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Life Cycle Analysis and Land Use Change of Ethanol

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***Workshop on Biofuel Land Use Change Simulations with the
GTAP Model***
Purdue University, Jan. 26, 2009

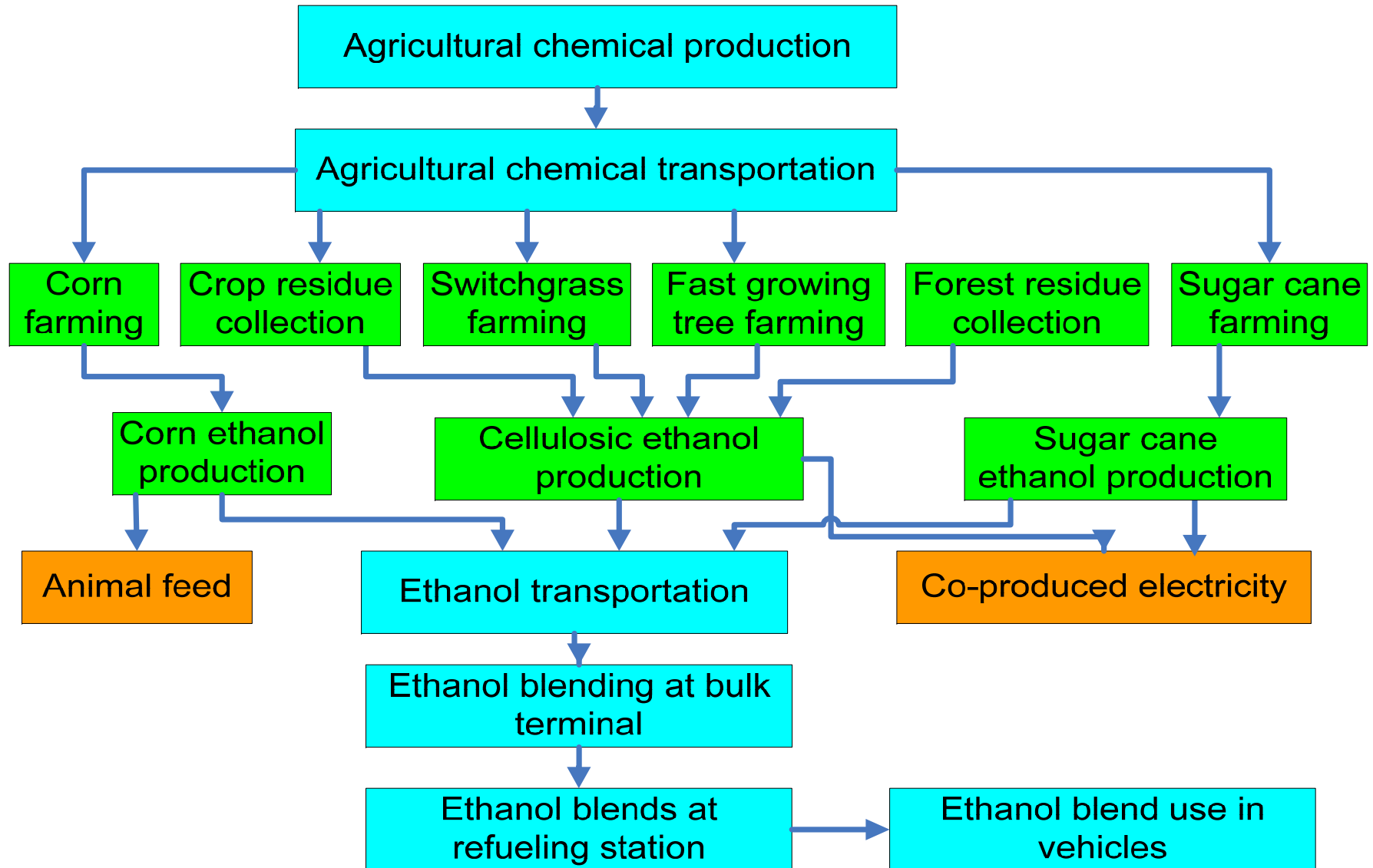


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REET Ethanol Life-Cycle Analysis Includes Activities from Fertilizer to Ethanol at Stations

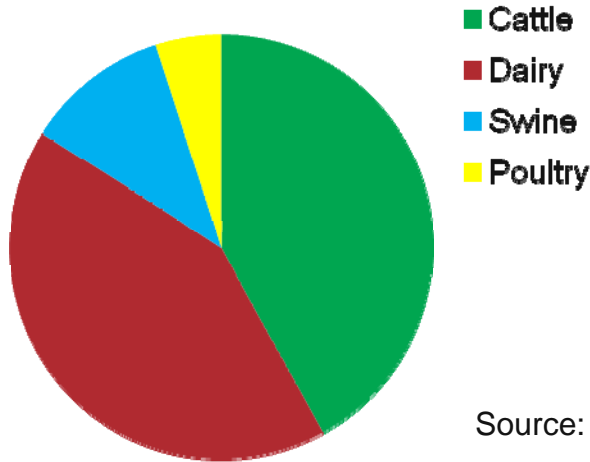


Key Issues Affecting Biofuel WTW Results

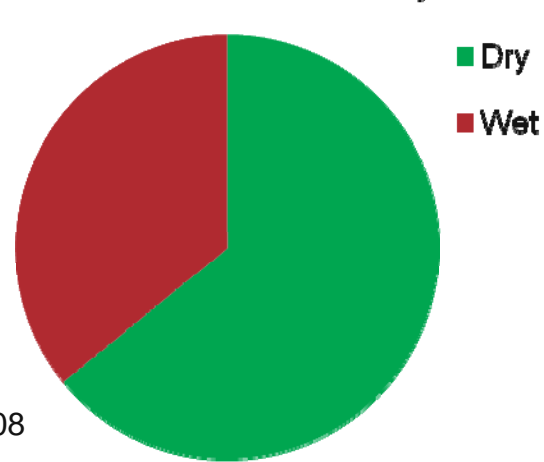
- ❑ Continued technology advancements
 - Agricultural farming: continued crop yield increase and resultant reduction of energy and chemical inputs per unit of yield
 - Energy use in ethanol plants: reduction in process fuel use and switch of process fuel types
- ❑ Methods of estimating emission credits of co-products of ethanol
 - Distillers grains and solubles (DGS) for corn ethanol: credits ranging from 0% to 46%
 - Electricity for cellulosic and sugarcane ethanol
- ❑ Direct and indirect land use changes and resulted GHG emissions
- ❑ Life-cycle analysis methodologies
 - Attributional LCA
 - Consequential LCA

Proper Accounting for Animal Feed Is Key to Corn Ethanol's Lifecycle Analysis

2007 US DGS Market Shares



2007 US DGS Wet and Dry Shares

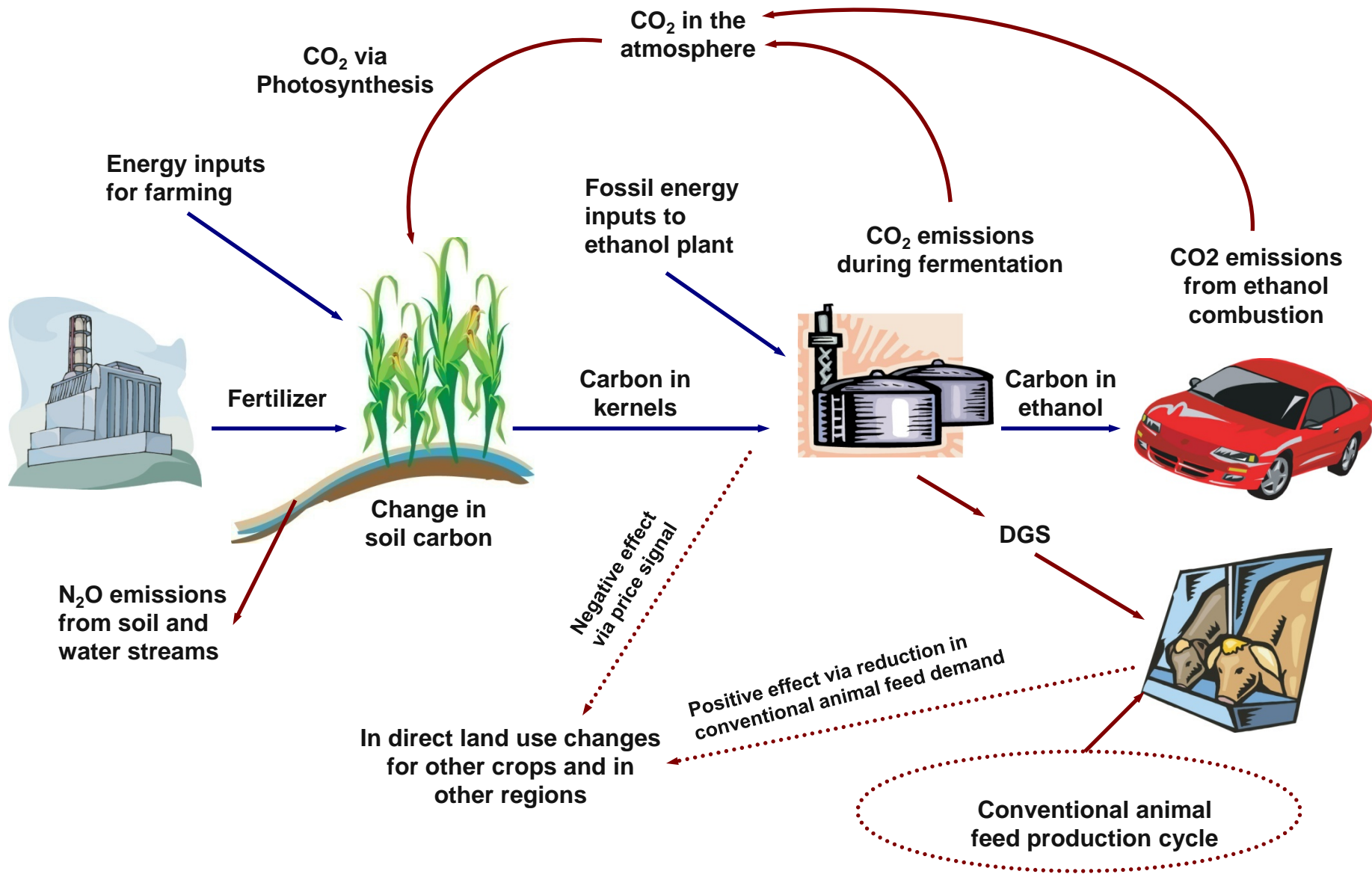


Source: RFA, 2008

Allocation Method	GHG to EtOH	GHG to DGS
Weight	54%	46%
Energy content	62%	38%
Process energy	68%	32%
Market value	77%	23%
Displacement	81%	19%

Argonne uses the displacement method, the most conservative method for ethanol evaluation.

GHG Benefits and Burdens for Fuel Ethanol Cycle Occur at Different Stages (and With Different Players)



REET Includes Very Limited LUC-Related GHG Emissions

- ❑ Domestic LUCs were modeled by USDA for Argonne on DOE request in 1998
 - Ethanol production of 4 billion gallons/year by 2010 was assumed
 - Only domestic LUCs were simulated
- ❑ REET includes LUC CO₂ emissions of 73 grams per gallon of corn ethanol produced (or 1 g/MJ)
- ❑ On the other hand, without considering LUC emissions, REET shows GHG emissions of ~7,470 grams for gasoline and ~5,460 grams for corn ethanol per ethanol-equivalent gallon (or 93 and 68 grams per MJ)

Key Steps to Address GHG Emissions of Potential Land Use Changes by Large-Scale Biofuel Production

- ❑ Simulations of potential land use changes
 - Significant efforts have been made in the past 12 months to improve existing CGE models
 - More efforts may still be required
- ❑ Carbon profiles of major land types
 - Both above-ground biomass and soil carbon are being considered
 - Of the available data sources, some are very detailed (e.g., the Century model) but others are very aggregate (e.g., IPCC)
 - There are mismatches between CGE simulated land types and land types in available carbon databases
 - Soil depth for soil carbon could be a major issues when energy crops are to be simulated

Specific Issues with CGE Modeling of Land Use Changes by Biofuel Production

□ Baseline definition

- Understanding of the issue has been advanced
- Definition itself may still not be agreed; scenarios may be the way to go

□ Various worldwide biofuel programs: are they parts of a biofuel system or competing individual programs?

□ Growth of crop yields

- Trend yield growth
- Yield growth response to price increase
- Two key technical parameters to predict yields: price elasticities; land rent (or other parameter)

□ How to value animal feeds in modeling?

- Nutrition value vs. market price approach
- Advancement has been made; reconciliation between the two approaches is still needed

General Issues with CGE Modeling of Land Use Changes

- ❑ Technology thinking vs. economic thinking
 - If you can get there, you should be there
 - If you are not there, price has prevented you from being there
 - Both technology and economic community need to work together to tackle this fundamental difference of thinking
- ❑ Land use changes vs. land use intensification
 - Conversion costs may play a major role

General Issues with LCA of Biofuels

- ❑ Correlations vs. causal effects
 - Identification of causes
 - Determination of responsibilities (a policy, not a LCA, issue)
- ❑ Time duration of biofuel programs
 - Determination of time duration needs a sound basis and consistency with other environmental policies
 - Application of the economic concept of discounting to emissions may be questionable
- ❑ System boundary of LCAs has been a moving target
 - Consistency vs. intuition (an issue of resource availability)
 - Research vs. policy development
 - Aggregate effects vs. attribution (and responsibility): consequential vs. attributional LCAs