United States Department of Agriculture—2007 Farm Bill Theme Paper

Energy and Agriculture
August 2006

I. Introduction

This paper is the fourth in a series of briefing papers that assess general themes advanced at the 2007 Farm Bill Forums held during 2005 by Secretary Mike Johanns as well as related issues that have emerged in recent months. Energy has been selected for a 2007 Farm Bill theme paper because of the relationship between energy, agriculture, and rural areas. This paper describes the current role of U.S. agriculture in energy production and efforts to conserve energy use in agriculture, discusses and evaluates energy programs administered by the Department of Agriculture (USDA), and concludes with a discussion of general policy approaches associated with energy and agriculture. The alternatives represent generalized approaches to addressing the key issues that have been raised with regard to energy and agriculture. The alternatives are not recommendations but are presented to further discussion on the 2007 Farm Bill.

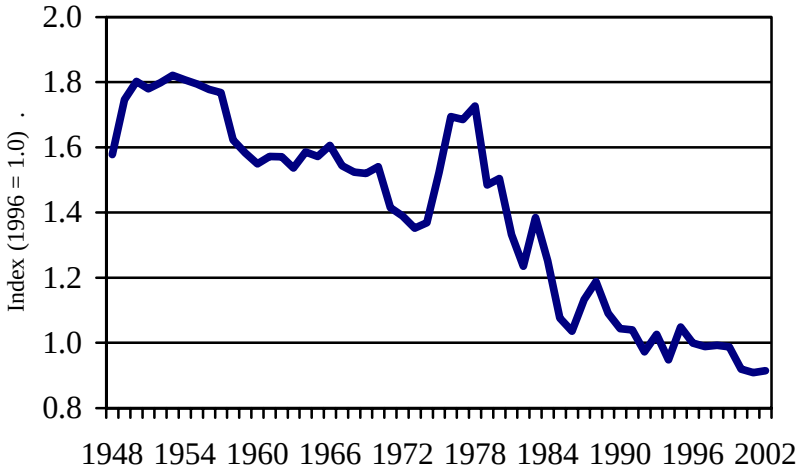
II. Background: Energy and U.S. Agriculture

Agriculture is a major user of energy, with direct energy consumption and indirect energy use through production inputs, such as fertilizer, accounting 15 percent of total farm cash production expenses. In addition, agriculture has the potential to become an increasingly important source of renewable energy and provide significant economic opportunities for farmers and ranchers. Renewable energy production stimulates the agricultural and rural economy, improves the environment, and enhances national energy security. The most effective government policies that have expanded renewable energy production are non-agricultural policies. (i.e., Energy Tax Act of 1978 and the Energy Policy Act of 2005). Most agriculture-related policy has centered on food and feed supply availability. This section discusses recent trends in energy use in agriculture, renewable energy production opportunities, the policies that have helped foster those opportunities, and the prospects for renewable energy markets.

Trends in Energy Use in Agriculture

Agriculture uses energy directly for operating machinery and equipment on the farm and indirectly in the fertilizers and pesticides produced off the farm. Energy use by agriculture peaked in 1978. However, rapidly rising energy prices caused by oil price shocks in the early 1980s forced farmers to become more energy efficient. Since 1978, the total energy use by the agricultural sector has fallen. Even though energy use has decreased, agricultural output has increased since the late 1970s. One measure of energy efficiency, the ratio of energy use to agricultural output, has fallen by about 50 percent since 1978 (Figure 1).

Figure 1. Energy Use Per Unit of Farm Output



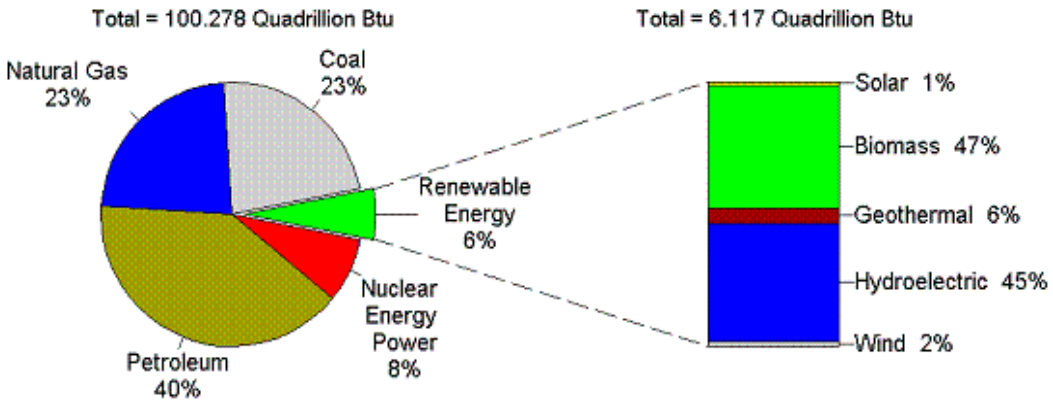
While both agricultural and fertilizer production have made significant improvements in energy efficiency over time, energy-related expenditures (electricity, fuels and oils, and fertilizers) make up an important share of total production expenses. Energy-related expenses rose from about 5 percent of total farm cash expenses in 1910 to over 17 percent of total farm cash expenses in the early 1980s. Since the early 1980s, improvements in efficiency and relatively stable nominal energy prices caused the share of energy-related expenses as a share of total farm cash expenses to fall to about 11 percent by 2003. However, due to increasing energy prices, the share of energy-related expenses as a share to total farm cash expenses rose in 2005 and is forecast to increase again in 2006. For 2005, energy-related expenses are estimated to account for 14 percent of total farm cash expenses, or $27.4 billion, including expenses of $12.8 billion for fertilizer, $11.2 billion for fuels and oils, and $3.4 billion for electricity. With expenses for fertilizer, fuels and oils, and electricity continuing to increase, energy-related expenses are forecasted to climb to $29.9 billion in 2006, 15 percent of total farm cash expenses and 50 percent above the level in 2003.

From the mid-1960s through 1981, commercial fertilizer use doubled, reaching a peak of over 23 million nutrient tons. Since the early 1980s, commercial fertilizer use has remained at about 22 million tons. In the short run, farmers may be able to reduce energy use by switching from conventional tillage practices to reduced or no-till, reducing fertilizer application rates, improving nutrient management practices that reduce nutrient losses, increasing the use of animal manure as a substitute for commercial fertilizers, or switching to crops that use less fertilizer and other energy-related inputs. Over the long term, farmers have considerable flexibility in reducing their energy use by acquiring more energy efficient equipment and making other changes to their farming operation. The adoption of precision farming practices (yield monitoring global positioning systems and calibrated application of pesticides and fertilizers) enable producers to use less fertilizer and other production inputs without adversely affecting crop yields. The combined effects of more energy efficient equipment and practices along with changes in crops produced and yields has allowed agriculture to become more energy efficient over the past 50 years.

Renewable Energy Production Today

Since the energy crisis of the 1970s, developing new energy sources from the agricultural sector has been viewed as a way to expand the domestic energy supply and help mitigate our growing dependence on imported oil. Including hydropower, renewable energy accounted for six percent of U.S. energy consumption in 2004, with energy from biomass contributing almost half of that total (Figure 2). Biomass energy is primarily produced from wood (70 percent) followed by waste (20 percent) and alcohol fuels (10 percent). While wood has provided most of the biomass energy over the years, ethanol has been the fastest growing renewable energy source over the past 10 years. Ten years ago ethanol's share of biomass energy was less than 4 percent.

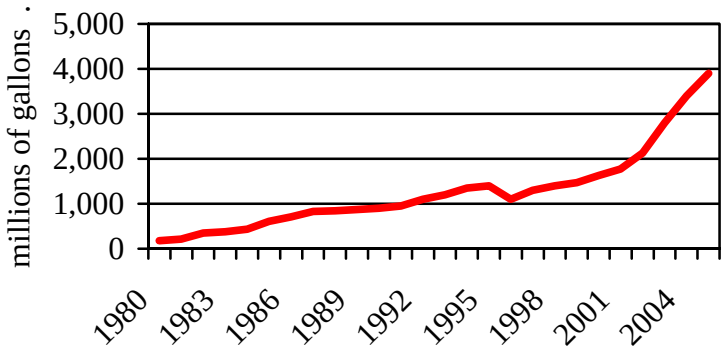
Figure 2. The Distribution of Renewable Energy Consumption in the United States, 2004.



Source: Department of Energy, Energy Information Administration

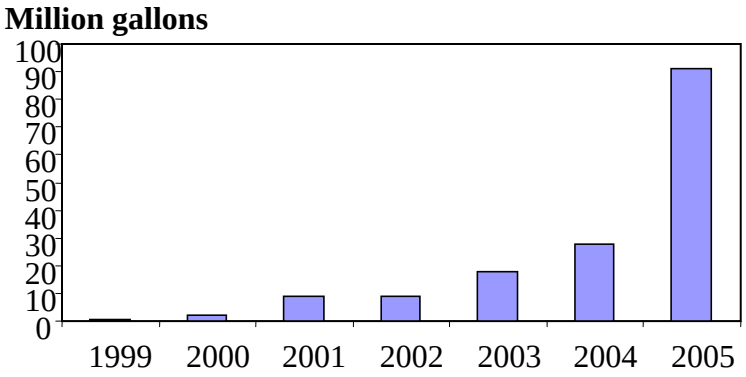
Government incentives encouraged investment in the ethanol industry and production grew rapidly throughout the 1980s and 1990s (Figure 3). In 2005, the ethanol industry produced 4 billion gallons of ethanol which is blended in 30 percent of the Nation's gasoline.

Figure 3. U.S. Annual Ethanol Production, 1980-2005.



Biodiesel, which is just beginning to establish a market in the United States, is a biofuel substitute for petroleum diesel (Figure 4). Biodiesel is most commonly blended with diesel fuel at levels of 20 percent or lower. The majority of the 91 million gallons of biodiesel produced in 2005 came from soybean oil, although it can also be made from other oilseed crops, animal fats, and grease.

Figure 4. U.S. Annual Biodiesel Production, 1999 – 2005.



The U.S. Department of Energy's (DOE) Energy Information Administration (EIA) estimates that the United States consumes about 140 billion gallons of gasoline and 60 billion gallons of diesel fuel per year. Therefore, in terms of their relative contribution to meet our transportation fuel needs, ethanol production met about 3 percent of gasoline consumption in the United States while biodiesel production met 0.15 percent of diesel fuel consumption in 2005.

In addition to ethanol and biodiesel, biomass and animal wastes can be used to produce renewable energy. Biomass is used to generate electric power by direct burning, using gasification systems, or mixing biomass with coal in coal-fired electrical generation facilities. The primary feedstocks include wood waste used by the pulp and paper industry for industrial heat and steam production. In addition, forest residues and municipal solid waste are used to generate electricity. Another potentially large source of renewable energy is animal waste which can be turned into methane gas through anaerobic digestion. Anaerobic digesters are being adopted by commercial livestock operations not only to produce energy, but also to meet new state and Federal regulations for controlling animal waste. Currently, there are over 90 anaerobic digester projects, either in operation or under construction, located throughout the United States. Nearly all the anaerobic digesters are associated with dairy operations, with a few associated with swine or poultry operations.

Another emerging approach to reducing U.S. fossil energy use is to replace petroleum based products with products made from biomass. There are many industrial and consumer products that have been traditionally made from biomass, including yarns and fabrics, soaps and detergents, pulp and paper, lubricants and greases, and adhesives and paints. However, agricultural feedstocks can be used to produce non-traditional products such as chemicals, plastics, hydraulic fluids, and pharmaceuticals. There are many agricultural feedstocks that can be used to make bioproducts, including a variety of crops, wood and plant oils, and agricultural and forestry residues. Bioproducts often require less energy to produce than the fossil and

inorganic products they replace. With the increasing costs of fossil fuels, U.S. industries have an increased incentive to consider and produce alternative bioproducts. As examples of new biobased technology, corn starch is being used to produce bioplastic products, and soybeans are being used to produce a polymer used to manufacture carpet backings. The chemical industry could potentially offer a large market for numerous high-value biobased chemicals and other materials made from agriculture.

Progress is also being made in developing energy from solar, wind, and geothermal resources although the amount of energy from these sources is relatively small. Small-scale solar applications are already commercially available that provide electricity for lighting, battery charging, water pumping, and electric fences. There also has been an emergence of large-scale solar technology that is being used in homes and in the industrial sector. Small-wind systems are currently being developed to generate electricity in remote areas and utility-size turbines have been increasing in numbers, especially on farms in areas with consistently high wind speeds. More geothermal resources are being tapped to produce electrical or thermal energy in local areas. There are many agricultural applications for geothermal energy, including heating greenhouses, providing warm water for aquaculture operations, and drying produce.

Although ethanol growth has been impressive in recent years, ethanol accounts for about 3 percent of total annual gasoline consumption. About 14 percent of the U.S. corn crop was used for ethanol in 2005/06 and USDA projects 20 percent of U.S. corn production will be converted into ethanol in 2006/07. Clearly, the supply of corn is relatively small compared to gasoline demand, so other domestic sources of renewable energy must be developed to replace oil imports if the U.S. is to greatly reduce its dependence on imported oil. Biodiesel can extend the diesel fuel supply, but the supply of oil crops, animal fats, and other feedstocks are also relatively small compared to the diesel fuel market. Research may provide technological breakthroughs leading to a significant expansion in ethanol production. In the near future, ethanol's feedstock base could expand significantly with the advancement of technology that could economically convert switchgrass and other low-valued biomass into cellulosic ethanol.

Legislative and Regulatory Incentives

Growth in renewable energy over the past two decades is largely due to government legislation and regulations. There have been several motivations behind renewable energy legislation, including enhancing national energy security, improving the environment, and stimulating the agricultural economy.

Energy Policy. Much of the growth in corn ethanol production can be attributed to government incentive programs that began in the 1970s. The Energy Tax Act of 1978 authorized the motor fuel excise tax exemption for ethanol blends, providing ethanol blends of at least 10 percent ethanol by volume a $0.40 per gallon exemption from the Federal motor fuels tax. Since then, several statutes have extended the tax exemption for ethanol. Currently, Federal law authorizes a tax credit of $0.51 per gallon for ethanol through 2010. Legislation has also been passed to give income tax credits and loan guarantees to small ethanol producers.

The American Jobs Creation Act of 2004 granted biodiesel blenders a tax credit of $1.00 per gallon of biodiesel made from oil crops and animal fats and a $0.50 per gallon tax credit for biodiesel made from recycled fats and oils. Largely due to this tax credit and other government incentives, biodiesel production has grown from about 500,000 gallons in 1999 to 91 million gallons in 2005. Legislation has also created tax credits for biomass, wind energy, and other renewable energy sources used to generate electricity.

The Energy Policy Act (EPACT) of 2005 included several provisions to help diversify domestic energy production through the development of renewable fuels. EPACT mandates a renewable fuel phase-in called the renewable fuels standard (RFS), requiring U.S. fuel production to include a minimum amount of renewable fuel each year, starting at 4 billion gallons in 2006 and reaching 7.5 billion gallons in 2012. EPACT also created the Cellulosic Biomass Program to encourage the production of cellulosic ethanol and fund research on conversion technology. Under this program, every one gallon of ethanol made from biomass, such as switchgrass, crop residues, and tree crops, counts as 2.5 gallons towards satisfying the RFS. EPACT also extended the biodiesel fuel excise tax credit through 2008 and authorized a $0.10 per gallon income tax credit to small biodiesel producers.

Environmental Policy. There is a significant opportunity to reduce air pollution and greenhouse gas (GHG) emissions by replacing fossil energy with renewable energy. Ethanol was first used as a fuel additive in the late 1970s when the Environmental Protection Agency (EPA) began phasing out lead in gasoline and ethanol replaced lead as an octane enhancer. Provisions of the Clean Air Act Amendments of 1990 (CAA) established the Oxygenated Fuels Program and the Reformulated Gasoline (RFG) Program to control carbon monoxide and ozone problems created by motor fuels. Refiners blended cleaner burning oxygenates into gasoline to meet the new standards. Ethanol and a petroleum-based additive called methyl tertiary butyl ether (MTBE) became the two oxygenates most commonly used to meet the requirements mandated by the CAA. The use of MTBE is currently being phased out and replaced with ethanol after MTBE was found to contaminate drinking water. Recently adopted EPA diesel fuel standards that require refiners to remove most of the sulfur from diesel fuel could increase biodiesel demand. Since biodiesel contains no sulfur and is an excellent lubricity agent, refiners could blend biodiesel with petroleum diesel to help meet the new standards.

Agricultural Policy. Agricultural policy has only recently been directed at energy conservation and renewable energy production. USDA's FY 2000 Appropriations Act authorized the establishment of pilot projects for harvesting biomass on lands enrolled in the Conservation Reserve Program (CRP). In 2000, USDA also initiated the Commodity Credit Corporation (CCC) Bioenergy Program to alleviate crop surpluses and stimulate production of biofuels. The Agricultural Risk Protection Act of 2000 included the Biomass Research and Development Act, which directed the USDA and DOE to cooperate and coordinate polices to promote research and development leading to the production of bioproducts.

The Farm Security and Rural Investment Act of 2002 (2002 Farm Bill) contained the first energy title in Farm Bill history. The 2002 Farm Bill energy title authorized a range of programs through 2007 to promote bioenergy and bioproduct production and consumption. Key provisions include the Federal Biobased Products Preferred Procurement Program (FB4P), which

requires Federal agencies to procure biobased products. Another program, the Biodiesel Fuel Education Program, awards competitive grants to educate government and private entities with vehicle fleets about the benefits of biodiesel fuel use. The Renewable Energy Systems and Energy Efficiency Improvements Program authorizes loans, loan guarantees, and grants to assist eligible farmers, ranchers, and rural small businesses in purchasing renewable energy systems and making energy efficiency improvements. The Value Added Grant Program (VAGP) was amended to make funds available to farm families and rural businesses to help them develop new value-added products, such as ethanol and biodiesel. The 2002 Farm Bill extended the CCC Bioenergy Program through FY 2006, expanded the CRP pilot biomass authority to a nationwide general authority, and authorized placement of wind turbines on land enrolled in CRP.

State Programs. There are also many State programs that encourage renewable energy use through tax credits, production incentives, and biofuel mandates. One of the first states to actively promote biofuels was Minnesota, which has consumption mandates for ethanol and biodiesel. Minnesota's two-percent biodiesel mandate, that became effective in 2004, created a 16 million gallon market for biodiesel. Almost every State has at least one renewable energy promotion program in place, and most have several.

Another important policy tool at the State level is a Renewable Portfolio Standard (RPS). A RPS is a policy that obligates a retail electricity supplier to include renewable resources in its electricity-generation portfolio and creates a demand for renewable energy sources. Retail suppliers can meet the obligation by constructing or owning eligible renewable resources or purchasing the power from eligible generators. To date, 20 States plus Washington, D.C., have adopted RPS policies or renewable purchase obligations, while several other States have adopted nonbinding renewable energy goals. A number of States have increased their renewable energy standards in recent years. The Union of Concerned Scientists projects that State RPS laws and regulations will provide support for nearly 31,100 megawatts (MW) of new renewable power by 2017—an increase of 230 percent over total 1997 U.S. levels (excluding hydroelectric).

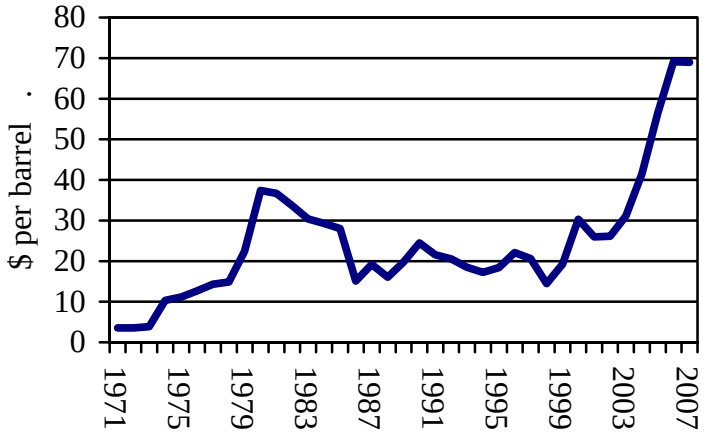
Market Prospects

Over the years, government incentives have been necessary to help ethanol and biodiesel compete with less costly petroleum-based fuels. However, the recent surge in oil prices has made biofuels much more cost competitive and these industries are attracting new investment. The number of biodiesel plants is growing rapidly due to government incentives and high diesel fuel prices – the number of plants increased from less than 10 in 2000 to 65 plants in 2006, with an annual industry capacity of 395 million gallons. Another 58 plants are under construction or in the process of expansion, adding another 318 million gallons of capacity upon completion. Ethanol production has also been growing rapidly. In 2000, there were 54 plants with capacity of about 1.75 billion gallons per year. Currently, there are over 100 ethanol plants with a combined production capacity of over 4.5 billion gallons a year. An additional 30 ethanol plants under construction are expected to add annual capacity of more than 2 billion gallons.

Ethanol and biodiesel production will continue to expand as long as government incentives continue and world petroleum prices remain high. World oil prices have increased sharply since

1999, when the annual average nominal price of West Texas Intermediate (WTI) oil jumped from $19.25 per barrel in 1999 to $30.29 in 2000 (Figure 5). Between 2000 and 2003, the

Figure 5. Annual Average and Forecasted U.S. Crude Oil Prices, 1971-2007.



average WTI price ranged from about $26 per barrel to $31 per barrel. In 2004, the WTI price increased to over $41 per barrel and the 2005 average WTI price increased to over $56 per barrel. EIA short-term projections indicate that the average WTI price for a barrel will climb to $69 in 2006 and remain at that level in 2007.

Higher crude oil prices have translated into higher wholesale and retail prices for gasoline and diesel fuel. EIA estimates that the average wholesale price for gasoline increased from $1.28 per gallon in 2004 to $2.04 per gallon in 2006. With cash and net feedstock costs for ethanol at about $1.00 per gallon, ethanol was not competitive with gasoline at 2004 prices without the income tax credit. However, with the recent increase in gasoline prices, corn-based ethanol is competitive with gasoline without the income tax credit.

Under EIA's long-term forecast, the real price of imported oil is expected to level-off after 2007 and perhaps show a slight decline by 2010. Nevertheless, world oil supplies are expected to remain tight as the demand for oil remains strong, keeping pressure on oil prices through 2030. If future oil prices reflect EIA projections, biodiesel and ethanol production will continue to grow with the rate of growth depending on the level of oil prices, feedstock costs, and changes in technology.

In the longer term, EIA expects domestic energy consumption to continue to grow (Table 1). By 2030, EIA forecasts that U.S. energy consumption will increase by over 30 percent, from 100 quadrillion Btus currently to 134 quadrillion Btus in 2030. Therefore, the supply of renewable energy must also increase by 30 percent over the same time just to maintain its current share of the overall energy market and expand further to reduce fossil-fuel dependence. The growth in energy consumption to meet the needs of the transportation sector is expected to increase by over 40 percent from 2005 to 2030.

Table 1. Projected Energy Consumption 2005-30.

	2005	2010	2015	2020	2025	2030
Energy Consumption (by Sector)	Quadrillion Btu					
Residential	22	23	24	25	26	27
Commercial	18	20	21	23	25	27
Industrial	33	35	36	37	39	41
Transportation	28	31	33	36	38	40
Total	101	108	114	121	127	134

Source: Department of Energy, Energy Information Administration. Totals may not add due to rounding.

While domestic energy production will also increase over time, EIA forecasts that imported energy will rise more rapidly (Table 2). While domestically produced energy is projected to increase by about 25 percent, from 71 quadrillion Btus in 2005 to 89 quadrillion Btus in 2030; energy imports are projected to increase by almost 50 percent, rising from 30 quadrillion Btus in 2005 to 44 quadrillion Btus by 2030. As a result, the share of U.S. energy use met by imported sources is projected to rise from 30 percent currently to 33 percent by 2030.

Table 2. Projected Energy Supply, 2005-30.

	2005	2010	2015	2020	2025	2030
Energy Supply	Quadrillion Btu					
Domestic Production	71	77	81	84	87	89
Net Imports	30	30	33	36	40	44
Total	101	108	114	121	127	134

Source: Department of Energy, Energy Information Administration. Totals may not add due to rounding.

III. USDA's Renewable Energy and Energy Efficiency Programs

USDA's Natural Resources Conservation Service (NRCS) has several programs that affect energy use on farms and ranches. These programs include the Conservation Security Program (CSP), the Environmental Quality Incentives Program (EQIP), Conservation Technical Assistance (CTA), as well as other programs.

Energy conservation and the conservation of natural resources by farmers and ranchers are complementary and many conservation measures significantly reduce fuel and other energy-related costs. Conservation practices such as crop residue management, irrigation water management, nutrient management, wind breaks, contour farming, and rotation grazing, among others, can contribute to protecting soil and water resources and reduce energy use. In addition,

the growing availability of precision agriculture has the potential to reduce energy use significantly as well as protect and enhance water quality and other environmental amenities.

During the past couple of decades, NRCS has helped farmers adopt no-till practices on about 62 million acres of cropland. Assuming an average savings of 3.5 gallons per acre in diesel fuel, this amounts to a savings of 217 million gallons of diesel fuel per year with a cost savings to farmers of about $500 million per year.

In FY 2004, with technical and financial assistance from NRCS, farmers and ranchers applied nutrient management on 2.9 million acres and pest management on 3.5 million acres. Improved application, timing, and placement of nitrogen fertilizer can save farmers from $10 to $20 per acre. Assuming average savings in nitrogen fertilizer costs of $15 per acre, the cost savings to farmers from the nutrient management practices adopted in FY 2004 would amount to just over $43 million per year.

Air quality concerns associated with agricultural production include odors, ozone precursors, ammonia, particulate emissions, and greenhouse gases. Addressing these concerns is an area of increasing emphasis in USDA's conservation programs. Livestock producers enrolled in EQIP can receive cost-share assistance for installing anaerobic waste digesters. These technologies significantly reduce odors associated with large animal feeding operations and, in many cases, can result in significantly lower methane emissions. NRCS has provided technical and financial assistance to help producers install at least 40 anaerobic digesters. Although some produce electricity either for on-farm use or for sale to electric utilities, there is a growing interest in using the methane directly on the farm to power equipment, heat buildings, and other on-farm uses.

Under EQIP, NRCS also offers innovation grants to accelerate the development, transfer and adoption of innovative technologies and approaches, including those related to energy. In FY 2006, NRCS awarded $20 million in Conservation Innovation Grants (CIG), of which $7.4 million (37 percent) was awarded to proposals that addressed energy conservation or the production of renewable fuels. Another $750,000 was awarded to assess the creation and delivery of carbon credits to private sector markets.

EQIP also provides farmers with payments to adopt nutrient management practices that reduce nitrogen fertilizer use and thus nitrous oxide emissions and to adopt crop residue management practices that increase the organic content of soils and sequester carbon. Wetlands restored by the Wetland Reserve Program also sequester substantial amounts of carbon. In addition, EQIP and CSP increase the adoption of conservation tillage and other practices that sequester carbon in cropland soils. CSP provides energy enhancement payments to producers who substitute their petroleum-based liquid fuels with ethanol or biodiesel fuels. In FY 2006, CSP obligated about $22 million to energy management enhancements.

USDA's Rural Development (RD) Mission Area is responsible for implementing several renewable energy related programs. The 2002 Farm Bill established the Renewable Energy Systems and Energy Efficiency Improvements Program. This program provides grants and loan guarantees to agricultural producers and rural small businesses to assist with purchasing

renewable energy systems and make energy efficient improvements. The purpose of the program is to help farmers, ranchers, and small rural businesses reduce energy costs and to support and stimulate rural economic development by helping agricultural producers and rural small businesses create new sources of income, create new jobs, and create new uses for agricultural products and wastes. Grants may not exceed 25 percent of the eligible project costs and guaranteed loans may not exceed 50 percent of the eligible project costs.

Eligible project costs include:

- Post-application purchase and installation of equipment, except agricultural tillage equipment and vehicles;
- Post-application construction or project improvements, except residential;
- Energy audits or assessments;
- Permit fees;
- Professional service fees, except for application preparation;
- Feasibility studies;
- Business plans;
- Retrofitting; and
- Construction of a new facility only when the facility is used for the same purpose, is approximately the same size, and based on the energy audit will provide more energy savings than improving an existing facility, with costs limited to those identified in the energy audit.

During the first three years of the program, USDA awarded a total of 435 grants totaling $66.8 million to agricultural producers and rural businesses in 36 States. These funds leveraged an additional $850 million in private sector funds. In addition, the first two loan guarantees were awarded at the end of FY 2005 for $10.1 million. In FY 2005, grants were awarded to recipients in 32 States.

The Value Added Producer Grants Program (VAPG) was initially authorized by the Agriculture Risk Protection Act of 2000 and extended through FY 2007 by the 2002 Farm Bill. Under the VAPG, grants may be provided for planning activities and working capital for marketing value-added agricultural products and for farm-based renewable energy. Grants may be used to develop business plans and strategies for creating marketing opportunities. Grants may also be used for feasibility studies and to provide capital to establish alliances or business ventures that allow producers of value-added agricultural products to better compete in domestic and international markets. Priority in the program is given to applicants who have at least 51 percent of project costs dedicated to activities for a bioenergy project.

Funding available for the VAPG totaled $32.78 million in FY 2006. Since the start of the program $20.5 million was allocated to projects to develop and market over 100 renewable energy projects in 29 States. This funding leveraged over $200 million in private sector resources. Renewable energy projects include biodiesel, ethanol or wind energy production, or the use of biomass to generate energy.

Projects to convert biomass into biobased products and produce bioenergy are eligible for financing under the Business and Industry (B&I) Guaranteed Loan Program. The overall

purpose of the B&I Guaranteed Loan Program is to help create jobs and stimulate rural economies by providing financial backing for rural businesses. Providing financial support for projects related to biobased products and bioenergy production is viewed as a way to create new market opportunities for farm and forestry resources.

During FY 2001-05, the B&I Guaranteed Loan Program supported 10 biomass projects of which 7 were for ethanol production facilities. Another four ethanol projects were funded under USDA's Rural Economic Development Loan Program and a biodiesel project was supported under the Energy Guaranteed Loan Program. In addition, several more biomass projects were supported by direct grants.

The Biomass Research and Development Program is operated jointly by USDA and DOE. This program supports research and development of biomass based products, bioenergy, biofuels, and related processes. Eligible entities are institutions of higher learning, national laboratories, Federal or State research agencies, private sector entities, and nonprofit organizations. FY 2006 funding for the Biomass Research and Development Program is $12 million.

Several other RD programs can be used to fund and support energy-related projects, although they are not directed specifically to that goal. For example, funding in several re-lending programs may ultimately be used to fund energy-related projects as part of a general business or community development effort. Utility programs, particularly for electric utilities, comprise a substantial part of the RD programs. Such programs directly or indirectly advance the development of energy conservation and distribution.

USDA's Agricultural Research Service (ARS) is USDA's primary research agency. Specific energy-related work being conducted by ARS follows:

- **Better understanding of ethanol-producing bacteria.** The process of cellulose degradation is not well understood. This research provides new information on the regulation of cellulose degradation by an organism that shows particular promise for converting cellulosic biomass.

- **Improved organisms for ethanol production.** Inhibitors formed during pretreatment of lignocellulosic material reduce the performance of ethanol-producing fermentation organisms. ARS scientists are using a method called directed adaptation, developing strains of organisms that have enhanced ability to convert toxic compounds into less toxic compounds. Development of these more tolerant organisms is a significant step toward achieving the technology necessary for commercial production of ethanol from cellulosic plant material.

- **Key gene in cell wall biosynthesis identified.** There is a need to identify genes that regulate cell wall composition of alfalfa so that new varieties can be developed that have greater potential as biofuel feedstocks. ARS scientists identified and characterized a gene, UDP-sugar pyrophosphorylase (USP), which plays an important role in cell wall biosynthesis in plants. The isolation of the USP gene and new knowledge learned about

the protein it produces will allow cell walls of alfalfa plants to be modified to improve the value of this crop as a bioenergy feedstock.

USDA's Cooperative State Research, Education, Extension and Service (CSREES) leverages the nationwide expertise housed at land grant universities. CSREES provides funding for about 60 projects that include an energy-related objective. The goals of these projects include:

- Reducing costs associated with the conversion of biomass to energy and industrial products,
- Increasing biobased product inventories to replace petroleum based products,
- Developing technologies for effectively converting agricultural (including forestry) residuals into energy and products,
- Developing cost effective biocatalysts capable of converting lignocellulosic materials economically, effectively and with low environmental impact, and
- Identifying unique biomass feedstocks for the sustainable production of bioenergy and industrial products.

USDA's Farm Service Agency (FSA) administers the Conservation Reserve Program (CRP) and the CCC Bio-Energy Program. The CRP was established by the Food Security Act of 1985 to assist owners and operators in conserving and improving soil, water, and wildlife resources on their farms and ranches by converting highly erodible and other environmentally sensitive cropland and marginal pasture to long-term resource conserving covers. Participants enroll cropland in the CRP for a period from 10 to 15 years in exchange for annual rental payments and cost-share assistance for installing certain conservation practices. Enrollment of up to 39.2 million acres is authorized, and there are currently about 36 million acres under contract.

CRP lands sequester significant amounts of carbon dioxide in soils and vegetative cover and many CRP lands have the potential to be used for the production of bioenergy crops, such as switchgrass, willows, and poplars. A 2003 analysis, for example, estimated that 13 million acres of cropland enrolled in the CRP could produce an average of about 4 tons of biomass per acre (dry matter) or over 50 million tons of biomass annually. The 2002 Farm Bill specifies the conditions under which CRP enrolled acreage can be utilized for biomass production. First, harvesting must be consistent with conservation of soil, water quality, and wildlife habitat, and second, payments must be reduced commensurate with the economic value of the biomass produced.

Under CRP's Biomass Pilot Program established in 2000, USDA approved the use of CRP land in 4 projects located in 4 States. The programs approved include one each in Minnesota (hybrid poplars), New York (willows), Iowa (switchgrass), and Pennsylvania (switchgrass). Projects were also approved in Oklahoma and Illinois.

The CCC Bioenergy Program began on December 1, 2000, and ended on June 30, 2006. Under the program, cash payments were made to bioenergy producers who increase their annual bioenergy production from eligible agricultural commodities. Eligible commodities included barley, corn, grain sorghum, oats, rice, wheat, soybeans, other oilseeds, cellulosic crops, and

animal fats and oils. From December 2000 through March 2006, the program reimbursed bioenergy producers $537 million for 2.5 billion gallons of increased ethanol production, 146.4 million gallons of increased biodiesel production, and 26.7 million gallons of base biodiesel production.

USDA's Office of Energy Policy and New Uses administers the Federal Biobased Preferred Products Procurement Program (FB4P), the USDA Certified Biobased Product Labeling Program and Biodiesel Education Program (BEP). All three programs were created by the 2002 Farm Bill.

Under the FB4P, Federal agencies will be required to give procurement preference to qualified biobased products if the products are available, meet performance standards, and are available at costs similar to their non-biobased counterparts. Biobased products are defined as commercial or industrial products that are composed, in whole or in significant part, of biological products or renewable domestic agricultural materials (including plant, animal, and marine materials) or renewable forestry materials. The first in a series of rules to designate items for preferred procurement was published as a final rule in March 2006. Six items were designated for preferred procurement by this rule: mobile equipment hydraulic fluids; biobased roof coatings; water tank coatings; diesel fuel additives; penetrating lubricants and; bedding, bed linens and towels. The 2002 Farm Bill also provides for a voluntary program authorizing producers of qualified biobased products to use a "USDA Certified Biobased Product" label and logo to identify qualified products.

The 2002 Farm Bill authorized funding of $1 million per year from FY 2003-07 for education grants under the BEP. Under BEP, two competitive grants were awarded to the National Biodiesel Board and the University of Idaho to educate the public, and government and private entities that operate vehicle fleets on the benefits of using biodiesel. Program funds have been used for organizing national conferences, conducting technical workshops, and distributing educational materials, including manuals on quality control. Many partnerships with other groups and government agencies have been formed to share information, leverage resources, coordinate activities, and avoid program redundancies.

USDA's Forest Service (FS) also plays a major role in energy production and conservation. The FS is working to increase production of all energy sources in an environmentally sound manner, capitalizing on the potential of woody biomass as a renewable energy resource, and contributing to the improvement of infrastructure for transmitting energy across the country. Increasing domestic energy supply includes providing energy facility corridors, ensuring that lands are available for energy mineral development and production, developing renewable energy resources such as woody biomass, wind, solar power, and geothermal energy, and re-licensing hydropower facilities.

Nearly 50 percent of the nation's geothermal energy production comes from Federal lands. There are currently 354 federal geothermal leases, 116 on National Forest lands, covering nearly 360,000 acres. At the present time, there are 5 producing leases on National Forest lands contributing to a 12 mega-watt plant and a 45 mega-watt power plant that, combined, have resulted in more than $12 million in royalties.

The FS actively participates in a government-wide initiative aimed at promoting development and use of biobased products and bioenergy. Programs include research on enhancing opportunities to use forest biomass to produce energy and other value-added products; developing economical, environmentally acceptable woody cropping systems to produce energy and other value-added products; exploring new processes to convert wood into ethanol; and identifying ways to increase energy conservation through changes in manufacturing technologies, harvesting technologies, building construction practices, and designed landscapes.

The focus of the FS Biomass and Bioenergy efforts is woody materials that are not part of the commercial forest product material flows. Woody biomass includes forest vegetation treatment residuals (tree limbs, tops, needles, leaves and other woody parts) that are by-products of forest management and ecosystem restoration. Currently these materials are underutilized, commercial value is low, and markets are small to non-existent.

A recent joint USDA and DOE report, *Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply*, commonly known as the "Billion Ton Report," projects that there are over 1.3 billion dry tons per year of biomass potential, enough to produce biofuels sufficient to meet more than one-third of the nation's current demand for transportation fuels by 2030. About one-quarter of that total, roughly 380 million dry tons of biomass could be produced in a sustainable manner from residues from private, State, Tribal and Federal forest lands and from forest wood wastes.

The Healthy Forest Restoration Act (HRRA) authorized the use of $5 million to help "…establish small-scale business enterprises to make use of biomass and small-diameter material." These funds were to be used to: (1) help reduce forest management costs on National Forest System lands by increasing the value of biomass and other forest products generated from hazardous fuel treatments; (2) create incentives and/or reduce business risk for increased use of biomass from or near national forestlands; (3) institute projects that target and help remove economic and market barriers to using small-diameter trees and wood biomass.

The EPACT authorized up to $50 million for grants to improve the commercial value of forest biomass for electric energy, useful heat, transportation fuels, and other commercial purposes. In FY 2006, 88 applications were received, totaling almost $18 million in requests. Eighteen proposals were funded at a Federal cost of $4.2 million. These projects leveraged approximately $9 million in non-Federal funds.

IV. Economic and Policy Issues for Renewable Energy and Energy Efficiency Programs

This section provides a general discussion of the support provided by current programs using several evaluation criteria: increase in production of renewable fuels and energy efficiency, program cost, effects on farms and rural areas, and implications for U.S. commitments under the World Trade Organization (WTO).

Effects on Renewable Energy Production and Energy Efficiency

Federal and State governments have helped create markets for renewable energy through tax incentives and mandates. Ethanol production has increased sharply since the late 1990s, to 4 billion gallons in 2005 up from 1.8 billion gallons in 2001. Biodiesel production has grown to over 90 million gallons in 2005, a nine-fold increase from 2001. The EPACT mandates that 7.5 billion gallons of renewable energy be used in motor vehicles by 2012, guaranteeing a future demand for the renewable fuels. In addition to Federal and State programs, high oil prices and the phase out of MTBE have contributed to the growth in renewable fuels production since 2001. While modest in size compared with tax incentives, USDA programs have contributed to this growth.

RD grants, loans, and loan guarantee programs supported the planning and construction of new production facilities and energy conservation projects, creating jobs and additional wealth-enhancing opportunities in rural America. In total, 650 renewable energy and energy efficiency projects have been funded between FY 2001-05 at a Federal cost of $356 million. In addition, matching and funding by the private sector supporting these projects totaled another $1.3 billion. Included in these programs are 132 ethanol and biodiesel, 130 wind, 20 solar, 4 geothermal, 2 hydrogen, and 11 hybrid projects; 92 anaerobic digesters and 7 landfill gas recover systems; 168 energy efficiency projects; and other projects including solid fuel research.

In 2005, additional conservation practices applied with the assistance of USDA that improved energy efficiency on farms and ranches included:

- Residue management on 4.5 million acres,
- Irrigation water management on 1.2 million acres,
- Nutrient management on 4.1 million acres, and
- Pesticide management on 3.9 million acres.

There is a significant opportunity to realize immediate economic and environmental gains through energy conservation activities. Preliminary estimates of the potential national savings from implementing the following five conservation measures could be greater than $2 billion per year. The measures include:

- Doubling of no-till acreage (from 62 to 124 million acres), saving 217 million gallons of diesel fuel and $500 million each year;
- Switching from high or medium pressure systems to low pressure systems, lowering electricity use, and saving $100 million in pumping irrigation water costs;
- Increasing diesel irrigation pump efficiency by 10-percent, reducing diesel consumption by almost 26 million gallons, and saving farmers and ranchers almost $60 million each year;
- Doubling manure-based nitrogen use to replace fertilizer produced from natural gas valued at $825 million and 100 billion cubic feet of natural gas annually; and
- Using precision agriculture on more acres to reduce application overlap on 250 million acres of cropland, saving up to $825 million in fertilizer and pesticide costs each year.

Program Costs

USDA has more than 300 program areas and leverages an extensive network of Federal, State, and local cooperators in serving the public. Biobased products, bioenergy, and other energy-related work spans across the various activities of the Department. During FY 2001-05, USDA funds expended on biobased products, bioenergy and other energy-related programs totaled $1.4 billion. USDA outlays in FY 2006 on biobased products, bioenergy and other energy-related programs is estimated at $272 million (Appendix Table 1). In addition, Federal and State income tax credits and other tax incentives that promote the use of ethanol and biodiesel reduce tax collections by over $2 billion annually.

A primary issue for the future is the role the public sector should play in supporting or subsidizing markets and in conducting research. The primary argument against public sector involvement is that if an economic incentive exists for renewable energy then economic forces should bring forth the appropriate resources, research, and development necessary to build the market infrastructure. In theory, this may be true, but there are often barriers to entry, for example, there are relatively few players in the petroleum industry that dominate the production and distribution systems. In addition, there are public benefits of renewable energy that do not have an explicit market value, such as environmental and energy security attributes. These positive externalities are often ignored in the marketplace, causing renewable energy to be undervalued, resulting in a lack of private investment. In cases where there is underinvestment in a desirable product from the public point of view, the government will often step-in and provide public investment for research and development.

Economic Impacts on Farms and Rural Areas

A USDA study conducted in 2000 estimated the economic effects on the farm economy from increasing annual ethanol production to 5 billion gallons by 2010. The increase in ethanol production was projected to increase the price of corn by $0.32 per bushel and annual net farm income by almost $3 billion in 2010. In addition, the increase in ethanol production lowered the U.S. trade deficit and higher corn prices resulted in lower farm program payments.

A 2001 USDA analysis of increasing biodiesel production found that an increase in biodiesel demand sufficient to increase soybean oil use by an average of 1.5 billion pounds per year, over a 10-year period, would increase the average soybean oil price by 22 percent. The average farm price for soybeans would increase by 3 percent. The study also showed a 0.7-percent increase in annual net farm income over the 10-year period.

Studies show that increasing ethanol and biodiesel production has a mixed effect on the livestock sector. Increased ethanol demand leads to higher prices for feed grains that initially may result in increased costs for some livestock producers. However, higher feed prices will be partially offset by increased supplies of distillers' dried grain (DDG), which is a coproduct of ethanol production. The response by the livestock sector to changes in feed prices depends on the relative importance of protein (primarily soybean meal) versus energy (primarily corn) and the size of the price changes associated with these feed components. Because protein is

relatively more important in the feed ration for poultry, feed costs for broilers and turkeys decline due to lower protein prices. On the other hand, the feed costs for beef and dairy cattle, and hogs would increase because their feed rations depend more on the energy content of the feed. These cost changes lead to small price declines in broilers and turkeys and small price increases in other livestock products. Since these production and price adjustments are small, increases in biofuels production over the next couple of years are not expected to have a major effect on the livestock sector.

USDA's Economic Research Service (ERS) conducted a study in 2002 assessing the employment effects of implementing a renewable fuels standard (RFS) requiring about 4.5 billion gallons of renewable fuel by 2012 (USDA, ERS, 2002). The authors assumed that the RFS would be satisfied mostly by ethanol from corn and a small amount of biodiesel from soybean oil. Model simulations were developed for two production scenarios that generated 12,600 to 31,400 new jobs. Since the EPACT created a RFS requiring 7.5 billion gallons by 2012, the employment effects could be greater.

Some have argued that increased renewable energy production from agriculture products diverts production away from food at a time when food supplies are needed to meet the needs of the rapidly growing world population. Up to this time, strong trend growth in agricultural productivity, chronic periods of excess production, and periodic low prices suggests that the U.S. farm production sector is not stressing its capability to produce a sufficient and affordable supply of food for its customers. However, it is apparent that if renewable fuels are to capture a significant share of the transportation fuels market, biomass feedstocks other than corn and soybean oil will have to be economically and technically feasible to convert to biofuels.

WTO Consistency

The Uruguay Round Agreement on Agriculture (URAA) of the WTO established criteria for classifying programs that provide benefits to agriculture by how much they distort production and trade. This classification is important because programs that are deemed to be minimally or non-trade distorting (so-called green box) are not subject to annual limits on support, as are programs that are classified as trade-distorting (referred to as amber box).

Green Box criteria. To be classified as green box support, a program must meet two sets of criteria. The first are fundamental requirements that the program must be publicly funded, not involve transfers from consumers, and not have the effect of providing price support to producers. In addition to these fundamental requirements, a program has to meet specific policy criteria, which are contained in Annex 2 to the URAA (the green box). If a program does not meet both sets of criteria, it must be reported to the WTO as amber box (or possibly blue box, but that option is not considered here). The most relevant policy-specific criteria for bioenergy programs are:

- **Paragraph 2: General services.** This paragraph covers a wide range of government activities that provide services or benefits to agriculture or rural communities. Such support includes research; pest and disease control; training; extension and advisory services; inspection; marketing and promotion; and infrastructure. Support cannot

involve direct payments to producers or processors, provide on-farm facilities or inputs, such as provision of irrigation water, or provide for preferential user charges.

- **Paragraph 6: Decoupled income support.** To be eligible for green box status, payments must be determined by clearly defined criteria such as income, landowner, factor use, or production level in a defined and fixed base period. Payments cannot be related to any production, prices, or factor of production after the base period. Finally, no production can be required to receive a payment.

- **Paragraph 10: Structural adjustment provided through resource retirement programs.** To be eligible for green box status, payments must be part of a well-defined government program that removes land or other resources from marketable agricultural production for a minimum of three years (permanently for livestock). Payments shall not require or specify an alternative use for the retired resources that involves the production of marketable agricultural products. Payments cannot relate to type or quantity of production, or to prices, applying to production using the land or any other resource remaining in production.

- **Paragraph 12: Payments under environmental programs.** To be eligible for green box status under this paragraph, payments must be part of a clearly-defined government environmental or conservation program and must fulfill specific conditions under the program, including those related to production or inputs. In addition, payments must be limited to the extra costs or loss of income involved in complying with the program.

WTO member countries are obligated to notify, or report, programs under the various domestic support categories. The last U.S. notification was made in 2004 for the crop years 2000 and 2001. No programs under the 2002 Farm Bill have been reported. Current and future programs should strive for consistency between bioenergy programs and WTO green box criteria. Issues in achieving this consistency can be illustrated by examining current USDA programs.

The CCC Bioenergy Program has not been notified to the WTO. The program does not meet any policy-specific criteria in the green box, so it would not qualify for green box status. Paragraph 2 does not allow for direct payments to be made to processors, which is the payment mechanism for this program. While payments under the CCC Bioenergy Program go to bioenergy processors, commodity producers benefit to the extent commodity prices are enhanced by increased demand. Annex 3, paragraph 7 of the URAA states, "Measures directed at agricultural processors shall be included to the extent that such measures benefit the producers of basic agricultural commodities." This suggests that payments under the CCC Bioenergy Program could be viewed as an amber box subsidy to the commodity on which the bioenergy producer received a payment.

With the possible exception of the Renewable Energy Systems and Energy Efficiency Improvements Program, the programs authorized by the 2002 Farm Bill either meet the criteria of Paragraph 2 for general services (green box) or would not be classified as agricultural programs. For example, to the extent that the energy systems under the Renewable Energy Systems and Energy Efficiency Improvements program help meet environmental goals (cleaner

water or air), the grants could be viewed as environmental payments. Because the grants are limited to 25 percent of the costs of a project, they would be consistent with Paragraph 12 of the green box. But to the extent the program provides an interest subsidy on farm production inputs, the loans and guarantees could be viewed as an amber box input subsidy.

The 2002 Farm Bill permits harvesting biomass from land enrolled in the CRP. With respect to this program, Paragraph 10 requires that enrolled land must be removed from marketable agricultural production for a minimum of three years to be considered a green box program. Whether biomass is considered marketable agricultural production has not been determined.

In addition to specific USDA initiatives, general incentives to encourage bioenergy use have existed for many years. These incentives were recently addressed in The American Jobs Creation Act of 2004 (Jobs Act), which replaced the ethanol excise tax exemption with new tax credits for blending ethanol or using ethanol directly. The Jobs Act also initiated new tax credits for biodiesel. These new tax provisions do not distinguish between domestic and imported bioenergy. Any subsidy that is contingent upon domestic use of a product would be a violation of WTO rules.

The U.S. has historically notified the (prior) excise tax exemption/tax credit provisions as a subsidy (income tax concession) to the WTO Committee on Subsidies and Countervailing Measures (SCM). In its most recent notification in October 2003 for FY 2002, the U.S. notified the annual tax revenue loss due to the tax provisions of $1.07 billion in FY 2002, and an annual revenue loss of $30 million from the (prior) small ethanol producer credit. No part of the subsidy has been notified as an agricultural subsidy because the benefit goes directly to the blender or producer of the ethanol. To receive the tax benefits, ethanol and biodiesel must be made from renewable sources, but these are not exclusively agricultural products, and the tax provisions do not specify any particular agricultural product(s) be used to produce the biofuel (with the exception of the additional incentive for agri-biodiesel).

EPACT established a renewable fuel standard (RFS) of 7.5 billion gallons by 2012. Production of renewable fuel is allowed from such traditional sources as corn and other crops or from plants, grasses, agricultural residues and waste products. Imported and domestically produced biofuels can be used to meet the mandate. There is no known precedent in the WTO for notification of a *de facto* subsidy as a result of a mandated use or consumption requirement, and the mandate itself has not been questioned under the WTO rules.

VI. Alternative Approaches to Enhancing Renewable Energy and Energy Efficiency

Afforable energy is essential for the American economy. This section suggests two alternative approaches to expanding renewable energy production and energy conservation. One approach is to expand the use of direct government intervention to change market incentives. Direct market approaches include the use of taxes, subsidies, or mandates on energy market participants to change their behavior. The second approach is to expand the use of indirect government support, such as research and demonstration projects, technology transfer activities, access to credit, outreach and education, and similar activities. These alternative approaches are not being

advocated by USDA. Each approach has both advantages and disadvantages. They are offered for the purpose of generating discussion and ideas for the 2007 Farm Bill.

In a competitive market, market prices usually provide the best stimulus to meet consumer demand in the most cost-effective way. Oil selling for $75 per barrel in mid-2006 provides substantial incentives to develop fossil and renewable energy supplies and conserve energy. Even so, there is a strong economic rationale for increased government support for the development of domestic alternative energy supplies. The rationale is based on several benefits of increased use of renewable fuels that are not reflected in the market price of renewable fuels. By not accounting for these positive externalities, the market is "underpricing" renewables and thus limiting their production. The rationale for government support is to "monetize" the nonmarket benefits to augment the market incentives. Care must be taken to create incentives that are commensurate with expected external benefits, so as not to distort markets. Key benefits of renewable energy that are not reflected in price include:

- **Environmental benefits.** Renewable energy provides a range of environmental benefits compared with fossil energy, including reduced emissions of toxic chemicals and greenhouse gases.

- **Energy security.** As described in the first section of this paper, DOE projects the United States will become increasingly dependent on oil imports in future years. Under this dependency, the United States is vulnerable to terrorism directed at foreign oil production, foreign political actions that withhold oil from the world market, and competition for limited global oil supplies from rapidly advancing developing countries. Sudden reductions in oil available to the United States would disrupt the U.S. economy imposing costs on U.S. citizens. Another cost not reflected in the price of oil is the U.S military and diplomatic costs of securing foreign oil supplies. A related cost of import dependency and the large import share of the United States is the "monopsony effect," or an increase in the global oil price and U.S. oil costs caused by an increase in U.S. oil imports. Reducing oil import dependency would reduce these various costs imposed on the United States.

- **The balance and exercise of geopolitical power.** As oil prices continue to set record highs, the resource value of oil exporting nations increases. The rising oil prices have increased the resources and leverage for some oil countries to pursue anti-U.S. interests. . Moreover, some oil exporting nations have weak free enterprise and democratic foundations, and record-high oil revenues have been used as justification for nationalizing energy resources and other anti-free enterprise actions. Increasing the supply of alternative energy to the point that it materially reduces U.S. oil imports and global oil prices would reduce the leverage and opportunity of global bad actors to pursue anti-free enterprise and undemocratic actions.

One cautionary note associated with increased biofuels production is that without the adoption of appropriate conservation practices, there is a potential for unintended adverse environmental impacts. For example, corn production may expand into environmentally sensitive areas and the excess removal of biomass for cellulosic ethanol production may adversely affect soil quality.

Although the following alternatives address direct and indirect support of renewable energy production, USDA will continue to emphasize energy efficiency and conservation through existing natural resource conservation programs. Items of interest in the 2007 Farm Bill discussion include EQIP authorities for NRCS to cost share on energy related activities including energy audits.

Alternative 1: Expand Federal Direct Market Intervention to Support Renewable Energy

Many direct market incentives exist now. Some of these policy tools have been created in legislation that is unrelated to a Farm Bill or to the jurisdiction of the agriculture committees. It is unclear how expansive energy provisions could be in the 2007 Farm Bill. Thus, this alternative offers a range of ideas for public consideration, with the understanding that jurisdiction for any suggestions requiring legislation may not be the under the jurisdiction of the agriculture committees. Some of the ideas listed here are currently under public discussion, and all represent areas where USDA might be expected to have a role in design or implementation. Thus, options that are unrelated to USDA are not considered (such as oil taxes or CAFE standards).

Possible expansions of direct market intervention include:

- **Raise the level of the Renewable Fuel Standard (RFS).** Because biofuel production currently exceeds the amount of renewable fuels required under the RFS, the standard is not expected to be binding and thus provides little incentive to produce additional biofuels. The RFS could be raised to provide a greater production incentive. The cellulosic requirement under the RFS could also be expanded and accelerated to begin before 2012.

- **Extend renewable energy tax credits to 2015 or later.** With credits expiring in 2008 and 2010, this change would reduce investment uncertainty created by the current expiration dates.

- **Reduce biofuel tax credits when they are not effective in increasing biofuel supply or are not needed.** This change would.avoid excessive use of credits and save Federal budget resources by making credits variable. Reductions could be accomplished a number of ways: limiting eligibility for credits to biofuel production in excess of the RFS, because the credits are not needed to ensure production up to the RFS level; linking the size of the credit to the price of oil, for example, the higher oil price, the lower the credit rate; or linking the credit to the cost of producing ethanol.

- **Provide accelerated depreciation on renewable energy equipment and facility investment.** This preferential tax treatment could help spur new investment in specialized production, handling, and processing equipment and facilities for biopower, biofuels, and bioproducts. The preference could be expansive or limited,

for example, only for facilities using biomass for cellulosic conversion, and it could be temporary.

- **Provide a depreciation allowance on certain land.** Examples include lands on which high voltage transmission, wind or solar generation, geothermal generation, land fill gas, and coal field methane development occurs. This allowance could be considered similar to the oil industry depletion allowance and would help increase the return on investment. The depreciation allowance should reflect any economic loss in the value of land due to degradation, which in the case of some uses, may be minimal. Similarly, a depreciation or depletion allowance, or alternatively a conservation payment, could be considered for cropland used to produce biomass to help protect wildlife habitat and limit soil erosion.

- **Use more land enrolled in the CRP for biomass harvesting and wind energy.** CRP land was used for pilot programs in the late 1990s, when farmers were allowed to harvest biomass for energy use with a reduced rental rate. The 2002 Farm Bill allowed the Secretary to permit the managed harvesting of biomass and the installation of wind turbines, consistent with the conservation of soil, water, water quality, and wildlife habitat.

- **Refocus the CCC Bioenergy Program.** The CCC Bioenergy Program expires in 2006. With the RFS and tax credits, the program is no longer needed. However, the CCC Bioenergy program could be recast to support only cellulosic ethanol feedstocks, including dedicated energy crops or agricultural/forestry residues to be made into cellulosic ethanol. A larger program could support biomass used for bioproduct processing. Consideration could be given to simplifying the program to provide a payment rate per unit of output (such as per gallon), examining the issue of a payment limit per eligible entity, and terminating the program as cellulosic ethanol or bioproducts become commercially feasible.

Economic Impacts. The list of approaches under this alternative would have a range of impacts. Expanding the RFS beyond the levels in current legislation could increase biofuel production. That production would likely come initially from corn, resulting in increased prices for corn and higher farm income. However, depending on the size of the increase in the RFS, there would likely be increased risk of tighter commodity markets, especially if weather or unforeseen export demand caused sharp corn price increases as was the case in 1996. Any resulting price spikes could disrupt the livestock, poultry, and processed product industries. Feedstock shortages could be addressed with a wavier of the RFS, but the use of a waiver may reduce confidence in the ethanol industry's ability to provide a reliable supply of biofuels.

Tax preferences, such as extended credits, accelerated depreciation, and related allowances, would increase the return on investment in renewable energy and thus increase its supply. A supply increase would be positive for energy security, rural development, and producers of renewable energy feedstocks. However, there are some concerns to consider. First, tax preferences reduce Federal revenues and increase the budget deficit. Second, using tax preferences to encourage production in a mandated market, such as the RFS, may have little

effect on production and result in a transfer of income from taxpayers to biofuel consumers. Third, in an environment of $75 a barrel oil, tax preferences are not currently needed to expand biofuel production. In light of these concerns, tax preferences should be structured to ensure that they generate new investment and are not excessive in relation to the price of oil and the cost of producing renewable energy. Making credits variable based on oil prices or biofuel costs could reduce taxpayer costs but would lessen investment incentives in renewable energy when oil prices are high and would likely be administratively complex.

Ethanol made from cellulosic feedstocks is viewed as potentially the most cost-effective way to provide large-scale ethanol production without creating commodity market shortages. Many groups have advocated specific targets for renewable fuels in the future. For example, in his State of the Union speech, President Bush stated the goal of replacing more than 75 percent of U.S. oil imports from the Middle East by 2025. His statement recognized that to achieve such a goal would require breakthroughs in technology that enabled ethanol to be produced not only form corn but from materials such as wood chips and switch grass. Refocusing the CCC Bioenergy Program on cellulosic ethanol would avoid subsidies where they would have limited effect and provide financial assistance to an industry that is not yet commercial and has feedstock production, handling, transportation, and processing barriers to overcome to make it economically feasible.

WTO Consistency. The components of this alternative have mixed implications for U.S. WTO obligations. Provided the RFS does not discriminate against imported ethanol or biodiesel in favor of domestically-produced biofuels, the RFS is not expected to be a WTO issue. The various tax preferences suggested would not be agricultural subsidies but would result in tax revenue changes that would be reported to the WTO as general subsidies (income tax concessions). A CRP payment made to a producer who is permitted to use CRP acreage for energy production could raise issues as to whether such a payment is a green box land retirement payment. However, if the CRP is viewed as an environmental program under WTO criteria, such a payment could be a green box payment, provided the CRP rental rate was reduced to reflect the value of the biomass and any remaining CRP payment on that acreage reflected compensation for the cost of environmental practices. The current CCC Bioenergy Program could be viewed as amber box, and a redefined CCC Bioenergy Program that made payments to biofuel or bioproduct processors for production specifically from biomass risks being viewed as amber box.

Alternative 2: Expand Federal Indirect Support for Renewable Energy

Indirect support for renewable energy would help overcome research and technology barriers, problems with access to credit, increase public awareness, and other measures that do not involve direct taxes, subsidies, or mandates.

Possible expansions of indirect Federal support include:

- **Expand agricultural support on the national research initiative for cellulosic ethanol.** Some have suggested that the public benefits of large-scale, cost-effective cellulosic ethanol production are so great that a major research and development

initiative between the government and private sector is warranted. This effort would substantially build on existing programs and the President's Advanced Energy Initiative. It could focus on biological and engineering research that promotes the development of economically viable raw materials, processing technologies, and products. The effort would involve Federal research facilities, competitive grants, public-private partnerships, and Federal-supported demonstration projects.

- **Expand creative financial engineering to support development of the biobased economy.** (See also the 2007 Farm Bill Theme Paper on Rural Development, Alternative 2.) Private sector firms engaged in development of the bioeconomy indicate the need for public sector support beyond grants, loans, and loan guarantees, such as some form of equity funding that could be leveraged with their own equity and debt financing. This funding is important when starting the first generation of commercial-scale demonstration or production plants using a technology without a proven record of commercial operation, such as cellulosic ethanol plants and biorefineries. Until the technology is proven economically and technically viable on a commercial scale, equity financing may be difficult to obtain, and debt financing alone is insufficient to launch most projects. A first step to developing new financing approaches is to evaluate the existing government development assistance programs to improve their effectiveness and recommend new financial products that could fill financing gaps. One financing mechanism to consider is to enable and assist Farm Credit System institutions and commercial banks to create investment subsidiaries to invest in non-farm rural businesses. Another idea is to provide insurance to a start-up bioenergy or bioproduct enterprises for specified losses through their first production cycle. Yet, another idea is to create a development program for new products and markets that provides data bases, forums for interaction between entrepreneurs and financing entities, and business start-up counseling.

- **Fund development, demonstration, and pre-commercial activities that will bridge the gap between federally-funded basic research and industry-funded applied research and development.** This funding gap, the so-called "Valley of Death," often involves proving a concept at a sufficient scale to encourage full-scale production, which is necessary to attract private investment. One approach is public-private partnerships as exemplified by the Advanced Technology Program (ATP) of the National Institute of Standards and Technology. Another approach is to use Federal facilities (or develop joint public-private facilities) to establish the proof-of-concept. Such facilities would contain large-scale processing equipment and qualified personnel. Examples of existing public-sector facilities that could play such a role are the DOE Alternative Fuel User Facility in Golden, Colorado and the USDA Laboratory for Agricultural Utilization Research in Peoria, Illinois.

- **Expand education and outreach for the bioeconomy.** Educating the public on the bioeconomy would facilitate the transition to greater use of biofuels and other bioproducts. There is still limited public understanding of economic, environmental, sustainable development, and energy security value of biofuels and other biobased products. Issues and benefits need to be better defined in consumer terms. An

outreach and education program that expands beyond the current Biodiesel Education Program, with clearly defined and measurable goals could increase interest in renewable and biobased products and support new biomass products and applications. Integration into schools could help to stimulate support for future bioproducts as well as interest young people in careers in this area. The pool of trained people is limited in areas such as natural products chemistry and carbohydrate chemistry.

- **Meet expected new demands for rural electric generation and transmission.** Demand for new electric power generation capacity is building, after many years of little or no new base load capacity being added. Substantial increases in loan guarantee authority are expected to be necessary to assure the required debt capital. While USDA loan guarantees typically are for 95-100 percent of the loan, consideration may be given to develop a more traditional loan guarantee program for private lenders and use partial loan guarantees or create a mechanism for lenders to bid for the level of guarantee they would require to provide financing. Loan guarantees and planning grants could be targeted to support the development of distributed generation facilities using biobased fuel, wind, solar, or geothermal resources. Often the distribution grid must be augmented to accommodate renewable or distributed generation power. Loan guarantee authority to support projects to upgrade the grid would help build renewable energy capacity. High voltage transmission capacity to move renewable energy from its source to demand locations is a serious constraint to renewable power development. Clarifying access rights and pricing for high voltage transmission could also be helpful in facilitating needed transmission development.

Economic Impacts. The essence of this alternative—research and development, creative financing, and education—avoids direct distortion of market incentives. These actions would reduce the risks currently faced by potential investors in bioproduct technologies. Commercialization of cellulosic ethanol has not yet begun; capital costs and the conversion process costs for the initial facilities are high. Several apparently effective technologies have been developed for cellulosic ethanol and other bioproducts and appear only to require the sufficient investment capital to become commercialized. Once these industries become established, improved production efficiencies are expected to reduce product cost, and along with that, the need for continued government assistance.

While avoiding direct market intervention, these approaches still affect market outcomes by reducing production costs through efficiency gains and through credit subsidies. Because these approaches use Federal support for specific technologies and firms, there is a risk that the government will support activities that in the long run are not cost effective. While having the government pick “winners” risks dissipating taxpayer dollars, the government can support a portfolio of technologies and firms to increase the probability of bringing an investment to economic success. On the down side, this approach would likely raise the costs of this alternative. All approaches require careful analysis of the role of public support versus private market incentives.

An expanded national research initiative to provide large volumes of cost-effective cellulosic ethanol would need to focus on a range of economic and technological barriers. The National Academy of Sciences (NAS) identified three priorities in biological research supporting a biobased industry: (1) the genetics of plants and bacteria that lead to an understanding of genes that control plant pathways and cellular processes, (2) the physiology and biochemistry of plants and microorganics directed toward improving bioconversion processes and modification of plant metabolism, and (3) protein engineering methods to allow the design of new biocatalysts and novel plant polymers. To maximize economic efficiency in designing the Federal initiative and the use of Federal labs, the government should try to ensure that it does not support research that would otherwise be done by the private sector, and that development and use of any facilities for precommercial work should obtain a significant fraction of the needed funds from the private sector.

If efforts to commercialize cellulosic ethanol and other bioproducts succeed on a large scale, there is a potential for substantial changes in the farm economy. A recent joint USDA and DOE study implied that to generate a supply of biomass to achieve 30 percent replacement of U.S. petroleum consumption by 2030 would require shifting of production to biomass from current crops, cropland pasture, and the CRP. The effects of a large-scale bioproduct industry are not well understood and further economic analysis is needed to investigate the potential inter-commodity affects. For example, there would be implications for the supply, types, and prices of available animal feeds. Along with the engineering and science research on feedstocks and processing, more information is needed on land use and availability and on co-production systems, including the use and availability of new protein feeds from biobased products. There would also likely be widespread environmental effects. Production of agricultural and forest feedstocks can have positive, negative, or neutral consequences on wildlife, soil, air, and water quality. These results depend on many factors, such as previous use of land and crop management practices.

The suggestion that greater support should go to renewable electricity projects and grid improvements to accommodate renewable energy is based on the potential economic benefits of distributed electric power generation. Distributed generation can more easily be scaled to local demand, reducing the need for large scale base load generation development. Distributed generation can also reduce the need for developing new high voltage transmission lines.

WTO Consistency. Most of the ideas for discussion presented here would not be considered agricultural subsidies, although the research and development programs may be considered green box programs consistent with paragraph 2, General Services, under Annex 2 of the URAA. The various credit and financing suggestions (loans, loan guarantees, and equity investments) for rural businesses would not be payments for using specific agricultural products. These programs would not be viewed as agricultural subsidies but as general subsidies, similar to the current treatment of such programs.

VII. Suggestions for Further Reading

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Appendix Table 1. USDA Outlays for Biobased Products/Bioenergy Programs

Biobased Products/Bioenergy Details	2001 Actual	2002 Actual	2003 Actual	2004 Actual	2005 Actual	2006 Est.
	(1,000s of dollars)					
Agricultural Research Service						
Biobased Products	$41,480	$46,236	$49,623	$51,294	$49,529	$49,879
Bioenergy	6,867	17,475	19,341	19,820	19,587	20,052
Federal Procurement of Biobased Products	506	506	536	591	608	627
Total ARS	48,853	64,217	69,500	71,705	69,724	70,558
Commodity Credit Corporation						
Bionenergy Incentive Payments	40,684	78,744	147,211	149,440	90,006	60,000
Cooperative State Research, Education, and Extension Service						
Biobased Products						
Formula Programs	4,012	4,047	3,349	3,152	3,192	3,202
National Research Initiative	4,003	2,654	4,985	4,600	6,601	6,601
Special Research Grants	4,217	5,484	3,732	3,607	3,740	3,731
Bioenergy						
Formula Programs	Above	Above	366	1,263	1,261	1,086
National Research Initiative	Above	Above	1,010	4,097	1,238	1,238
Special Grants	Above	Above	1,539	2,217	2,212	2,223
Total, CSREES	12,428	12,185	14,981	18,936	18,244	18,081
Forest Service						
Biobased Products Research	12,000	12,000	12,000	12,000	10,000	10,000
Bioenergy Research	450	450	450	444	2,450	2,450
Total, FS Research	12,450	12,450	12,450	12,444	12,450	12,450
Natural Resource Conservation Service						
Conservation Operations	20	0	0	0	0	0
Forestry Incentives Program	6,311	6,811	0	0	0	0
RC&D Bioenergy Demonstration Projects	728	728	723	0	0	0
Biomass R&D (Section 9008, Farm Bill)	0	5,000	13,909	13,525	12,627	11,650
CCC Section 11 Administrative Costs Biomass R&D			200	351	350	350
Total, NRCS 1/	7,059	12,539	14,832	13,876	12,977	12,000

Biobased Products/Bioenergy Details	2001 Actual	2002 Actual	2003 Actual	2004 Actual	2005 Actual	2006 Est.
	(1,000s of dollars)					
Office of the Chief Economist						
Biobased Products and Bioenergy	612	612	630	630	635	628
Preferred Procurement and Labeling Program for Biobased Products	0	0	0	0	1,540	1,525
Federal Procurement of Biobased Products (Section 9002, Farm Bill)	0	1,000	1,000	1,000	1,000	1,000
Biodiesel Fuel Education Program (Section 9004, Farm Bill)	0	0	1,000	1,000	1,000	1,000
Total, OCE	612	1,612	2,630	2,630	4,175	4,153
Office of Procurement and Property Management						
Alternative Fuels and Preferred Products	65	67	69	69	78	78
Federal Procurement of Biobased Products	0	0	0	720	187	193
Total, OPPM	65	67	69	789	265	271
Rural Development						
RCAP/DOE Matching Grant	0	2,820	133	0	0	0
Value-Added Grants 2/	0	0	0	500	1,946	2,500
Renewable Energy Programs: 3/						
Grants	0	0	0	22,812	22,238	11,385
Loans	0	0	0	0	579	11,385
Renewable Energy Grants and Loans (Section 9006, Farm Bill)	0	0	21,707	0	0	0
Other RD grant programs	474	0	0	0	0	0
Other RD loan programs	1,550	0	0	0	0	0
Total, RD	2,024	2,820	21,840	23,312	24,763	25,270
Total, USDA Biobased Products/Bioenergy	**124,175**	**184,634**	**283,513**	**293,132**	**232,604**	**202,783**
Other Energy Related Programs	57,237	31,298	55,543	68,867	60,287	69,048
Total Biobased Products, Bioenergy and Energy Programs	**181,412**	**215,932**	**339,056**	**361,999**	**292,891**	**271,831**

1/ In FY 2005, of the $14 million authorized to NRCS for the Biomass program, $540,525 was obligated for grants. The remaining was committed in FY 2005, and obligated in FY 2006.
2/ Only the portion of the program funding awarded for bioenergy is shown.
3/ Loans and grants are made to all renewable energy and energy efficiency projects.