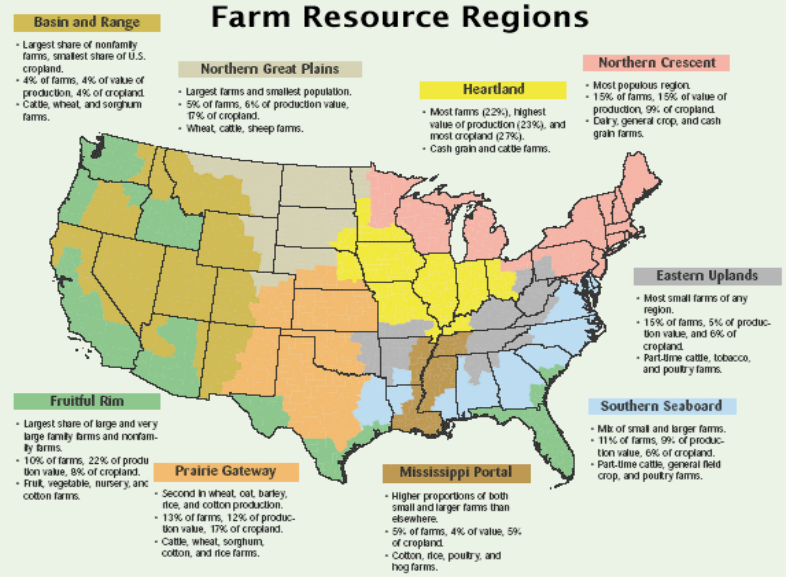
A Brief Description of AGSIM:
An Econometric-Simulation Model of the Agricultural Economy Used for Biofuel Evaluation

C. Robert Taylor
Mollie M. Taylor

AGSIM is an economic impact simulation model of the United States agricultural economy. The simulation model is based on a large set of econometrically estimated dynamic demand and supply equations for major field crops produced in the United States. The present "BioFuel" version of the model includes supply and utilization of major field crops for biofuel production. Supply of the major field crops is regionalized for the nine resource regions defined by United States Department of Agriculture (USDA) (see Figure 1). Demand for each commodity is separated into various components, including exports, several categories of domestic utilization, and ending stocks. Production of ethanol from corn and soy-based biodiesel is exogenously specified by year and can be varied to estimate the aggregate economic impacts of increasing or decreasing biofuel production.

Figure 1. USDA Farm Resource Regions



AGSIM simulates the aggregate economic impacts of exogenously specified biofuel production on all endogenous variables in the model, including prices, utilization by category, regional acreage planted and harvested, and production for each crop for each year, starting with historical data and predicting into the

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future as far as the 2030/31 crop year. [1] AGSIM also provides estimates of the changes in economic welfare based on the concept of economic surplus, which is generally accepted as the best empirically operational measure of how policy would impact the agricultural economy and food consumers. AGSIM is keyed to the USDA annual baseline published in February of each year.

The model is capable of analyzing the effects of changes in policies that affect crop yields or production costs simultaneously with biofuel policy. Regional supply of each commodity in the model depends on per-acre returns of that commodity relative to per-acre returns of other crops modeled. This is achieved by estimating how farmers will adjust crop acreage between commodities when relative profitability changes as a result of policy-induced crop yield and/or production cost changes. Acreage and yield changes from various scenarios affect total production of crops, which simultaneously affects both commodity prices and consumption.

The simulation component of the model finds the set of prices for all commodities endogenous to the model that simultaneously clear all markets in each year over the simulation period. Commodity price changes, in turn, affect profitability and cropping patterns in subsequent years. Federal farm program and conservation reserve program (CRP) effects are also incorporated into the model. CRP acreage by region and by year is exogenously specified in the model, and can be exogenously specified to differ by biofuel policy in each future year.

AGSIM is contained in a single Excel file that includes historical data back to 1976, baseline data for future years, and data for the policy scenario generated by AGSIM from exogenously specified biofuel policy parameters. The set of prices that simultaneously clear all crop markets in each year is obtained numerically with a VBA (Visual Basic for Applications) program that is hidden from the user but triggered by an Excel macro. Availability of all historical data, baseline data and policy estimates allows the user great flexibility in graphing and summarizing model results of interest. Some variables, such as price changes, total acreage changes, and economic surplus changes are automatically graphed when the model runs.

Historical and Forecasted Baseline Data

Historical data on about one thousand variables are included in the model. This serves two purposes in the model. First, historical data are required to initialize simulation of dynamic demand and supply relationships. Second, econometric software can be used to access the historical data in Excel worksheets for statistical estimation.

[1] AGSIM estimates "direct" economic impacts and, as such, does not estimate the indirect or "multiplier" effects on either the agricultural or non-agricultural industries, although input/output (multiplier) models can be linked to AGSIM output.

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AGSIM requires full internal consistency of historical data, future baseline data, and simulated policy data. The sum of regional production of each crop in a particular year must equal national production of that crop for the same year. Similarly, production of a crop in a particular year and region must equal acreage harvested times yield per harvested acre. Supply and utilization (demand) identities are also required for internal consistency. For each crop, beginning stocks plus imports plus production must equal ending stocks plus exports plus domestic utilization.

Maintaining this internal consistency, we developed historical and forecasted data for planted acreage, harvested acreage, yield, utilization, and prices for the major field crops modeled in AGSIM, using data primarily from the USDA. The utilization data include exports, imports, feed or fiber use, other domestic use, stocks, and biofuel use for each crop. Table 1 presents the sources used for the historical data through 2008.

Table 1. Sources for Supply and Utilization Data Through 2008 for the Major Field Crops

Crops	Source
Corn, Sorghum, Barley & Oats	http://www.ers.usda.gov/Data/Feedgrains/StandardReports/YBtable4.htm
Wheat	http://www.ers.usda.gov/Data/Wheat/
Cotton	http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1282
Rice	http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1229
Soybean & Peanut	http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1290
Hay	http://www.ers.usda.gov/Data/FeedGrains/StandardReports/YBtable8.htm

Since the supply component is based on USDA regions that do not follow state boundaries (Figure 1), the regional historical acreage and production data for each crop was developed from USDA county-level acreage, yield and production data.[2] Occasionally the sum of regional acreages obtained from aggregating county data did not sum to the total acreage reported by USDA. When this was found, the regional acreage was keyed to the reported national acreage, and acreage in each region proportionally adjusted to maintain full internal consistency in AGSIM.

[2] Data available at: http://www.nass.usda.gov/QuickStats/Create_County_All.jsp. The county-to-farm-region crosswalk is available at: http://www.ers.usda.gov/briefing/ARMS/resourceregions/readme.htm.

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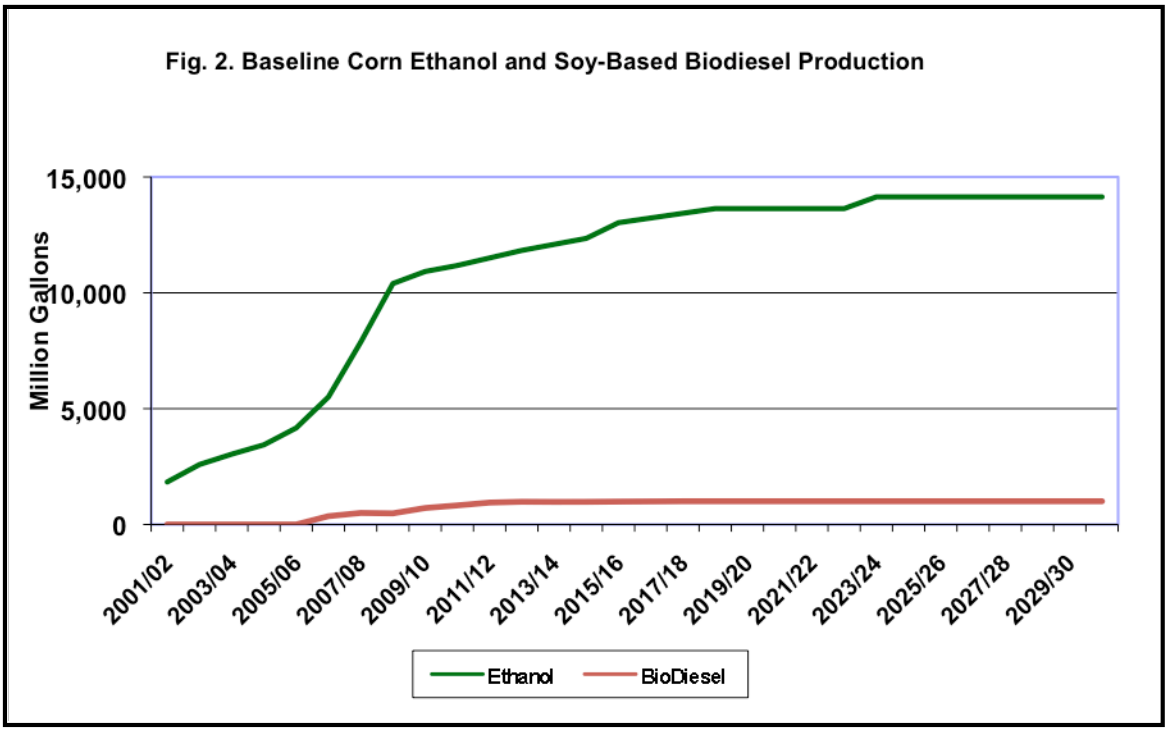
To develop forecasts for the year 2009-2031, we used the "USDA baseline,"[3] which extends for ten years (2009-2018) beyond the last year of historical data, currently 2008. For additional forecast years (2019-2031), we used repeated values from the final year (2018) of the USDA baseline. Because of dynamic relationships in the model, the longer future horizon is needed to capture full equilibrium impacts of policies implemented in earlier years.

Peanuts and hay are not included in the USDA baseline, so for these crops we used a baseline developed by the Food and Agricultural Policy Research Institute (FAPRI).[4] The FAPRI baseline for soybean-based biodiesel was also used in the model, while the corn ethanol baseline was obtained from the USDA. Baseline corn ethanol and soy biodiesel production incorporated into the 2009 baseline are shown in Figure 2.



USDA and FAPRI do not provide regional baseline acreage needed in AGSIM. Consequently, we used the most recent five-year regional averages to generate regional planted and harvested acreage and production from the national baseline.

[3] The USDA baseline for 2009-2018 is available at: http://usda.mannlib.cornell.edu/MannUsda/viewStaticPage.do?url=http://usda.mannlib.cornell.edu/usda/ers/94005/./2009/index.html

[4] The FAPRI forecast is available at: http://www.fapri.iastate.edu/outlook/2009/

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Given the demand and supply relationships in AGSIM, the baseline simulation is used to compute, in essence, demand and supply intercepts to make the appropriate demand and supply relationships intersect at the baseline price and quantity in each year. Intercepts so computed are used in the policy simulation to maintain internal consistency between the baseline and the policy simulation. These two simulations are then compared to estimate the economic impacts of the policy scenario.

Other historical data in the model include variable costs of production for each crop for each of the nine farm resource regions, macroeconomic data including U.S. and world population, U.S. disposable per-capita income, CPI, and real commodity-specific foreign exchange rates. Regional CRP data were aggregated from the county-level using the methodology described above for regional crop acreage. Table 2 lists the sources for these data.

Table 2. Sources for Other Historical Data

Data Type	Source
Regional production costs	http://www.ers.usda.gov/Data/CostsAndReturns/testpick.htm for 2006 and 2007. Future national variable production costs for each crop is available from the USDA baseline. These national future variable costs were treated as crop-specific indices to project regional variable production costs from the 2006 and 2007 values obtained at the above link.
Macroeconomic data	http://www.ers.usda.gov/Publications/AgOutlook/AOTables/
Real trade-weighted commodity specific exchange rate data	http://www.ers.usda.gov/Data/ExchangeRates/
Conservation Reserve Program (CRP)	http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=crp-st

Economic Surplus Calculation

AGSIM provides estimates of the changes in economic welfare based on the widely accepted concept of economic surplus. Consumers' surplus is calculated as the change in price (policy scenario relative to the baseline) times the average quantity (policy and baseline). Consumers' surplus is computed based on farm gate prices and quantities. To the extent that marketing margins are constant at the wholesale and retail levels, this measure of consumers' surplus shows effects on final consumers of food and other commodities produced from the crops included in AGSIM.

Consumer surplus is computed for each utilization category (e.g. feed, food, stocks, export) and for each year simulated. Surplus based on the import equations represents an undetermined amalgam of domestic consumers' and foreign producers' surplus.

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Consumers' surplus based on livestock and poultry feed demand (which are separate utilization categories for each crop) theoretically captures economic welfare impacts of biofuel policy on both livestock and poultry producers, and meat and poultry final consumers. However, since livestock and poultry supply and demand are not modeled, it is impossible in the present version to separate consumers' surplus effects estimated from feed demand equations on producers and final consumers.

Aggregating consumers' surplus change implicitly assumes that all consumers are weighted equally. In other words, a dollar change in foreign consumers' surplus (based on export demand) is equal in welfare terms to a dollar change in domestic surplus. Other weighting schemes could be (but are not) applied to different categories of utilization or to effects in different time periods.

Producers' surplus is typically shown in textbooks as the area above a supply (marginal cost) equation and below the equilibrium price. Theoretically this is equivalent to returns above variable costs. However, agricultural supply equations have historically been so strongly influenced by farm programs that it is not clear exactly what econometrically supply equations measure, other than the net response to prices. In essence, an econometrically estimated agricultural supply equation may not represent marginal production cost because of the historical effects of farm programs, even after econometric specification for AGSIM to try to account for these programs. Hence, in AGSIM effects on "producers" are computed directly from equilibrium prices, crop yields and variable costs of production.

Because land is the primary fixed-factor of production, theory shows that producers' surplus (or net farm income changes computed in AGSIM) generally accrues to land owners. We now have about 75% absentee ownership of cropland in the U.S. Thus there is a growing "labeling" issue with surpluses. What we have traditionally called producers' surplus or farm income increasingly accrues to landowners who are not farmers. So, beneficial effects of biofuel scenarios on "producers" actually accrue mostly to landowners and not to farmers per se.

A Brief Description of Econometrically Estimated Supply and Demand Underlying AGSIM

The crop supply component of AGSIM is based on a set of regional supply equations for the major field crops produced in the United States. Acreage planted is the behavioral relationship driving the regional supply component of the model. There are two key differences between the AGSIM and other large-scale models of the agricultural economy in econometric and simulation specification. One key difference is that AGSIM uses a single behavioral relationship to account for the total planted acreage in a region, while a set of "share" equations allocate the total to individual crops in that region. The total planted acreage equation depends on expected returns to cropping going back as far as ten years. Individual crop share equations depend on expected returns in the current year only. The total planted acreage equation thus accounts for long-run dynamics and is intended to mimic the intermediate-run decision farmers make on how much land to farm, while the individual crop share equations show the short-run decision of what crops to plant on the farm.

A second key difference between AGSIM and other large-scale models of the agricultural economy is that acreage response is based on expected per acre net returns of crop alternatives. Land is the primary fixed

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factor of production, so it is logical that alternative crops would compete on the basis of per acre returns. However, traditional acreage specifications in essentially all other agricultural supply models are based on unit price (e.g. per bushel price of corn), with yield and per acre production cost not appearing in any way in the econometric model specification and thus not appearing in the simulation model. With supply models based on price only, there are potential econometric specification biases; furthermore, there is no logical way to evaluate economic consequences of any policy that would change per acre yield or production costs.

Effects of historical farm programs are reflected in the econometric specification of the supply component of the model, and thus are included in the simulation model. Recent farm programs have essentially decoupled farm program payments from acreage and other production parameters. The 2008 Farm Bill contains direct payments to participating producers and also loan rates for program crops. However, with decoupled payments and commodity loan rates far below current and projected market prices, the program does not have a substantive impact on economic effect of biofuel policy estimated with AGSIM. Thus, historical farm programs are an important consideration in econometric estimation of supply relationships based on historical data, but relatively unimportant given the strong market prices in the USDA baseline.

Demand for each utilization category has a traditional double-log specification, with lagged utilization to account for the dynamics of demand.

BioFuel Parameters

AGSIM is presently structured to evaluate the economic effects of exogenously specified quantities of ethanol from corn and biodiesel from soybeans by year up to the 2030/31 crop year. At present, the model is not structured to evaluate ethanol or bio-oil from conversion of crop residues, hay, or dedicated energy crops.

We exogenously specify biofuel demand. Theoretically, as well as mechanically, we could specify a downward sloping demand function for biofuel, and let AGSIM determine the market equilibrium biofuel price and quantity along with food price and quantity. But given biofuel policy mandates, our present modeling approach is more accurate.Evaluation of corn ethanol and/or soy biodiesel requires exogenous specification of a set of technical parameters. For corn ethanol, the parameters that must be specified by year are:

- Quantity of ethanol to be produced above or below the baseline,
- Per gallon subsidy for corn ethanol conversion (used in economic surplus calculation)
- Bushels of corn required to produce a gallon of ethanol,
- Pounds of by-products (DDGS) that would be generated per bushel of corn,
- Feed equivalent of the by-products in terms of
    - Corn equivalents
    - Soybean (meal) equivalents

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DDGS are included in the present model, and substitute in part for corn feed and for soybeans (meal) feed. DDGS from expanded corn ethanol production would be returned to livestock feed and reduce the net demand for corn and soybeans.

Evaluation of soy-based biodiesel production is incorporated into the model by increasing the domestic demand to crush soybeans for oil and meal. Parameters that must be exogenously specified by year are:

- Quantity of biodiesel to be produced from soybeans, above or below the baseline,
- Pounds of soybean oil per bushel of soybeans crushed,
- Pounds of soybean oil required per gallon of biodiesel produced,
- Per gallon subsidy for biodiesel production from soybean oil (used in economic surplus calculation)

User-specified biodiesel parameters are used to shift the demand for soybeans. Expanded corn ethanol production decreases somewhat the demand for soybeans for crushing, while biodiesel production increases the demand for soybeans for crushing. For policies considering changing both corn ethanol and biodiesel production, the model computes the net effect on soybean demand based on the exogenously specified parameters listed above.

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