Biofuels, Food & Feed Tradeoffs

April 12-13, 2007 — *St. Louis, Missouri*

Executive Summary

More than 170 leaders in agriculture, energy, government and academia participated in the *Biofuels, Food and Feed Tradeoffs* conference April 12-13, 2007, in St. Louis, Missouri. Presentations focused on potential scenarios for the evolving biofuels industry and possible implications for the food and livestock sectors worldwide. The conference closed with comments by Dr. Wallace E. Tyner of Purdue University on "what we know and what we need to know." His comments are summarized in the four tables found in this executive summary.

The conference was organized by Farm Foundation in collaboration with USDA Rural Development and USDA's Office of Energy Policy and New Uses. Members of the Planning Committee were: Harry Baumes and Jim Duffield, USDA Office of Energy Policy and New Uses; John Beghin, Iowa State University; Keith Collins, USDA; Vern Eidman, University of Minnesota; Burton English, University of Tennessee; James Fischer, Columbia, MO; Steve Halbrook, Farm Foundation; John Kruse, Seth Meyer and Pat Westhoff, University of Missouri-Columbia; Joe Outlaw, Texas A&M University; Janet Perry and Greg Pompelli, USDA Economic Research Service; and Wallace Tyner, Purdue University. Conference presentations and papers are posted at the Farm Foundation Web site, *www.farmfoundation.org*.

High gasoline prices and instability in major petroleum producing areas have focused attention on the need to reduce the United States' growing dependence on foreign oil, and the potential of biofuels production. While petroleum is expected to have a significant role in the nation's energy policy well into the future, meeting additional demand will require multiple technologies, strategies and sources, including biofuels.

Biofuels have been promoted in the United States for more than 30 years. Within the last decade, strong political support and economic incentives have resulted in dramatic production increases. Ethanol production is projected to be 5.6 billion gallons in 2007, a 250% increase from 2000. Likewise, 2007 biodiesel production is estimated at 500 million gallons, an increase from 2 million gallons eight years before. Including plants under construction, U.S. ethanol production has the capacity to double, and biodiesel production has the capacity to triple in the next few years.

Biofuels are a home-grown, renewable energy source with environmental benefits. Ethanol is presently used as an oxygenate and an octane enhancer in gasoline replacing MTBE, which has been shown to be a groundwater contaminant. As a fuel extender, ethanol is marketed as E10—a 10% ethanol, 90% gasoline blend. It is also sold as E85—85% ethanol, 15% gasoline fuel—for use in motor vehicles with flexible fuel engines. Biodiesel is used as an additive in diesel (B5), or as a substitute for diesel (B100). At present levels, biofuels provide a small but important percentage of overall transportation needs (1.2 percent in 2005).

Corn-based ethanol and soybean-based biodiesel are produced from agricultural commodities. It is projected that in 2007, 27% of the corn crop and 17% of the soybean crop will go to ethanol and biodiesel production, respectively. New biofuels production capacity now coming online or under construction will further increase demand for corn and soybeans in the near future.

Farmers are responding to these market demands. In 2007, corn acres are projected to increase 15% from the past year to 90.5 million acres, the largest planted corn area since World War II. As more land is planted in corn, planted acres of other commodities have decreased, pushing prices up. Higher corn prices are expected to result in declines in exports and utilization for livestock feed.

The increasing demand for corn and soybeans to produce fuel has raised the question of whether there will be

Table 1. Corn-based fuels—What we know and what we need to know

What We Know	What We Need to Know
The technology works and works well. Under the current policy regime and oil prices, production will continue to grow until the price of corn chokes off increased growth. Most people feel that with no change in policy or oil prices, the choke point is likely to be around 15 billion gallons of corn ethanol.	What will happen to the price of ethanol as production increases? At today's ethanol production levels, ethanol commands a premium because of its value as an octane enhancer and oxygenate. Many believe that as production increases and the oxygenate and octane additive values diminish, ethanol pricing will move towards gasoline on an energy equivalent basis. In other words, ethanol ultimately could be valued at about 70% of gasoline price. Many uncertainties are associated with that path and its timing.
Corn and other feed ingredient prices will be substantially higher than historical norms. Other markets will adjust to these substantial price changes.	Some models show that most of the response is in export markets, while others show that a good bit of the response is in domestic feed markets. Unknown is how other markets will react to a change of this magnitude.
Food prices are expected to increase because of the higher ethanol demand, but perhaps not at a very high rate locally and globally—at least initially. That is mainly true because agricultural commodity prices are a small fraction of food item costs except for livestock products.	What will the political reaction be to rising food costs, especially if shocks are larger than currently expected?
Increased corn production will have some adverse environmental consequences.	How large will the environmental consequences be of either a substantial increase of corn production or ethanol production?
There are early signs of considerable supply response capability in the United States in reaction to higher corn prices.	The supply response potential in the rest of the world is unknown, except perhaps for sugarcane in Brazil. Brazil has about 35 million hectares of land that could be put into sugarcane production without reducing soybean acreage.
With the low stocks-to-use ratio projected for the next few years, the United States is more vulnerable to supply shocks. It is quite likely that commodity prices will be more variable.	How will other global markets adjust to higher commodity prices and/or increased variability?
If the current government policy of a fixed subsidy per gallon of ethanol continues, government costs will rise quickly as ethanol production increases.	What would be the government cost and other impacts if variable subsidy policies or fuel economy standards were enacted?
While most believe that corn ethanol will peak around 15 billion gallons, some believe it could go much higher.	Evaluation is needed of the impacts of renewable fuel standards that might be partitioned between corn ethanol and cellulose-based ethanol production.
There are tremendous logistical and transportation infrastructure implications of this energy revolution.	Greater understanding is needed of logistics and transportation infrastructure changes, including changes required to bring ethanol to market, and changes needed to bring the distillers dried grains to feed and export markets.

enough stocks for food, animal feed and fuel. Most experts believe the food supply is not in danger. The world produces more food than is needed for human consumption. Most of the hunger in the world is the result of politics or distribution problems. Higher grain prices will, however, impact the volume of grain directed for food aid worldwide.

Only a small percentage of the U.S. corn crop is used directly for food. Higher commodity prices are expected to have only a modest impact on retail food prices. The majority of the cost of most grocery items in the United States is from processing, transportation and labor. The actual commodity input value is proportionally very small. Impacts may be greater in foreign markets where the commodity value can make up a greater proportion at retail, and higher prices may limit exports.

Historically, animal feeding consumes about two-thirds of corn utilization. Higher commodity prices impact livestock profitability. These costs may be passed on to the retail level.

A byproduct of corn-based ethanol production is distillers grains, which can be used as animal feed. The two main ethanol production processes produce distillers grains with different nutrient content and feeding characteristics.

Wet distillers grains may be fed to cattle (ruminants) but are generally not fed to hogs and poultry (monogastrics). Dried distillers grains may be used as a ruminant feed additive and are appropriate for monogastrics, albeit as a smaller percentage of the ration. While there is consensus that distillers grains are a viable livestock feed additive, there are price, transportation, carcass quality and nutritional issues. If those issues are resolved and use of distillers grains in animal feeding increases, it has the potential to take much of the pressure off higher grain prices. The potential also exists for livestock feeding operations and dairies to locate near ethanol plants to take advantage of a ready supply of distillers grain.

The Reality of Ethanol

Many believe that if petroleum prices stay high and the present ethanol production incentives remain in place, U.S. ethanol production will peak at about 15 billion gallons a year. That is a little over two and one half times the 2007 estimated ethanol production. Others project ethanol production going even higher.

Transporting, marketing and consuming higher quantities of ethanol in a petroleum-dominated marketplace poses challenges. Ethanol currently sells at a premium relative to gasoline due to its value as an oxygenate and octane enhancer. As production increases, ethanol is expected to be valued on an energy equivalent basis, or at about 70% of the market price of gasoline. It is not clear at what point ethanol's price will adjust to a new basis.

The ever increasing amount of corn finding a new use in ethanol production is a rapid and unprecedented sea change that raises many questions.

- A greater demand for corn-based ethanol will lead to higher and more variable corn and commodity prices. Domestic commodity and food markets will adjust, but it is not yet known in which sectors or to what degree. Some economic models indicate that most of the adjustments will occur in the domestic animal feed market. Other models indicate most of the response will be in export markets.
- Market changes have been manageable to date. A weather event, such as a drought-induced short corn crop supply, could have major impacts on agricultural markets and corn-based ethanol profitability. How world commodity markets would react to higher and more variable corn prices is not fully understood.
- If ethanol production increases as predicted, maintaining the current subsidy allotment could lead to significantly higher government costs. How political considerations will shape ethanol's future is very much unknown.
- There is a limit to corn-based ethanol production. Using current technology, it is estimated that if all of the U.S. corn acreage went to ethanol production (neglecting food and feed), it would displace only about 15% of U.S. gasoline usage. Diversifying away from petroleum will require more than corn-based ethanol and soybean-based biodiesel.

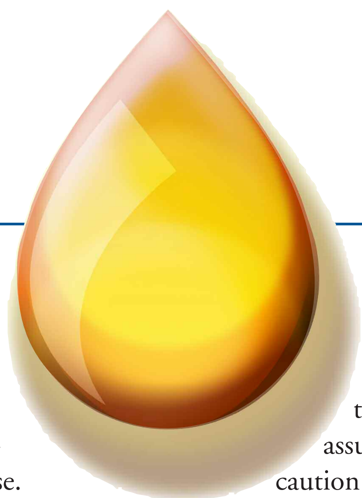
New and Advanced Technologies

Recent advancements in research are poised to move significantly higher corn and soybean yields from the laboratory to the farm. Scientists are combining biotechnology and marker-assisted breeding to boost yields. Researchers are selecting for yield traits, desirable kernel attributes, disease and insect resistance, and drought tolerance to increase production on available acreage. The goal is to produce more grain per acre for food or fuel use.

Another promising area of research is cellulosic biofuels. Instead of fermenting the corn kernel into ethanol, this process utilizes crop wastes, wood or grasses. Combining use of corn stover with traditional corn-based ethanol will further increase the ethanol yield per acre. Trial cellulosic ethanol plants are being fielded in six states. Commercial-scale production could begin as early as 2009.

Table 2. Cellulose-based biofuels—What we know and what we need to know

What We Know	What We Need to Know
Liquid fuels can be made from cellulose materials using a variety of technologies. With today's technology the cost of producing cellulose-based ethanol is around $100 per barrel of crude oil on an energy equivalent basis.	How much of the cost of producing cellulose-based biofuels can be reduced and over what time period?
Substantial progress in reducing biofuels cost can be made only with substantial investments in research and development—termed an Apollo program for energy security.	Even if an Apollo program for energy security were launched, how much can the cost be reduced and how much time will be required to do so?
Cellulosic raw materials are likely to cost $50-$80 per delivered dry ton except in niche markets. The often discussed figure of $30 per dry ton is not in the cards except in very special circumstances.	More localized case studies of cellulose cost are needed. Cellulosic biofuel is a distributed system and will be local by its very character.
Cellulose yields are likely to be in the range of 5-8 tons per acre, perhaps as much as 10, but not the 20 tons per acre some are claiming.	Analysis is needed of the logistical implications of transporting all this cellulose to local plants.
	Cellulosic crops will have to compete for land with corn at $3.50 to $4.50 per bushel and other high value crops. Study is needed of the implications of the interaction between high commodity prices and what it would take to increase substantially area in cellulosic crops.



Gains have been made in development of the biochemical process necessary to make liquid fuels from cellulose. While many consider cellulosic ethanol the holy grail of biofuels, it remains a developing technology. At present, production costs are far from competitive with corn-based ethanol. Some believe a national commitment and a significant investment in research will be needed to perfect the process.

At the same time, research is being done on the economics, as well as the logistical and infrastructural requirements of a cellulosic ethanol industry. Yields per acre of feedstock crops, such as switchgrass, will probably be much lower on a county-level basis than what many have assumed. Some researchers caution that the cost of cellulosic feedstock has been underestimated due to the need to bid production away from other crop uses.

Significant feedstock transportation and handling issues also exist. Corn-based ethanol uses the existing grain handling infrastructure, and production is predominantly located in the major corn-producing areas. A cellulosic ethanol plant will require a new infrastructure to handle the feedstock, as well as development of a local feedstock source.

Biobutanol is another new technological advance. Like ethanol, biobutanol is an alcohol, but it has fuel characteristics similar to gasoline. It can be produced in existing ethanol plants. Since it does not absorb water, it can be transported by pipeline, which is a major advantage over ethanol.

Many promising technologies are under development in the laboratory and in field trials. It will take policy commitments and investment to move advancements from the laboratory to the field to consumers' gas tanks in a timely manner. For ethanol consumption to increase dramatically will require broader retail availability and pump space. The manufacture of flex-fuel vehicles will need to increase if a greater

Table 3. Global Impacts—What we know and what we need to know

What We Know	What We Need to Know
The impacts seen in the U.S. markets for corn, soybeans and wheat are global because U.S. prices are really world prices.	What will these price changes mean in terms of global production, trade, prices or poverty increases or decreases?
Policies of the United States and European Union will have impacts that reach into every corner of the world.	Who will win and who will lose globally, especially in developing countries? Better understanding is needed of the global impacts of developed-country policies aimed at using more biological resources for energy instead of food and feed.
Brazil has tremendous potential to export sugarcane-based ethanol worldwide.	Evaluation is needed of the impacts of a reduction or elimination of the U.S. tariff on ethanol. Examination is needed of policy alternatives that would permit some growth in ethanol trade that could enhance use of renewable fuels in the United States as cellulosic ethanol is taking off.
Renewable fuels could have very positive greenhouse gas (GHG) reduction impacts.	Quantitatively, how important will GHG emissions reductions be? Work is needed on innovative policy alternatives to credit renewable fuels for their contribution to GHG reductions.

quantity of ethanol is to be marketed as a primary fuel. More rail cars and trucks will have to be dedicated to ethanol transportation since it cannot use most pipelines. There will be no benefits in producing a product that the consumer does not want or cannot purchase.

Global Markets and Impacts

The United States is part of a small but rapidly growing world biofuels market. The increasing production and use of biofuels worldwide will impact global prices and trade of agricultural commodities. Today, the degree or magnitude of the effect biofuels will have on world commodity markets is not fully understood. It is believed that as more corn is used for U.S. biofuels production, corn prices will rise, U.S. corn exports will decrease, and other countries will increase corn production. Unintended consequences, such as the impacts higher commodity prices will have on global hunger and food assistance, will have to be addressed. Research is also needed to assess how developing countries or those with food deficits will be impacted as a greater proportion of the agricultural resources of developed nations are directed to energy.

With recent production increases, the United States has become the leading producer of ethanol, surpassing Brazil. For the last 30 years, Brazil has aggressively developed a sugarcane-based ethanol industry. In 2006, Brazil, which also has a significant domestic oil industry, achieved energy independence.

The United States is second to the European Union in biodiesel production. The EU has made a policy decision to specialize in biodiesel for both energy security and environmental reasons. Compared to the United States, the EU also has a larger proportion of diesel-powered engines. Rapeseed oil is used to produce 95% of European biodiesel.

Global trade in biofuels is presently modest, but has the potential to increase

markedly. Brazil has a tremendous potential to produce greater quantities of ethanol from sugarcane and cellulose. More analysis is needed on the impacts to the U.S. ethanol industry of tariff reductions and greater biofuels imports from Brazil and other countries. Additional research is also needed on the potential environmental impacts, both positive and negative, of increased world biofuels production.

Summary

Biofuels are a promising part of a U.S. energy security strategy. Biofuels face competition from other motor vehicle fuel technologies and other sources of energy. Petroleum prices are a major wildcard in the success of alternative fuels. As oil prices fall, so does biofuels profitability.

At this time, for everything known about biofuels, there are corresponding uncertainties. Most importantly, not enough is known about how biofuels will integrate into the energy economy or affect the agricultural economy. Experience to date indicates the impacts biofuels can have across commodities, sectors and countries. More research can provide the understanding needed of options, alternatives and consequences for public- and private-sector decision makers to make informed choices.

Table 4. Economic Analysis—What we know and what we need to know

What We Know	What We Need to Know
At the conference, four models were presented with different analyses of particular issues. The models yield different answers because they use different assumptions regarding such things as cost, yields and supply response. In general, the size of the shocks supplied to the models are fairly small, so they don't give a good idea of the implications of the large shocks now being witnessed.	While it may be impossible for analytical and/or political reasons to get the models on the same page in terms of assumptions, a closer alignment may provide better understanding of the key drivers of the differences.
Better systems research is needed that evaluates the pros and cons of different energy options.	A good example of where better systems research is needed is in the use of distillers dried grain with solubles (DDGS). Systems work is hard, requiring close interaction among disciplines. To resolve these problems, it is imperative that more systems work be done.
There is plenty of work to be done and much of it needs to be done quickly.	It is not at all clear that in the rush to fund technology research, enough funding will be designated for economic and policy research. Continued work is needed to increase funding in these areas.
Given all the uncertainties in moving to cellulose-based energy production, finding ways of public/private risk sharing will be important.	More research is needed of risk reduction, government cost, and other impacts of a wide range of policy alternatives.
The policy choices and policy pathways followed will be critical.	How can the analysis needed be done so that issues are left to choice, not chance?

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