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Mr. Chairman, thank you for the opportunity to discuss renewable energy in relation to U.S. agriculture. While biomass energy from wood and waste have long been important sources of renewable energy, biofuels from agricultural crops are a rapidly growing source of renewable energy, with exciting prospects for the future. I will provide a brief status report on renewable energy focusing on biofuels, then discuss emerging issues related to the rapid growth in biofuels, and conclude with a brief summary of USDA activities in renewable energy.

U.S. consumers want an adequate, clean and affordable supply of energy. Renewable energy can help achieve that goal by utilizing naturally occurring sources such as wind and biomass. Renewable energy can reduce our dependence on fossil fuels, diversify energy sources, improve the trade balance, reduce environmental impacts, and generate income for farmers, ranchers, rural areas and others who harness these natural sources of energy. The Department of Agriculture (USDA) has programs that support renewable energy production, including research, technical assistance, loan and loan guarantee programs, and competitive grants. For example, Section 9006 of the 2002 Farm Bill, the Renewable Energy Systems and Energy Efficiency Improvements Program, has provided $73 million in grants and loans from 2003 to 2006. This program makes loans, loan guarantees, and grants to farmers, ranchers and rural small businesses to purchase renewable energy systems and make energy efficiency improvements. USDA works closely with the Department of Energy (DOE) and other Federal agencies to efficiently coordinate and implement programs to increase renewable energy production.

Overview of Energy Markets

The Energy Information Administration's (EIA) AEO 07 Reference case projections released in December 2006 place U.S. energy consumption at 101 quadrillion Btus (quads) in 2006, eight times the level at the beginning of the last century. Renewable energy consumption in 2006, including hydropower, is estimated at about 6.4 quads, less than four times the level at the start of the last century. U.S. energy use is projected to increase by 30 percent by 2030: from 101 to 131 quads. This means renewable energy production must also increase by 30 percent over the period simply to maintain its current small share of total energy use. The expected growth in energy demand represents a significant challenge if our nation is to reduce its dependence on fossil fuels. However, this growth in total U.S. energy demand also represents an enormous potential for renewable energy, including renewable fuels, with critical implications for agriculture, forestry, and rural America.

The AEO 07 EIA Reference case projects that the real price (2005 dollars) of crude oil will slowly decline from $62 per barrel in 2006 to $46 per barrel by 2012. Oil price and many other factors will influence future demand for ethanol.

Biofuels

Ethanol. In 2000, about 1.6 billion gallons of ethanol were produced in the United States, with ethanol utilizing about 6 percent of the 2000 corn harvest. In 2006, an estimated 5 billion gallons of ethanol were produced, and ethanol accounted for 20 percent of the 2006 corn harvest. Renewable Fuels Association data indicate there are now 110 ethanol plants with total capacity of 5.4 billion gallons and another 73 ethanol plants under construction and another 8 facilities expanding. When construction and expansion are completed, ethanol capacity in the United States will be 11.4 billion gallons per year, which is likely to occur during 2008-09. To

provide an indication of how rapidly this expansion is occurring, in August 2006, just 6 months ago, the capacity of known plants and those under construction and expansion was 7.4 billion gallons, some 4 billion less than current estimates. The rapid expansion has been facilitated by high oil prices, the 51 cent per gallon tax credit provided to blenders, low corn prices until this fall, the ethanol import duty of 54 cents per gallon, the Renewable Fuels Standard (RFS), and the elimination of ethanol's main oxygenate competitor, methyl tertiary butyl ether (MTBE).

Another factor supporting ethanol production has been improving production economics. Ethanol production costs declined between 1980 and 1998 due to higher yields of ethanol per bushel of corn, lower enzyme costs, and production automation which lowered labor costs. Energy input costs also fell over this period. U.S. Department of Agriculture (USDA) surveys indicate that between 1998 and 2002 the average cost of producing ethanol (excluding capital costs) remained at about 95 cents per gallon. Since 2002, the cost of producing ethanol has increased to the range of $1.45 per gallon due the increased cost of energy (electricity and natural gas) and corn. Each $1 increase in the per bushel price of corn adds about 36 cents per gallon to the production cost of ethanol, assuming no change in the price of co-products and 24 cents per gallon assuming the prices of co-products increase proportionally with the price of corn. While corn prices have risen, the price of ethanol has been quite volatile. The Chicago futures price for January 2007 delivery fell from over $2.50 per gallon last June and July to about $1.70 in late September and then rose most recently to about $2.40, suggesting a fairly good return on average at the ethanol plant.

Various industry analysts believe there are many more ethanol plants in different stages of planning in addition to the plants currently under construction or expansion. Projected ethanol

production capacity currently falls in the range of 13 to 15 billion gallons by 2012, which could change if there is a collapse in the price of ethanol.

Biodiesel. U.S. biodiesel production was very small until USDA initiated the Bioenergy Program in Fiscal Year (FY) 2000 that encouraged biodiesel production through cash payments to producers. Mostly due to this incentive, biodiesel production increased from a half million gallons in 1999 to 28 million gallons in 2004 and 91 million gallons in 2005. The Bioenergy Program authorization ended in FY 2006, but the up to $1 per gallon biodiesel tax credit was extended until 2008 by the Energy Policy Act of 2005. High diesel prices and new tax incentives continue to spur production. USDA estimates U.S. biodiesel production reached 250 million gallons in 2006, a 173-percent increase from 2005. For the 2005/06 crop year, biodiesel production accounted for 8 percent of soybean oil use; for 2006/07, biodiesel is expected to account for 2.6 billion pounds of soybean oil or 13 percent of total domestic soybean oil use. The 2.6 billion pounds equals the oil extracted from 229 million bushels of soybeans or 7 percent of estimated U.S. soybean production in 2006.

As of November 2006, the National Biodiesel Board indicated there were 87 U.S. biodiesel plants, varying markedly in size, with a total annual production capacity of about 582 million gallons. Most plants have an annual production capacity below 6 million gallons. The National Biodiesel Board reports that there were also 65 new plants under construction and 13 under expansion that are expected to add another 1.4 billion gallons to annual capacity. While soybean oil is the most common feedstock, one plant under construction that will have an annual expected capacity of 85 million gallons plans to use canola oil.

The cost of producing biodiesel depends heavily on feedstock and processing costs. Soybean oil has a higher cost than other feedstocks, but other feedstocks, such as yellow grease

and beef tallow, cost more to process. The processing cost per gallon of biodiesel made from soybean oil—which currently accounts for over 90 percent of biodiesel production—including materials, labor, energy, plant depreciation, and interest is about $0.50 per gallon for a 5 million gallon per year plant. The cost of the feedstock is by far the largest production expense item. For example, soybean oil at current prices would cost over $2.00 for one gallon of biodiesel, resulting in a total production cost (excluding capital costs) of about $2.50 per gallon. With low sulfur spot diesel selling at Gulf ports for about $1.66 per gallon in late December, even with the $1.00 per gallon tax credit and a $0.10 per gallon small producer tax credit for biodiesel, the margin above costs at the biodiesel plant is thin.

Judging from the capacity that is currently being built by investors, biodiesel production is expected to continue growing rapidly over the next few years. Given the thin margins in biodiesel production and projections for declining real crude oil prices, biodiesel production is expected to be sharply higher but below 400 million gallons in 2007. Even so, biodiesel could account for 20 percent of U.S. soybean oil production for the 2007/08 crop year. For perspective, 400 million gallons of biodiesel equals about 1 percent of expected highway diesel use in 2007 according to EIA. So while any displacement of fossil fuels with biofuels is generally beneficial for the nation, it is clear that we cannot grow our way to energy independence, but agriculture can make an important contribution.

Other Renewable Energy. Other renewable energy sources, while still small, are growing rapidly and offer important opportunities for participation by U.S. farmers, ranchers, and rural areas. Electricity generation from wind increased from 0.06 quads in 2000 to 0.146 quads in 2005, up 160 percent. EIA's preliminary reference case projects wind power to rise to 0.48 quads by 2010, up 230 percent from 2005. Several factors have stimulated the expansion,

including high natural gas prices, the Federal wind production tax credit of 1.9 cents per kilowatt hour for the first 10 years of a project's production, regulatory policies promoting greater access to the electricity grid by wind power producers, state incentives and mandates for renewable electricity use, improved turbine efficiency and reliability, declines in production costs that now put wind power costs similar to gas combined-cycle and coal in areas where wind turbines can operate at high levels of capacity, and the emergence of marketing programs for green power.

The leading wind power state is California, however, wind power is also growing in Midwestern states from Minnesota to Texas. Many Midwestern and Western states have the wind resources to produce much more wind power. U.S. farmers and ranchers are providing land to turbine owners, and in some cases, owning the turbines. The major decision factors considered by potential wind developers are having sufficient wind for economically feasible electricity production, having access to transmission lines, and estimating whether construction can be completed in time to be eligible for the Federal wind production tax credit.

Another small but increasingly important source of renewable energy for agriculture is electricity from methane. Anaerobic digestion of animal wastes breaks down the wastes into biogas and other co-products. The biogas is usually used to generate electricity on the farm and may be sold onto the electricity grid. The effluent is used as a fertilizer and solids extracted from the effluent are used as animal bedding material. New, large digester complexes that utilize manure from multiple farming operations are scrubbing the biogas and piping it as a natural gas substitute. Most digesters are on dairy or hog operations and the number of digesters has increased sharply in recent years.

The Environmental Protection Agency's (EPA) AgStar program, with support from USDA and DOE, promotes digesters to reduce methane emissions and achieve other benefits.

Most direct financial support for digesters has come from USDA programs, although many states provide grants, loans, or technical assistance. The economics of digesters are complex and feasibility depends on many factors, including the supply of manure, the ability to use or sell power generated, and the efficiency of the digester. Farms using digesters successfully benefit from electricity generation, better manure and fertilizer management and reduced costs, less potential for water contamination, better odor and fly control, reduced herbicide use as the applied effluent may contain fewer weed seeds than manure, and reduced methane emissions, a potent greenhouse gas.

Emerging Biofuels Issues

The rapid growth of biofuels production has stimulated much enthusiasm about the prospects for ethanol and biodiesel making substantial inroads in reducing gasoline and diesel fuel consumption. Yet, the rapid growth has generated many questions about its sustainability and the current and potential impacts of this evolving industry. This section reviews some of these issues.

Acreage. The increase in corn production used for ethanol has set in motion an expectation of a substantial adjustment in U.S. field crop production for 2007. As more corn moves to more ethanol plants, corn prices have risen signaling the market's need for more corn acreage and production. For 2006/07, USDA forecasts the total use of U.S. corn will be equivalent to the production on 85.6 million acres. Yet, only 78.6 million acres were planted in 2006. Corn supplies are expected to meet demand because of large carryin stocks of corn, which are expected to be reduced by more than half. During August 2006, prior to the start of the 2006/07 crop year, the average price received by farmers for corn was $2.09 per bushel. By December 2006, after a corn harvest that was slightly below summer expectations and a growing

awareness that ethanol production capacity is coming on line at a very rapid rate, U.S. farm-level corn prices averaged $3.01 per bushel, an increase of 44 percent from the August level.

As corn farmers ponder spring planting decisions, they will likely consider corn and soybean futures prices. The Chicago Board of Trade December 2007 corn futures contract recently traded at about $3.75 per bushel. The ratio of the November 2007 soybean futures price to the December 2007 corn futures price has been about 2 to 1, well below the August soybean-to-corn farm price ratio of 2.5 to 1. With market prices shifting in favor of planting corn at the expense of soybeans and other crops, a sharp increase is expected in corn acreage this spring. The prospective increase in corn acreage is already having ripple effects on agricultural commodity markets. For example, despite having a high level of stocks at the start of the 2006/07 marketing season and record-high production this fall, soybean prices have increased in anticipation of reduced soybean planted area this spring.

Looking ahead to the 2007 crop of corn, it is quite likely, based on current ethanol plant construction, that corn used in ethanol production will rise by more than 1 billion bushels from the 2.15 billion bushels of the 2006 corn crop expected to be used for ethanol. Use of 1 billion bushels, at a trend yield of 152 bushels per acre, would require an additional 6.5 million acres of corn, if corn consumed in other uses remains unchanged from this year's projected levels. With corn stock levels already being reduced this year, another large drawdown in stocks for the 2007-crop marketing year will not be available to meet the rising demand, thus the higher corn prices that are signaling more planting. Beyond 2007, to achieve steady increases in ethanol production from corn will require ever more acreage or higher corn yields per acre, or both.

A related issue is the implication of farming substantially more corn acres. These implications include the possible environmental consequences of more nitrogen fertilizer use,

and the potential that more marginal lands may come into production having greater vulnerability to erosion, nutrient runoff, and leaching. To meet the demand for biofuels, some corn acreage could return to production from land in the long-term Conservation Reserve Program (CRP) as contracts mature, but that land may be environmentally sensitive and would need to be properly farmed. In addition, former CRP land may have lower yields and take some time before such land can be made suitable for crop production. The productivity of cropland and the environmental challenges may be addressed at least partially by the programs of the Farm Security and Rural Investment Act of 2002, which greatly increased financial support for conservation programs. In addition, farm management is steadily improving and the 2007 Farm Bill could also address these challenges.

Corn yields. Research was the founding role for USDA and has continued to be a fundamental function of the Department for nearly 150 years. Research, whether performed and supported by USDA, or by others, has enhanced agricultural productivity, increased agricultural output, and expanded agricultural exports, all while less cropland is being farmed. Productivity measures the ability to produce more output from a given set of inputs. Technology advances that have raised productivity have been a critical source of income growth, wealth creation, and international competitiveness. In fact, virtually all the growth in U.S. agricultural output over the last 50 years is explained by growth in productivity. Growth in inputs used, such as land, has been quite modest.

Research and the resultant productivity gains could potentially solve much of the acreage challenge facing corn ethanol production. Since 1948, corn yields have increased four-fold, from 40 bushels per acre to 160 bushels in 2004 due to fertilizers, better management, technology, and improved crop genetics. It appears corn yields in the past couple of years have moved above the

long-term trend and may continue to do so in coming years as well, helping to meet biofuel demand and reduce pressure on corn prices and acreage. Acreage planted to genetically engineered corn varieties has increased from 25 percent of corn acres in 2000 to 61 percent this year. Over the past few years, new generation root worm resistant corn has been introduced and is showing strong yield increases in many areas. Over the next couple of years, drought-tolerant varieties of corn are expected to become commercially available. As we look out over the next decade, USDA trend projections suggest U.S. corn yields per acre rising to 168 bushels by 2015, however, at least one seed company projects yields that are more than 20 bushels per acre above that level. Each 5 bushel increase in yield above the current trend level would be the equivalent of adding around 2.5 million acres to corn plantings, enough to produce an additional one billion gallons of ethanol each year.

Effects on crop consumers. With ethanol fueling a push for more corn acres, major crop prices are generally expected to be higher over the next couple of years than in the recent past. Soybeans, while facing competition from ethanol feed co-products, such as Distillers Dried Grains (DDG), are still likely to face higher prices over time, as lower expected soybean acreage offsets the lower soybean meal demand and more soybean oil is demanded for biodiesel production.

Livestock and poultry profitability declines under higher corn feeding costs. For example for hogs, which are heavily dependent on corn and limited in the level of DDGs that can be put into feeding rations, a $1 per bushel increase in the price of corn would raise the cost of producing hogs by about $6 per cwt. With hogs selling for a U.S. average of $43 per cwt in December 2006, the cost of production increase would be about 10 percent of the market price. The farm level value of hogs was about 29 percent of retail value of pork in November 2006, so

if the higher feed costs were fully passed on to retail over time, a $1 per bushel increase in the price of corn would translate into about a 3 percent increase in the consumer price of pork. This increase could be more or less depending on how much pork production declines, the speed of market adjustments, the extent to which DDGs substitute for corn and soybean meal, and how other users adjust demand in response to the increase in corn prices. Poultry producers, also heavy users of corn would be similarly affected. Cattle producers overall face a smaller impact than hog and poultry producers, because of their heavier reliance on hay, rangeland, and pasture for weight gain and cattle can accommodate a higher portion of DDGs in their rations.

USDA forecasts that choice cattle prices in 2007 will average $85 per cwt, about the same in 2006 as beef production expands modestly. Hog prices are expected to decline 13 percent as production increases by nearly 4 percent over 2006. The lower hog prices and higher feed costs will likely slow expansion beyond 2007. Broiler prices are expected to increase in 2007 as production grows more slowly due to reduced prices in 2006 and higher feed costs.

Despite higher corn and soybean prices this year, exports for both commodities remain strong. In the future, to the extent that corn and soybean prices continue to rise, exports would be expected to decline as foreign livestock produces cut back on feed use and purchase feed from other sources, such as Brazil and Argentina.

Profitability of ethanol. How the growth of corn ethanol and its effects on agricultural producers unfolds in the future depends importantly on the profitability of producing ethanol. As ethanol production expands beyond regulated markets, such as reformulated gasoline, and beyond the market for ethanol as an octane enhancer, the long-standing price premium of ethanol over gasoline is likely to decline toward ethanol's energy equivalent with gasoline.

Can ethanol's rapid production gains outstrip demand growth? If the 140 billion gallons of gasoline now consumed was E10, or 10 percent ethanol, roughly 14 billion gallons of ethanol would be used. However, the practical limit on E10 would be less than that as it would be very difficult to distribute and blend E10 everywhere. Unless E85 and flex-fuel vehicles become much more pervasive or blend levels above 10 percent are used in conventional engines (which requires regulatory approval and engine warranty coverage), demand growth for ethanol is likely to slow in several years as the E10 market approaches its limit. In the face of continued production increases, the price of ethanol could even fall below its energy equivalent to gasoline. If corn prices continue to stay strong and ethanol demand growth slows, ethanol profitability would decline and expansion could slow appreciably in several years. While this scenario would take pressure off the acreage adjustments and commodity prices in agriculture, it would diminish the ability to reduce U.S. energy dependence on fossil fuel. If ethanol is to continue its expansion beyond 10 percent of U.S. gasoline use, higher blend levels and E85 will have to become far more pervasive than they are today, and, given corn production constraints, cellulosic ethanol will have to become economically feasible.

Cellulosic ethanol. A key challenge facing renewable fuels is in the area of alternative feedstocks. Even with higher corn yields, corn ethanol alone cannot greatly reduce U.S. crude oil imports. Nearly 60 percent of U.S. crude oil use is imported. In 2006, ethanol production on an energy content basis was equivalent to only 1.5 percent of U.S. crude oil imports and a little over 2 percent of gasoline consumption. Despite ethanol's small share of gasoline demand, it already claims a large share of corn production. Ethanol could account for over 25 percent of the 2007 crop of corn, compared with 20 percent for the 2006 crop. Clearly, developing biofuels from alternative feedstocks will be necessary for long-term expansion of biofuels.

Cellulosic ethanol appears to be the best biofuel alternative for reducing crude oil imports, but making it commercially feasible on a wide scale is a formidable challenge. Information from investors and potential producers suggest some technologies are close to being economically viable but need demonstration plants to prove the efficiency on a larger scale and secure low-cost financing. The capital requirement per gallon of ethanol is much higher for ethanol produced from cellulose than for corn ethanol. Ethanol yield is lower per ton of feedstock and conversion is complex, requiring enzymes that cost substantially more than for corn ethanol. Harvesting, bailing, storing, and transportation of biomass are expensive compared with corn. Research and investment capital are now being directed at overcoming these barriers.

For example, one ethanol producer has announced the expansion beginning in 2007 of an existing corn ethanol plant in Iowa so it can use corn stover to produce ethanol. Also, much has been learned about producing, harvesting, storing and processing switchgrass in electric power generation. In addition, the President's Advanced Energy Initiative includes increased funding for research aimed at improving the technology for cellulosic ethanol production. DOE has a goal of reducing the cost of cellulosic ethanol to $1.07 per gallon by 2012, which would likely put it at or below the cost of producing ethanol from corn, opening up an enormous opportunity for producing cellulosic ethanol.

Activities of USDA

USDA has a variety of programs to support renewable energy. Many programs are conducted cooperatively with DOE, EPA, other agencies, university researchers and private business. Without going into detail, the following list illustrates the range of activities:

- **Research programs.** The Agricultural Research Service conducts research on issues such as: ethanol from starch crops other than corn; co-products from grain-based ethanol

production; biodiesel production processes and product quality; cellulosic ethanol, including cellulosic feedstock design, which aims to develop an understanding of plant cell wall molecular biology and to develop high yielding biomass feedstock suitable to as many ecoregions in the U.S. as possible; cellulosic feedstock production, which focuses on production management techniques, including ways to help provide biorefineries with year-round supplies; cellulosic feedstock logistics, which addresses the need for sustainable and efficient harvesting, handling, storage and delivery of biomass; and cellulosic feedstock conversion. The Cooperative State Research, Education and Extension Service supports renewable energy through formula funding and competitive grants under the National Research Initiative, the Small Business Innovation Research Program, and the Sustainable Agricultural Research and Education Program. The Forest Service conducts research on sustainable feedstock systems with a goal of reducing costs of wood production, transportation, and conversion to ethanol and other biobased products.

- **Rural development programs.** USDA's Rural Development offers a range of renewable programs that may be used for renewable energy production, including loans to rural electric cooperative borrowers for producing and distributing renewable energy; grants for planning and working capital, such as for ethanol and biodiesel plants; grants and loans for renewable energy production and energy conservation under section 9006 of the 2002 Farm Bill, the Renewable Energy Systems and Energy Efficiency Improvements Program; loan guarantees for renewable energy ; and competitive research and demonstration grants under the section 9008 of the 2002 Farm Bill, the Biomass Research and Development Act Initiative.
- **Conservation programs.** The Natural Resources Conservation Service helps producers farm sustainably through technical assistance and through financial assistance under the

Environmental Quality Incentives Program and the Conservation Security Program (CSP). CSP provides financial assistance for specific energy production and conservation activities.

- **Biofuel production direct financial assistance.** The Farm Service Agency operated the Bioenergy Program under section 9010 of the 2002 Farm Bill until authority expired in 2006. The program, directly subsidized biofuel production at $150 million in Fiscal Year 2006.
- **Biodiesel and bioproduct marketing support.** The Office of Energy Policy and New Uses in the Office of the Chief Economist administers section 9004 in the 2002 Farm Bill, which is the national Biodiesel Education Program and section 9002, "Biopreferred," the Federal Biobased Product Preferred Procurement Program.
- **USDA renewable energy use.** USDA's Departmental Administration administers legislation and Executive Order 13149 directed at reducing USDA use of fossil fuels and increasing use of alternative fuels, including biofuels.

Conclusion

In conclusion, the strong and growing U.S. economy has an undeniable need for energy. Meeting this demand in a cost-effective way that promotes domestic economic growth and energy security offers biofuels a tremendous economic opportunity. Increasing the market share of biofuels to the point that energy security is markedly enhanced will be a long-term and complex effort. Such an expansion can occur only with achievements on multiple fronts—higher crop yields, more acres planted to energy crops, alternative feedstocks, higher value co-products, more efficient conversion and distribution systems for both feedstocks and biofuels. Market-based policies and intelligent joint public-private efforts are keys to success. Targeted government grants for feasibility and development work and research expenditures to overcome cost barriers are positive approaches that help overcome expansion barriers and still rely on

market signals to allocate resources efficiently. The 2007 Farm Bill provides another opportunity to address the implications of expanding renewable energy for U.S. agriculture and rural areas.

That completes my comments and thank you, Mr. Chairman.