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Report to the Chairman, Subcommittee on Energy and Power, Committee on Energy and Commerce, House of Representatives

July 1990

ALCOHOL FUELS

Impacts From Increased Use of Ethanol Blended Fuels

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Resources, Community, and
Economic Development Division

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July 16, 1990

The Honorable Philip R. Sharp
Chairman, Subcommittee on Energy
and Power
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

As you requested, this report presents information on the ethanol industry's capability to expand its production capacity, the effects that expanded ethanol production could have on the agricultural sector and consumer food prices, and how the increased production could affect certain aspects of the federal budget. The preliminary results of our work were presented in our Statement for the Record (GAO/T-RCED-90-23) submitted for the February 1, 1990, House Committee on Ways and Means hearings on certain alcohol fuel tax and trade initiatives.

As arranged with your office, we plan no further distribution of this report until 30 days from the date of this letter. At that time, we will send copies to the Secretary of Agriculture, the Secretary of Energy and other interested parties. We will also make copies available to others upon request. Should you need further information, please contact me on (202) 275-1441. Other major contributors to this report are listed in appendix III.

Sincerely yours,

Victor S. Rezendes
Director, Energy Issues

Executive Summary

Purpose

Ethanol is an alcohol that, when blended with gasoline, provides an effective renewable fuel additive, extends gasoline supplies, and increases gasoline octane levels. Because ethanol fuel blends burn cleaner than gasoline, they also reduce harmful auto emissions. Ethanol blends currently account for about 8 percent of the gasoline sold in the U.S. Since most ethanol is made from corn, its production provides a valuable market for American farmers. Although ethanol costs more to produce than gasoline, federal and state tax incentives make ethanol blends competitive with gasoline. For example, ethanol fuel blends are currently exempt from 6 cents of the 9-cent per gallon federal tax on motor fuels.

Congressional proposals to encourage greater use of alternative motor fuels could increase the demand for ethanol. In view of such proposals, the Chairman, Subcommittee on Energy and Power, House Committee on Energy and Commerce, requested GAO to determine (1) if the domestic ethanol industry could expand to meet the increased demand that such legislation could create, (2) the effects that expanded ethanol production could have on the agricultural sector and consumer food prices, and (3) how the increased production and use of ethanol could affect the federal budget.

Background

Ethanol is widely used in the U.S. as a gasoline additive—generally in a 10 percent ethanol-90 percent gasoline blend called gasohol. The U.S. ethanol industry has the capacity to produce about 1 billion gallons per year. About 95 percent of the ethanol is made from corn—representing, on average, about 4 percent of domestic corn production in a typical growing year.

GAO developed two scenarios depicting an approximate doubling and tripling of current annual ethanol production capacity (to 2.2 billion and 3.3 billion gallons) over an 8-year period to allow a realistic time frame for industry to expand. GAO's growth scenarios were compared with a baseline scenario that assumed normal crop production, a continuation of current agricultural trends and policies, and little expansion in ethanol production. GAO used the Wharton Econometric Forecasting Associates (WEFA) model of U.S. agriculture in estimating the effect of these production increases on the agricultural sector, federal farm program costs, and consumer food prices.

Results in Brief

The ethanol industry is capable of doubling or tripling domestic ethanol production to 2.2 or 3.3 billion gallons per year during the next 8 years, and American farmers could supply the corn needed for this production increase. However, industry officials caution that continued government incentives and/or a legislative requirement for the use of alternative fuels, such as ethanol, would be needed to maintain such growth.

GAO's modeling showed that the expanded use of ethanol fuels would have mixed effects on various sectors of American agriculture. Corn producers would benefit the most because of the increased demand for corn to make ethanol and the resulting higher corn prices. However, through a complex system of economic relationships, some other sectors would not fare as well. For example, soybean processors and producers would face lowered demand and prices for their products because the conversion of corn into ethanol generates protein-rich feed and corn oil by-products that compete with soybean meal and soybean oil. Increased corn prices would raise feed costs and hurt cattle producers, but the lower cost of high-protein feeds could benefit poultry producers. Overall net farm cash income would increase, and there would be a slight increase in consumers' food prices.

GAO's modeling also showed that expanded ethanol production would decrease federal farm program outlays as the increase in demand for and the price of grains, primarily corn, would cause fewer farmers to participate in these support programs. The estimated decrease in outlays showed annual fluctuations depending, in general, on the relationship among market prices and projected federal program target prices and loan rates. At the same time, the increased use of ethanol fuels would reduce federal motor fuel tax revenues because of ethanol's partial tax exemption. Motor fuel tax revenues were projected to decrease with the expansion in the use of ethanol over the simulation period. On average, the reductions in farm program outlays would exceed the increased tax revenue losses over the 8-year period. However, in response to the primary interests of the Chairman, GAO's study was limited to the impacts of expanded ethanol production on the agricultural program outlays and motor fuel excise tax revenues on the federal budget; it did not explore all the federal budget or consumer impacts that might result from expanded production, such as the income taxes paid by farmers, ethanol producers, and fuel distributors.

GAO's Analysis

Industry Expansion

According to industry officials, the ethanol industry has the capability, experience, and resources to operate additional production facilities. Ethanol production capacity in 1989 was about 1 billion gallons per year. GAO's high-growth scenario assumes that ethanol production capacity would grow by 288 million gallons in each of the 8 expansion years, which is in line with past industry growth. However, because of the relatively high production costs, the ethanol industry relies heavily on federal and state tax incentives to remain competitive with producers of gasoline and other fuel additives, and industry officials cautioned that assurances of continued government incentives and/or a legislative requirement for the use of alternative fuels, such as ethanol, would be needed to sustain such growth.

Impact on Agriculture

According to GAO model simulations, corn farmers would significantly benefit as additional ethanol production would increase the demand for and price of corn. By 1997, the expanded ethanol production under GAO's high-growth scenario would increase corn demand by nearly 6 percent and corn prices by about 15 percent. The availability of additional high-protein feed by-products from the conversion of corn into ethanol would, however, reduce the price of soybean meals and soybean oils and lower the demand and price of soybeans. Corn is the principal feed used in livestock operations, and the higher corn prices, caused by increased demand from added ethanol production, would increase cattle producers' feed costs and lower their profits. On the other hand, the lower prices for soybean meal and other high-protein feed could benefit poultry producers.

GAO's modeling also showed that farmers' overall net farm cash income would increase by an average of about 1.3 percent and that consumers would face slightly higher food prices. The overall food component of the consumer food price index would increase by an average of 0.1 percent—an approximate 10-cent increase on a $100 food purchase.

Impact on Federal Budget

GAO's modeling showed that an expansion of ethanol production would reduce the federal farm program outlays by an annual average of about $930 million and $1.421 billion under its low- and high-growth scenarios, respectively, during the 8-year growth period. On the other hand, the increased use of ethanol fuels, if coupled with an extension of the 6-cent per gallon tax exemption for ethanol blended fuels (past its scheduled 1993 expiration date), could further reduce annual motor fuel tax revenues by an average of about $442 million and $813 million, respectively, for GAO's two scenarios.

Summing-up only the impacts that expanded ethanol production would have on federal farm program outlays and motor fuel tax revenues, GAO's projections indicate that reductions in farm program outlays would exceed the additional tax revenue losses, on average, by about $488 million and $608 million per year, respectively, under the low- and high-growth scenarios. However, GAO's model simulations showed wide variations in yearly farm program outlays that resulted in net budget impacts varying widely from year to year. For example, in one year tax revenue losses exceeded farm program outlay reductions by $924 million. In another year, the outlay reductions exceeded the revenue losses by $2.7 billion. As agreed with the Chairman's office, GAO's study was not designed to explore all the impacts that expanded ethanol production could have on the federal budget, such as changes in income tax revenues from farmers, ethanol producers, and the petroleum industry. GAO's study, however, indicated that the expanded use of ethanol will cause higher ethanol production costs, and it may be necessary to increase the level of government subsidies or to pass the costs on to the consumers through higher motor fuel costs.

Recommendation

GAO is not making recommendations in this report.

Agency Comments

GAO obtained and incorporated the views of Department of Agriculture and Department of Energy officials on the information presented in this report. These officials generally agreed with GAO's analysis and facts. However, as requested, GAO did not obtain official agency comments on a draft of this report.

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Tables

Abbreviations

ASCS	Agricultural Stabilization and Conservation Service
CCC	Commodity Credit Corporation
DOE	Department of Energy
EC	European Community
ETBE	ethyl tertiary-butyl ether
GAO	General Accounting Office
MTBE	methyl tertiary-butyl ether
USDA	United States Department of Agriculture
WEFA	Wharton Econometric Forecasting Associates

Introduction

Ethanol is an alcohol that, when blended with gasoline, provides an effective fuel additive. Ethanol increases the fuel octane level of gasoline, and, because it burns cleaner than gasoline, it can reduce carbon monoxide emissions from motor vehicles. Most ethanol is made from corn, providing a valuable market for America's farmers. Ethanol blended fuels also reduce the country's dependence on oil for its transportation needs because less oil is needed to produce a gallon of motor fuel.

Gasoline/ethanol blends currently account for about 8 percent of all motor fuel sold in the U.S., making ethanol one of the most commonly used alternative fuels. Although not marketed in the U.S., straight ethanol can also be used as a motor fuel replacement for gasoline—as it is in Brazil. However, compared to gasoline, ethanol costs more to produce and poses additional distribution problems. Federal and state tax and financial incentives have been a major factor in the growth and development of this country's ethanol industry. These incentives enable ethanol fuel blends to compete with gasoline and other blending agents in many U.S. markets.

Recent Congressional and Administration proposals would require a greater use of alternative fuels and could increase the demand for ethanol in this country. While the Congress is considering this issue, it is also considering whether to extend federal tax incentives for ethanol production and use.

Characteristics of Ethanol

Ethanol can be made from almost any raw material containing sugar or carbohydrates. As of August 1989, about 95 percent of U.S. ethanol was made from corn, a readily available domestic feedstock that stores well and can be converted to ethanol and other valuable products (including sweeteners, oils, and starches). Wheat, sorghum, barley, and food processing wastes are among the other feedstocks used in the U.S. to make ethanol. Brazil, which uses straight ethanol and gasoline-ethanol blends as motor fuel, produces most of its ethanol from sugar cane.

Ethanol's use as a motor vehicle fuel in the U.S. is generally in a 10 percent ethanol-90 percent gasoline blend, commonly called gasohol. The use of ethanol fuels grew out of concern over our nation's increasing dependence on foreign oil and the abundant supplies of domestic corn. Replacing a portion of a gallon of gasoline with ethanol helps reduce America's reliance on petroleum used in producing motor fuels and provides additional markets for domestic corn and other grains. In 1988, 812 million gallons of ethanol were produced in the U.S.[1] —the motor fuel equivalent of about 23 million barrels of crude oil.

Ethanol is also blended with gasoline to raise the fuel octane level and to reduce motor vehicle emissions. Ethanol is an effective substitute for lead as a gasoline octane booster. Also, some urban areas in Colorado, Arizona, New Mexico, and Nevada—where carbon monoxide emissions are a serious problem during winter months—currently require the blending of ethanol, or other high oxygen additives (oxygenates), with gasoline during the problem periods.[2] Blending gasoline with oxygenates significantly reduces carbon monoxide emissions, especially in older vehicles. Ethanol and MTBE (methyl tertiary-butyl ether)[3] are the most commonly used oxygenates.

The cost of ethanol and its handling properties, however, complicate its use as a motor fuel. For example, it costs between $0.94 to $1.73 to produce a gallon of ethanol (with corn prices at about $2.40 per bushel) according to 1989 estimates provided by Information Resources, Inc. The ethanol feedstock used and the type and size of the production plant will affect the product cost. By comparison, with crude oil prices at or about $20 per barrel (as they were in September 1989), gasoline production costs range between 45 to 55 cents per gallon, according to estimates from the American Petroleum Institute. Ethanol also requires special handling because it attracts water. Moisture in a motor vehicle's fuel system can lead to poor operating performance. Therefore, fuel distributors must ensure that their storage tanks and transport facilities are moisture-free when ethanol fuel blends are used. Ethanol fuels are generally transported by truck or rail, rather than by the more economical oil pipelines, because of their susceptibility to contamination by pipeline moisture. While measures can be taken to move ethanol fuels through oil pipelines, this method is more costly.

Ethanol can also be used to produce ETBE (ethyl tertiary-butyl ether)[4], which has recently received considerable attention as a potential high-

[1] According to Information Resources, Inc., Washington, D.C.

[2] Denver, Colorado and the surrounding area have required the blending of oxygenates during the past three winter seasons. Albuquerque, New Mexico; Phoenix, Arizona; and Las Vegas, Nevada are other urban areas that now require the use of high oxygenated additives in the winter months.

[3] MTBE is an organic ether produced from a reaction of methanol with isobutylene—a chemical produced from various refining-type processes.

[4] ETBE is an ether produced from a reaction of ethanol with isobutylene.

oxygen motor fuel additive. Although not yet commercially available, supporters contend that ETBE blends will outperform ethanol and MTBE as a gasoline additive without the distribution problems associated with ethanol and ethanol blends. While ETBE provides promise for reaching additional fuel markets, its commercial use may also depend on the availability of government incentives for its production and use.

Government Support of Ethanol

Federal and state incentives continue to play an important role in the development and use of ethanol blended fuels. Since 1978, the federal government has provided research funds to encourage the development of ethanol fuels, loans and loan guarantees to encourage construction of ethanol production facilities, and tax credits and exemptions to make ethanol blended fuels more cost competitive with unblended gasoline. Also, surplus federal grain was, on occasion, distributed to ethanol producers. In addition to the federal support, 23 states—as of August 1989—provided tax incentives on ethanol fuel blends and/or direct payments to ethanol producers. This federal and state support reduces the effective cost of producing ethanol and enables ethanol to compete with gasoline and other fuels and additives.

The principal federal incentive to promote the use of alcohol fuels is a 6-cent exemption from the 9-cent per gallon federal motor fuel excise tax. The 9-cent tax, which is levied on each gallon of gasoline sold, helps build and maintain roads and bridges in the U.S. Each gallon of gasoline blended with at least 10 percent ethanol produced from renewable resources, such as corn, is eligible for the exemption.[5] Using a 10 percent blend, each gallon of ethanol could be blended with nine gallons of gasoline to make 10 gallons of an ethanol blended motor fuel. All 10 gallons would be eligible for the 6-cent per gallon exemption, which equates to a total exemption of 60 cents on each gallon of ethanol.

Also, an equivalent 60-cent per gallon federal blenders' income tax credit or refund is available to fuel distributors that blend ethanol with gasoline for use as a motor fuel; the tax credit or refund can be taken in lieu of the excise tax exemption. Because of the tax exemption and credit, ethanol can be offered to the retail market at a lower price.

Changes in the federal fuel-tax exemption and tax credit coverage could significantly affect domestic ethanol production. Current and previous

[5]Exemption applies to alcohol (ethanol or methanol) but does not include alcohol made from natural gas, petroleum, or coal.

Congresses have considered extending, amending, or eliminating ethanol's tax exemption and blenders' tax credit provisions—currently scheduled to expire in September 1993 and December 1992, respectively. In addition, in March 1990, the Treasury Department issued regulations extending the blenders' tax credit to ETBE blended fuels.

Several proposals introduced in the 100th Congress would have affected the use of ethanol fuels. Two bills would have required that, by 1992, on the average, at least 5 percent of all motor fuel sold in the U.S. (by volume) contain ethanol—which would require ethanol production of over 5 billion gallons per year.[6] Another bill would have required that, beginning in 1988, all gasoline sold in the U.S. be blended with alcohol—half in the 10 percent ethanol blend, and half in a 5 percent methanol/2.5 percent ethanol blend.[7] This would have required ethanol production of over 6 billion gallons per year. Neither of these bills was enacted.

Proposals to amend the Clean Air Act from the Administration and Congressional sponsors could also expand the use of clean-burning alternative fuels, such as ethanol. The Administration's July 1989 proposal, among other things, would have required the manufacture, sale, and distribution of over 9 million vehicles capable of using clean alternative fuels—from model years 1995 through 2004—for use in urban areas with populations of 250,000 or more, which are not in compliance with national ozone abatement mandates.[8] The Senate and the House of Representatives passed their versions of the Clean Air Act Amendments on April 3, 1990[9] and May 23, 1990[10], respectively, without this production requirement. While the Senate and House have not reached agreement on the clean alternative fuels section of the Clean Air Act Amendments, each of the proposals contains provisions requiring the use of clean-burning automotive fuels.

[6]The Ethanol Motor Fuel Act of 1987, H.R. 2052, 100th Cong., 1st Sess. (1987); S. 1304, 100th Cong., 1st Sess. (1987).

[7]H.R. 2031, 100th Cong., 1st Sess. (1987).

[8]Clean Air Act Amendments of 1989, H.R. 3030, 101st Cong., 1st Sess.(1989).

[9]Clean Air Act Amendments of 1990, S. 1630, 101st Cong., 2nd Sess. (1990).

[10]Clean Air Act Amendments of 1990, H.R. 3030, 101st. Cong., 2nd Sess. (1990).

Objectives, Scope, and Methodology

Because proposals to increase the use of ethanol as a fuel or fuel blend could significantly affect the agricultural and other sectors of the economy, the Chairman, Subcommittee on Energy and Power, House Committee on Energy and Commerce, requested that GAO determine

- whether the domestic ethanol industry could expand to meet an increased demand for ethanol that legislation could create,
- the impacts that expanded ethanol production could have on the agricultural sector and consumer food prices, and
- how the increased production and use would affect the federal budget.

In conducting this review, we drew upon various studies on ethanol recently conducted by the Departments of Agriculture and Energy, the Congressional Research Service, the American Petroleum Institute, and a special panel established by the Congress in 1987. We also met with officials from the Departments of Agriculture and Energy, the Congressional Research Service, and the American Petroleum Institute.

To assess the current capacity and expansion potential of America's ethanol industry, we interviewed and obtained documentation from ethanol industry officials and ethanol and motor fuel trade associations—primarily the Renewable Fuels Association and Information Resources, Inc.—who provided information on the current makeup, capacity, and operations of the industry. We discussed the potential for industry expansion with current ethanol producers, a potential producer, and other affected parties—including oil companies, chemical industries; and the corn milling and corn processing industries.

We then developed and modeled two growth scenarios; a low-growth projection with ethanol production increasing to 2.2 billion gallons annually (about double the current 1 billion gallon per year capacity) and a higher-growth projection with production increasing to 3.3 billion gallons annually (about triple current capacity).

To capture the widest range of impacts our ethanol growth scenarios could have on American agriculture, consumer food prices, and federal farm program outlays, we used a large scale econometric model of United States agriculture maintained by WEFA. We selected the WEFA model because it could capture the interactions between major crops and livestock sectors and it could estimate the impact on key variables such as demand and prices for crops and livestock, farm income, consumer prices, and federal agricultural budget outlays. We used three scenarios for our analyses. Our starting point was WEFA's baseline scenario, which provides long-term projections for U.S. agriculture and assumes normal crop production, a continuation of current agricultural trends and policies, and little expansion in ethanol production. To the extent possible, our analyses captured all major and quantifiable impacts of an expansion of ethanol production on agriculture sectors. However, we made some necessary simplifying assumptions to reduce the scale of the problem to a more manageable size. The major assumptions underlying our modeling procedure and the baseline scenario are discussed in appendix I.

We then compared the projections from the two growth scenarios with the baseline scenario to measure the results of changes due to increased ethanol production. We chose an 8-year period for our analyses to allow a realistic and reasonable time frame for ethanol industry expansion to the described production levels. Our choice of 8 years was based on the time frames used in analyses on this subject by others—usually 5 to 8 years—and discussions with government and industry officials. The growth in ethanol production required under our scenarios is less ambitious than that required under legislative proposals introduced in the previous Congress—5 billion gallons per year within 5 years (H.R. 2052, S. 1304) or 6.25 billion gallons per year within 1 year (H.R. 2031). Our analyses of these earlier proposals showed that they seemed to call for ethanol production levels that would be beyond what would be reasonable for the industry to accomplish in these periods of time. We also assumed that legislation requiring the greater use of alternative fuels would probably provide additional market opportunities for ethanol. We estimated that our high-growth scenario would provide about one-third of the alternative fuel needed to meet the requirements of the administration's July 1989 Clean Air Act proposal (H.R.3030). Given the uncertainty of the Clean Air Act provisions that the Senate and House will enact, we could not determine the potential impact of these provisions on the use of ethanol fuels.

Recognizing that current market conditions and government incentives are not likely to stimulate such growth, we assumed that the added ethanol production would (1) increase to the levels used in our scenarios for the purpose of analyzing impacts and (2) actually occur only if mandated by legislation, regulations, or other means. Furthermore, we recognize that efforts to stimulate any large scale expansion could raise ethanol feedstock prices (namely corn) to a point that ethanol could not compete with other fuels under current conditions. However, we did not determine the level of ethanol subsidy that would be needed or the increase in fuel prices that would result under our scenarios.

We assumed that provisions of the current (1985) farm program legislation remained in place over our 8-year simulation period. While market adjustments due to ethanol expansion would continue after 1997, our estimates did not consider changes beyond 1997. Our modeling effort utilized 1988-1989 agricultural information, including results of the drought-stricken 1988 crop year. We discussed and obtained agreement on our modeling approach and procedures with WEFA analysts and Department of Agriculture officials familiar with agricultural modeling and the importance of underlying model assumptions.

In assessing the federal budget impacts of expanded ethanol production and use under our scenarios, we assumed that the current federal tax incentives—the fuel excise tax exemption and blenders' tax credit—were the only federal incentives in place and were extended through 1997. While the expansion of ethanol production and use could influence other federal revenues and/or outlays, this report does not identify or evaluate those other impacts.

This report does not assess the market place economics of ethanol fuel blends or compare ethanol's attributes with those of gasoline or other fuel additives. Furthermore, this report does not assess the impact of ethanol imports on the development of the domestic ethanol industry or the impact on air quality of ethanol fuel blends.

Our review work was performed from May 1988 through January 1990. We discussed the factual information in this report with officials from the Renewable Fuels Association, Information Resources Inc., the American Petroleum Institute, the Department of Energy (Office of Alcohol Fuels), and the Department of Agriculture (Office of Energy, Economic Research Service and Agricultural Stabilization and Conservation Service). These officials generally agreed with our analyses and with the information contained in this report. On the basis of these discussions, we made clarifications in the report, where appropriate. However, as requested, we did not obtain official agency comments on this report.

Ethanol Production Capacity Can Be Expanded

The 1989 production capacity of ethanol plants operating in the United States was about 1 billion gallons per year—actual production in 1988 was 812 million gallons. Our analysis showed that it is feasible to increase production to the amounts used in our growth scenarios—2.2 or 3.3 billion gallons annually. The industry has the capability and experience to design, build, and operate ethanol plants, and the feedstock supplies needed to produce 3.3 billion gallons per year are available. However, an expansion of this scale would be a major financial undertaking and, according to industry officials, would be contingent on the continued availability of government incentives for ethanol fuels and/or a legislative requirement to use ethanol fuels.

The Ethanol Industry Today

Current ethanol production capacity is concentrated among a few large producers. The largest producer operates four ethanol plants with a combined annual capacity of 600 million gallons—about 60 percent of U.S. production capacity. The 43 ethanol plants in operation as of December 1988 had production capabilities ranging from 0.5 to 275 million gallons per year—their combined annual capacity totalled about 974 million gallons. In 1988, actual production was 812 million gallons of ethanol.

Faced with uncertain market conditions, some ethanol plants have discontinued operations. In addition to the 43 producing plants, there were 70 idle ethanol plants—with combined production capacity of about 340 million gallons per year—as of December 1988, according to Information Resources, Inc. These included old, small, or technically obsolete plants that have stopped operating for extended periods of time. It is uncertain, according to industry officials, whether these idle plants would reopen.

While the largest ethanol producers are located in or near large corn-producing states, small ethanol producers can be found throughout the country. Large ethanol plants generally operate more efficiently than smaller units because of the operating economies of scale, according to industry officials and a recent Department of Energy (DOE) study[1]. One industry official said that the most efficient plants are those capable of producing at least 60 million gallons of ethanol per year. Small plants,

[1] Understanding the Challenges and Future of Fuel Alcohol in the United States (prepared for the U.S. Department of Energy, Office of Alcohol Fuels, by Information Resources, Inc.), Sept. 1988.

nevertheless, can take advantage of local situations and remain competitive with the large ethanol producers. A 1989 U.S. Department of Agriculture (USDA) study said that small producers can find market niches that will permit ethanol production at sites with access to low cost grain supplies, such as locations distant from major grain market centers; unconventional ethanol feedstocks, such as cheese or other industrial processing wastes; and local ethanol by-product markets, such as adjacent feedlots that will buy the ethanol feed by-products.[2]

Feasibility of Ethanol Industry Expansion

There are no technological reasons why domestic producers could not supply the ethanol required for either of our growth scenarios, according to industry and government officials familiar with the ethanol industry. These officials said that an expansion of annual ethanol production to 3.3 billion gallons within 8 years was achievable, the logistics of such an expansion are reasonable, and the timeframes are realistic. Furthermore, some industry officials said that with appropriate government incentives—such as an extension of the ethanol fuel-tax exemption—annual ethanol production could potentially double within 4 or 5 years and might eventually reach 5 billion gallons per year. However, according to a USDA 1988 report, large scale ethanol production growth becomes self-limiting once it raises feedstock prices so high that ethanol cannot compete with other alternative energy sources such as liquid fuel from coal or shale oil.[3] USDA said that doubling or tripling current ethanol production would begin to place strong upward pressure on agricultural feedstocks.

According to industry officials and information regarding past industry growth that we analyzed, the ethanol industry seems to have the capability, the experience, and the resources to build and operate additional production facilities. Our low- and high-growth scenarios assume that ethanol production capacity would grow by 150 million and 288 million gallons in each of the 8 years, which is in line with past industry growth. Some of the added capacity would likely come from expanding existing plants or adding ethanol production to other corn processing plants, which, according to industry officials, are less costly options than building new facilities.

[2] Economics of Ethanol Production in the United States (U.S. Department of Agriculture, Economic Research Service, Mar. 1989.)

[3] Ethanol: Economic and Policy Tradeoffs (USDA, Economic Research Service, Apr. 1988.)

Capital costs are important considerations in the expansion of ethanol production capacity. The type of production facility and the accessibility to transportation and utilities will also affect construction costs. Expanding an existing plant is less costly than building a new plant on an undeveloped site. According to industry officials, the cost of constructing an ethanol plant could range from $0.50 per gallon of added annual capacity at an existing grain processing facility to $3.00 per gallon at a new undeveloped site. Therefore, expanding current capacity by 2.3 billion gallons—enough to reach our high-growth target—could cost from $1.2 billion to nearly $7 billion, depending on development patterns.

According to the 1989 USDA report mentioned above, the ethanol industry would need to see a reasonable likelihood of favorable conditions over the next 10 to 15 years to justify significant expansion. The ethanol industry has relied heavily on government incentives, and, according to industry officials, ethanol fuels are likely to require continuing government incentives to remain competitive with the price of gasoline. Industry officials told us that special incentives, such as tax credits, an extension of motor fuel tax exemptions, or fuel taxes based on vehicle tailpipe emissions, might be required to encourage industry expansion. A potential producer said that reliance on government incentives could entail risk for producers because there is no assurance of the continuity of these incentives in the future. Some industry officials, however, indicate that if ethanol fuel use were mandated, other governmental incentives may not be necessary.

Impact of Expansion on Feedstock Suppliers

An expansion of ethanol production would place new demands on America's farmers. Expanding annual ethanol production to 3.3 billion gallons per year—our high-growth scenario—would represent an approximate one billion-bushel increase in the demand for corn as ethanol feedstock[4]. A bushel of corn converts to about 2.5 gallons of ethanol. Assuming that all ethanol is made from corn, the 812 million gallons of ethanol produced in 1988 would represent about 325 million bushels of corn. The production of 3.3 billion gallons per year would represent about 1.3 billion bushels of corn. Producing 2.2 billion gallons of ethanol per year under our low-growth scenario would represent about 880 million bushels of corn.

[4]This is the gross increase in ethanol's corn demand. The overall net corn demand increase would be smaller due to subsequent adjustments in corn demand by other sectors, such as livestock production. This is discussed further in chapter 3.

While an additional billion bushels is a significant requirement, recent corn production levels would indicate that America's farmers, under the right market and weather conditions, could meet this demand. During the 1980s, normal corn harvests ranged from about 7 to 8 billion bushels, and WEFA forecasts they will exceed 9 billion bushels by 1997. In 1988 the drought-reduced harvest was about 4.9 billion bushels. The 325 million bushels of corn needed to meet 1988 ethanol production levels (812 million gallons) represents about 4 percent of a typical 1980s harvest.

The National Corn Growers Association supports the expanded use of corn for ethanol production and estimates that ethanol-based demand for corn could increase to 1.2 billion bushels by 1995. Furthermore, it is unlikely that all the additional ethanol will be made from corn. Although corn currently accounts for 95 percent of ethanol feedstock usage, it is likely that some wheat, sorghum, food processing wastes, and other feedstocks will continue to be used.

Conclusions

No technical barriers preclude an expansion of annual ethanol production to 3.3 billion gallons over the next 8 years. The ethanol industry has shown that expansion of production capacity is possible. While drought and other weather conditions can disrupt ethanol's corn feedstock supply and price, production levels in the 1980s indicate that America's farmers could meet the demand generated by the expansion in ethanol production under our scenarios. However, the ethanol industry continues to be heavily reliant on federal incentives to remain competitive with gasoline and other fuel additives. The construction of additional ethanol facilities will likely be based on economic and other factors, including continued federal incentives, that go beyond the technological capability to expand. Implementing an ethanol-use mandate would result in domestic capacity expansion only if producers find that production incentives outweigh the risks of investing in a product that currently depends on long-term government support.

Agricultural Impact of Expanded Ethanol Production

The expansion of domestic ethanol production would have a marked impact on American agriculture. Based on model simulations, the corn sector—which is ethanol's primary feedstock supplier—would be the sector most affected by expanding ethanol production. Corn farmers would benefit as the demand for and price of corn would increase. However, through a complex system of economic relationships, other sectors of American agriculture would also be affected—some positively and some negatively:

- Soybean producers would be adversely affected by the lower demand for and price of soybeans because soybean meal and soybean oil would face increased competition from the feed by-products of ethanol production in the high-protein animal feed and vegetable oil markets.
- Cattle producers would face increased corn-feed costs and lower profits, causing them to reduce their herds.
- Poultry producers could benefit from the additional supply and lower price of high-protein feeds.
- Overall net farm cash income would increase as increased cash income from crops would offset decreased cash income from livestock and higher cash expenses.

Consumers would face slightly higher food prices because of these agricultural impacts.

Impact on the Corn and Other Feed-Grain Sectors

Corn is the primary ethanol feedstock and the crop most affected by expanding ethanol production. Expanding the production of ethanol would increase both the demand for and price of corn. The size of the increase depends on the amount of ethanol produced, the amount of acreage farmers would shift into corn production, and the sensitivity of livestock and export markets to changes in corn prices.

The initial demand for corn to make ethanol would increase (over the projected baseline) under our high-growth scenario by about 970 million bushels per year at the end of our 8-year simulation period.[1] However, this increase would be partially offset as higher corn prices trigger a reduction in the corn demand for livestock feed or for export. With these offsets, our model shows that the net increased demand for corn would be about 540 million bushels by 1997—about a 6-percent increase over the projected baseline demand.

[1] All modeling results discussed are for our high-growth scenario unless otherwise specified.

The model results showed that corn prices would increase over baseline projections by 32 cents a bushel (15 percent) and 19 cents per bushel (9 percent)—under our high-growth and low-growth scenarios—by the end of the simulation period. The average annual price increase over the 8-year period was 22 cents per bushel for the high-growth and 12 cents per bushel for the low-growth scenario.

As increased prices make corn a relatively more profitable crop, farmers would respond by planting corn on idle land and by switching other crop acreage (mainly soybean acreage) into corn production[2]. Soybeans are the primary competitor for corn acreage, especially in the Corn Belt states where about 55 percent of the corn is grown.[3] Our modeling estimates showed that by 1997, about 4.2 million acres of idle acreage or other crop acreage would be placed into corn production. The resulting increased corn production and supply would partially offset corn price increases.

Higher prices would also trigger adjustments in demand for corn in livestock and export markets. The higher corn prices raise livestock-feed costs and reduce the amount of corn purchased for animal feed. Export markets for corn would also be negatively affected, as higher prices would reduce the foreign demand for American-grown corn. Our modeling estimates showed that corn exports would decline, on average, by 5 percent and 2 percent for the high- and low-growth scenarios, respectively.

While corn is the dominant feed grain in the United States—accounting for 83 percent of feed grains used in 1986 and 1987—sorghum, barley, and oats are also used in livestock feeding. In our model simulation we assumed that corn would be the only feed stock used in producing ethanol. Other animal-feed grains would be substituted for corn that would be redirected toward ethanol production. With concurrent changes in demand and supply, the overall price of other feed grains increased by about 2 cents per bushel. The net impact of increased ethanol production on the demand for and price of other feed grains would likely be different if these grains were also used as ethanol feedstock.

[2]Federal agriculture policies and programs could also affect the farmer's incentive to shift acreage (see chapter 4).

[3]The Corn Belt states are Illinois, Indiana, Iowa, Missouri, and Ohio.

Impact on the Soybean Sector

Our model simulation showed that the domestic soybean sector would be adversely affected by the increased production of ethanol, with both soybean production and prices declining.[4] The expanded ethanol production would increase the supply of protein-rich feed and corn oil by-products resulting from the conversion of corn to ethanol. These by-products compete with soybean meal in the high-protein animal-feed markets and with soybean oil, which competes in the vegetable oil markets. This would reduce soybean meal and soybean oil prices, decrease soybean processors' profit margins, and lower the demand for and price of soybeans. Soybean production would also decline as soybean growers—faced with lower soybean prices and the higher corn prices—switch acreage to corn.

Our model results showed that at the end of the 8-year high-growth model simulation period, the average annual price of soybeans would decrease about 35 cents per bushel from the baseline—about a 6-percent decline. At the end of the high-growth simulation period, the model showed soybean prices would be 66 cents per bushel below baseline prices. An initial estimated decrease in soybean prices would be higher. However, the initial decrease would be partially offset as soybean farmers adjust production and domestic and export demands increase in response to lower prices.

Increasing ethanol production to 3.3 billion gallons per year would increase the supply of high-protein animal-feed by-products by about 5.1 million tons—as measured on a soybean meal protein-equivalent basis, a 17-percent increase in the supply of high-protein feeds. Currently, some ethanol by-product feeds are exported, primarily to European Community (EC) countries, and foreign markets offer potential outlets for the additional supply of high-protein feed. However, if future tariffs and trade restrictions limit America's access to EC and other foreign markets, the additional high-protein feed supply produced by ethanol would likely have to be absorbed by domestic markets. The larger the restrictions on ethanol by-product feed exports, the greater the impact on domestic soybean meal demand and price. In our simulations we assumed that both domestic and export demands expand in response to lower prices for soybean meal.

The negative impact of lower soybean prices would be less on those farmers who are willing and able to switch from soybean acreage to

[4] Our simulation results are for the soybean sector; however, ethanol expansion would have similar impact on other oil seeds.

more profitable grains, especially corn. Our model results showed that farmers would shift nearly 1.4 million acres out of soybeans by the end of the simulation period. However, in some areas, primarily outside the Corn Belt, soybean farmers would be unable to shift acreage and, faced with lower soybean prices, would realize a decline in their overall crop income. The degree of crop switching would affect the supply and final equilibrium price of soybeans.

Impact on the Livestock Sector

Corn and other feed grains are an important component in the livestock production process—accounting for about half the feed used in livestock operations. Therefore, any change in feed prices would have a major effect on the profitability of livestock production and could cause production adjustments. Our model simulation showed that higher feed-grain prices and lower prices for high-protein supplements have mixed results in the livestock markets.

Higher corn prices would increase cattle producers' corn and other feed-grain costs and lower their profits. As a result, there may be increased slaughter of grain fed cattle. Our model simulation showed that the higher corn prices (induced by expanded ethanol production) would lead to a 10-percent increase in feed costs by the end of our simulation period. In response to higher feed costs, producers would reduce the total number of cattle by 4 percent—from 105 to 101 million head by 1997.

In contrast, to the extent that high-protein feed by-products of ethanol production could be used in poultry feeding, poultry producers would respond positively to the lower prices for this feed and increase their production of turkeys and chickens. All changes in livestock markets would eventually translate into changes in the price of meat, poultry, and dairy products.

Impact on Net Farm Cash Income

While expanded ethanol production would increase overall net farm cash income, some agriculture sectors would not benefit. Higher prices coupled with increased production would increase farm income from the sale of cash corn crops. On the other hand, lower prices and reduced production for soybeans and some other feed grains would reduce cash crop income.

Our model showed that an expansion of ethanol production would result in an overall average increase in net farm cash income (excluding changes in government cash payments to farmers) by about $415 million, or an annual average increase of 1.3 percent over the 8-year model simulation period. Overall combined net cash receipts from crops and livestock would increase by an average of about $814 million per year, while farm cash expenses would increase by an average of about $399 million per year.[5] Individual farmers would be affected differently.

Since federal agriculture support programs, to a large extent, insulate the farmers from market price changes, the increase in farm cash income from higher corn prices would be offset by reduced program payments. Conversely, the lower cash income from other program crops would trigger higher program payments from the government. Individual farmers would be affected differently, depending on their crop or livestock production. Federal agriculture support programs are discussed further in chapter 4 and appendix II.

Impact on Consumer Food Prices

Increased production of ethanol would have a small impact on the overall consumer food price index, raising it by an average of about 0.1 percent over our model baseline projections.[6] This represents a 10-cent increase for a $100 food purchase. The 0.1-percent increase in the consumer food price index, as shown by our model simulation, translates to about a 0.02-percent increase in the overall consumer price index.[7]

Some individual price indexes would increase more than 0.1 percent with expanded ethanol production. Our model simulation showed that with higher feed costs and lower livestock production, the consumer price index for meat, poultry and fish products would increase by an average 0.28 percent—a 28-cent increase for a $100 purchase. The higher grain prices would also increase the consumer price index for cereal and bakery products by an average 0.21 percent. There would be very slight increases in the price of dairy products under our model simulations.

Conclusions

Our model showed that a major expansion of corn-based ethanol production would benefit America's agriculture sector. The impact of these

[5]Includes changes due only to agricultural impacts. Potential changes in other factors, e.g., changes in fuel prices due to ethanol expansion or interest rates are not included.

[6]See footnote 5.

[7]A 1-percent increase in the food price index translates to about a 0.16- to 0.17-percent increase in the overall consumer price index.

changes would vary, depending upon one's position in the agriculture production and food process chain. However, modeling complex economic relationships, such as those existing in the agriculture sector, is subject to great uncertainty, especially when models deal with events such as large-scale increases in demand for corn. Our modeling results provide insights into the interaction of various agriculture sectors and the general order of magnitude of change associated with these sectors only for the period under study. However, the results should not be considered as exact predictions. Any change in assumptions, such as timing and size of the expansion scenarios, market and weather conditions, government agricultural policies, or farmer's responses to these policies could materially affect the final results and estimates of the model.

Impact of Expanded Ethanol Production on Federal Programs

The expanded production of ethanol would reduce federal outlays for farm support programs. But at the same time, federal revenues from motor fuel taxes would also be reduced, if existing exemptions and credits are retained. Our model showed reductions in federal outlays for farm support programs that would average about $930 million and $1.421 billion per year, respectively, under our low- and high-growth scenarios. Our analysis of potential tax impacts showed that a continuation of ethanol's tax exemption could further reduce federal tax revenues by an annual average $442 million and $813 million, respectively, under the 8-year low- and high-growth scenarios.

Summing-up only these two impacts would indicate that there would be an average annual savings to the federal budget of about $488 and $608 million, respectively, due to expanded ethanol production under our scenarios. The impact on the budget, however, shows wide year-to-year fluctuations. For example, the yearly net budget difference over the 8-year period ranged from a negative budget impact of $924 million to a positive impact of $2.7 billion. However, these are modeling estimates, and there are no assurances that the impacts projected will actually occur during, at the end, or after the modeling period. Furthermore, our study did not explore all the impacts of expanded ethanol use on the federal budget. For example, we did not analyze changes in income tax revenues from farmers, ethanol producers, and oil companies that could result from an expanded ethanol industry. Our study, however, indicated that the expanded use of ethanol will cause higher ethanol production costs, and it may be necessary to increase the level of government subsidies or to pass the costs on to the consumers through higher motor fuel prices. Thus, an overall federal budget impact assessment is precluded.[1]

How Ethanol Production Affects Agriculture Program Outlays

Federal outlays for farm support programs significantly increased since 1980—from $2.8 billion to a high of $25.8 billion by fiscal year 1986. Net program outlays dropped sharply to $12.5 billion in fiscal year 1988 partly due to the 1988 drought. Increased ethanol production would reduce these farm support program outlays because the additional ethanol production would increase prices of corn and some other grains, resulting in

[1]Given the uncertainties surrounding production costs of ethanol and gasoline, we do not know the extent of government subsidies needed to induce expansion of ethanol production to the levels of our scenarios. On the other hand, a legislative requirement leading to an expanded use of ethanol could change the economics of ethanol production to the extent that tax exemptions or other subsidies would not be needed but fuel prices would increase.

- fewer farmers defaulting on their government backed loans, thus reducing federal outlays to cover loan losses and storage costs of the forfeited crops;
- reduced federal deficiency payments to farmers, as the grain prices rise toward or surpass the federally established target price; and
- lower federal payments for acreage diversion and other associated costs as the incentives for farmers' participation in agriculture programs decreases.

For our analysis, we only assessed the effect of increased ethanol production on federal outlays for commodity loan, farmer-owned reserve, deficiency payment, and land diversion programs established to support producers of corn and other feed grains, soybeans, and wheat. Our model considered program outlays for corn, wheat, soybeans, barley, sorghum, and oats, but did not include dairy programs, export assistance, or disaster program payments. We generally assumed that the provisions of the 1985 Food Security Act—which defines the regulatory framework for the farm programs—would be continued throughout the simulation period. The farm support programs and the results of our analyses are discussed in the following sections and in more detail in appendix II.

Commodity Loan Program

Expanded ethanol production would decrease program outlays made under the commodity loan program. Under this program, according to USDA documents, participating farmers receive loans (the amount is based on government-determined loan rates) and offer their crops as collateral. After harvest, farmers (1) have nine months to repay the loan, with interest, and reclaim their crops, or (2) forfeit their crops to the government in lieu of repayment. It is a nonrecourse loan; therefore, the government must accept the collateralized crops in lieu of repayment of the loan principal and interest. When the crop prices are relatively low and there is no profitability through use of generic certificates, farmers are better off forfeiting the crops than repaying the loan and the interest. In case of default, the cost to the government would be the amount of the loan (loan rate times the number of bushels under loan) plus the storage cost for the crops forfeited to the government. Expanded ethanol production would reduce federal outlays for these loans by increasing crop prices—particularly corn which has the largest share of the program costs—and thereby reducing the incentive for farmers to default on their loans.

Farmer-Owned Reserve Program

Crop loans can also be extended or originated under the Farmer-Owned Reserve Program. Under this program, according to USDA documents, wheat and feed grain producers can receive storage payments on their collateralized grain after their nonrecourse loan matures. The participating farmers receive storage payments for keeping their crops off the market. Expanded ethanol production and the resulting higher grain prices, would reduce the cost of this program as higher prices would reduce the need for the government to keep crops off the market.

Deficiency Payment Program

Expanded ethanol production would also affect the Deficiency Payment Program. Under this program, according to USDA documents, farmers producing eligible crops[2] receive income support payments equal to the difference between a legislatively-set target price for the crops and either (1) the average national market price or (2) the basic loan rate—whichever is higher—for the crops. Farmers receive these income-support payments when crop prices are below the target prices. As the expanded ethanol production increases the market price for corn, the deficiency payments to farmers would be reduced. If the market price were to surpass the target price, deficiency payments would be eliminated.

Acreage Control Programs

According to USDA documents, farmers participating in the loan or the deficiency programs may be required to set aside a predetermined percent of their land under the Acreage Reduction or Paid Land Diversion Programs. They are not allowed to plant any cash crops on these set-aside acres. However, under the Land Diversion Program, farmers can be paid a specified per acre amount in exchange for idling their land. Expansion of ethanol production would create higher crop prices that would reduce farmers' incentives to participate in the loan and deficiency programs. This, in turn, would reduce the need for land-diversion payments.

[2]Wheat, rice, feed grains, and cotton.

Impact on Farm Support Program Outlays

Our modeling results show that overall federal agriculture program outlays for the commodity loan, farmer-owned reserve, and deficiency payment programs would be reduced if ethanol production was expanded to meet our low- and high-growth scenarios.[3] We were interested in the overall impacts on federal farm program outlays and chose not to discuss the impacts on the individual farm support programs. These reductions would average about $930 million and $1.421 billion per year, respectively, under our low- and high-growth simulations. The cumulative outlay reductions over the 8-year period would total about $7.4 billion and $11.4 billion, respectively. With more ethanol produced, the demand for and the price of corn would increase, causing fewer farmers to participate in farm support programs, fewer farmers to default on their commodity loans, and deficiency program and acreage diversion program payments to decrease. Table 4.1 shows the cumulative and average annual savings during our model simulation period.

Table 4.1: Federal Agriculture Program Outlay Reductions Over 8-Year Model Simulation Period

Dollars in billions

	High-growth Scenario	Low-growth Scenario
Cumulative reductions (8 years)	11.371	7.440
Average annual reductions	1.421	0.930

Our model results show that under these programs, the major reductions would come from corn support programs, with smaller reductions in wheat program outlays and small increases in outlays for soybean and sorghum programs.

The reduction in agriculture program outlays due to expanded ethanol production are dependent on the current and the future provisions of the agriculture programs as well as agriculture market conditions. Our program reductions are based on baseline projections that assumed program "target prices" for feed grains would continue their downward trend from 1990 to 1995 and remain constant afterwards. Our baseline projections also assume a generally downward trend in market prices over the simulation period. Changes in either the baseline projections for the crop prices (especially for corn) or in the provisions of federal agriculture programs, over the simulation period, could substantially affect the outlay.

[3]Under the Acreage Reduction Program, there are no payments to participating farmers. However, acreage set aside may be required as a condition for participation in government programs.

Other analysts who have recently assessed the impact of expanded ethanol production on government outlays also found that there would be net reductions in agriculture program outlays. A 1988 USDA report[4] estimated outlay reductions of about $1 billion per year, and a 1987 Congressional Research Service report[5] cited potential reductions ranging from about $3 billion to about $7 billion per year. These estimates vary depending on the size of ethanol expansion, the years of coverage, the agricultural programs considered, and the future course of agriculture markets and programs depicted in the analysis. Because of these varying assumptions, no meaningful comparison of these estimates with our results was attempted. Even though the assumptions and methods behind each study varied, they all imply that there will be overall reductions in federal agricultural program outlays with expanded ethanol production.

Impact on Motor Fuel Tax Revenues

The expansion of ethanol production and the increased use of ethanol blended fuels would reduce collections of federal motor fuel taxes. The federal government collected nearly $9.3 billion in motor fuel excise taxes for fiscal year 1988. The 6-cent per gallon tax exemption on fuels blended with ethanol reduced 1988 motor fuel tax collections by an estimated $480 million. We assumed that the current 6-cent exemption was available throughout our simulation period. Our analysis of potential tax exemption impacts showed that, under our baseline projection, the annual tax revenue losses would reach $530 million at the end of 8 years. We estimate that a continuation of ethanol's tax exemption could further reduce tax revenues by an annual average $442 million and $813 million, respectively, over the 8-year low- and high-growth scenarios. The cumulative reductions in tax revenues over the 8-year period would total about $3.5 billion and $6.5 billion over the baseline amounts for our low- and high-growth scenarios. Table 4.2 shows the cumulative and average annual tax revenue reductions under our scenarios.

Table 4.2: Foregone Motor Fuel Tax Revenues Over Baseline Amounts

Dollars in billions

	High-growth scenario	Low-growth scenario
Cumulative tax revenue reductions (8 years)	$6.506	$3.536
Average annual tax revenue reductions	$.813	$.442

[4] Ethanol: Economic and Policy Tradeoffs (USDA, Economic Research Service, Apr. 1988.)

[5] Analysis of Possible Effects of H.R.2052, Legislation Mandating Use of Ethanol In Gasoline (Congressional Research Service, Oct. 1987.)

Foregone annual fuel tax revenues would increase, over the baseline amounts, by about $0.79 billion and $1.45 billion, respectively, in the final year (1997) of our simulation period when the use of ethanol fuels would reach 2.2 billion and 3.3 billion gallons per year.

Summary of Budget Impacts on Farm Program Outlays and Motor Fuel Tax Revenues

Summing-up only the budgetary impacts on federal farm program outlays and federal motor fuel tax revenues due to the expanded production of ethanol would indicate that, over the 8-year period of our low- and high-growth scenarios, there would be net savings to the federal budget. Table 4.3 shows the net cumulative and net average annual savings.

Table 4.3: Budget Impacts on Farm Program Outlays and Motor Fuel Tax Revenues

Dollars in billions

	High-growth Scenario	Low-growth Scenario
Cumulative impacts over 8 years		
Farm program savings	11.371	7.440
Foregone tax revenues	−6.506	−3.536
Net cumulative savings	**4.865**	**3.904**
Average annual savings over 8 years		
Farm program savings	1.421	.930
Foregone tax revenues	−.813	−.442
Net average annual savings	**.608**	**.488**

Note: All figures represent impacts due to the increased ethanol production over the baseline production.

We chose to show the annual average and cumulative impacts for the 8-year period covered by our scenarios rather than year-by-year impacts in order to provide insights into the magnitude of change that would result from increased production of ethanol. Our model projections of federal farm program outlays under both our low- and high-growth scenarios show wide year-to-year fluctuations, depending primarily on the relationship among market prices as well as federal program target prices and loan rates. On the other hand, there was a constant rate of decrease in motor fuel tax revenues as we projected a constant expansion in the use of ethanol fuels under our scenarios. When the two impacts are combined, the net budget impacts vary widely on a year-to-year basis. For example, under our high-growth scenario the impacts ranged from a negative budget impact in one year where tax revenue losses exceeded farm program outlay reductions by $924 million to a positive budget impact in another year where farm program outlays exceeded the tax revenue losses by $2.7 billion. Under our low-growth scenario the impacts ranged from a negative budget impact of $391 million to a net positive impact of $2.6 billion. Whether the overall favorable comparison between outlays and revenues would continue in follow-on years is speculative.

The above mentioned reductions in federal farm program outlays and motor fuel tax revenues are but two monetary impacts on the federal budget. There also are many other possible budgetary impacts, outside the scope of our study, that preclude an overall budget impact assessment, such as changes in income tax revenues from farmers, ethanol producers, and the petroleum industry. The budget could also be affected by the prevailing market conditions and government incentives available to producers when ethanol production is expanded. Ethanol currently costs more to produce than gasoline, and our study indicates that the cost to produce ethanol will likely increase with an expansion of production to the levels in our scenarios. The higher production costs can be attributed to (1) higher corn prices (as shown by our model projections in chapter 3) since most ethanol is made from corn, (2) an uncertainty as to whether the level of ethanol by-product cost offsets can be maintained with the expanded production, and (3) the cost of constructing additional ethanol production facilities. Any efforts to increase ethanol's use, therefore, must somehow cover these higher production costs. If ethanol production costs, net of existing subsidies, increase more than those for gasoline, it may be necessary to increase the level of government subsidies, pass the additional costs on to the consumer through higher fuel prices, or various combinations of these approaches.

Given the uncertainties surrounding production costs of ethanol and gasoline, we do not know the extent of government subsidies needed or the costs that might be passed on to the consumer under our scenarios. Some industry officials, however, indicated that government subsidies may not be necessary if ethanol fuel use is mandated and the costs are passed on to the consumers. Our study assumed that the current motor fuel tax exemption and the tax credit on gasohol blends would be the only federal incentives provided to ethanol fuels. Under this assumption and with current market conditions, the expansion of ethanol production to levels envisioned in our scenarios is unlikely to occur without additional government incentives (i.e., subsidies) or requirements (i.e., mandates).

For example, assuming a gallon of ethanol that costs $1.10 to produce is used in the 10 percent gasohol blend and receives an equivalent 60-cents per gallon tax subsidy, it would be cost competitive with gasoline that costs 50 cents a gallon to produce (as it did in October 1989—see chapter 1). If ethanol production costs increased 10 percent (or 11 cents per gallon) to $1.21, the additional cost in federal and state government subsidies or in consumer fuel prices could total as much as $242 million and $363 million annually under our low and high scenarios, respectively. A 50-percent increase in ethanol production costs (equal to 55 cents per gallon) could necessitate either additional government subsidies or higher consumer fuel prices of about $1.2 billion or $1.8 billion annually under our two scenarios. Conversely, any new Clean Air Act requirements to reformulate gasoline and oil supply interruptions could increase gasoline production costs. Increased gasoline costs would make ethanol more cost competitive and could reduce government subsidies.

The impact of an expanded use of ethanol fuels would extend beyond the economic and marketplace changes discussed above. While the transportation fuel industry, especially the producers and distributors of gasoline and ethanol, would be most directly affected, other agri-businesses and various related support industries could also be affected. We did not attempt to measure these other economic impacts. However, if motor fuel prices increase because of higher ethanol production costs, the overall cost of living would also increase. For example, a 50-percent increase in ethanol production costs could increase the overall cost of living—as measured by the consumer price index for urban consumers—by slightly more than 0.3 percent.

Conclusions

Our modeling simulates a transition to the expanded use of ethanol fuels over an 8-year period—through 1997—and we are not projecting impacts beyond that point. Our model simulations showed that farm program outlays would decrease because of the expanded ethanol production. The reductions would differ from year to year, depending primarily on the relationship among market prices, target prices, and loan rates. Our analysis of tax revenue impacts reflects a consistent buildup in ethanol production and use over the 8-year period and, therefore, a consistent decrease in tax revenues. Considering just the impacts that expanded ethanol production would have on federal farm program outlays and motor fuel tax revenues indicates a net average annual savings to the federal budget of $488 million and $608 million, respectively, under our low- and high-growth scenarios. However, expanded ethanol production could mean higher ethanol production costs, which could increase the level of government subsidies and therefore offset, or more than offset, these budget savings. Other possible budgetary impacts, outside the scope of our study, would have to be considered to determine an overall federal budgetary impact.

Modeling Procedure and Assumptions

This appendix describes the modeling procedure and assumptions used in estimating impacts of expanded ethanol production on the agricultural sector and federal farm support program outlays. We used the WEFA long-term quarterly model of U.S. agriculture to simulate potential impacts of expanded ethanol production between 1989 and 1997. To measure these impacts, we developed two scenarios for the possible expansion of ethanol production[1] and compared the simulation results against a third "baseline" scenario. For our baseline scenario, we used WEFA's long range forecast for U.S. agriculture.[2] Changes resulting from the expansion of ethanol production were measured as additions or subtractions from the baseline scenario.

Baseline Forecasts and Assumptions for U.S. Agriculture

The baseline forecasts used in our analysis are projections for U.S. agriculture that assume continuation of current trends and policies concerning agriculture markets. Baseline projections provide a forecaster's best judgment of the future performance of the economy. They take into account the economic trends that could affect the conditions, but do not address unexpected or unpredictable future change—such as a drought, which could have a major impact on the forecasts.

The baseline forecast used in our analysis projects a moderate improvement in U.S. agriculture over 8 years. Agriculture sectors were expected to gradually recover from the drought of 1988. Farm prices, though high in comparison to pre-drought levels, were expected to show a decline by 1997. Domestic and export demand were expected to respond to the drop in prices and show moderate increases by 1997.

In general, the corn, soybean, other feed grain, and livestock sectors were expected to gradually recover from the impact of the 1988 drought. Corn prices were expected to drop from a high of $2.55 per bushel in 1989 to $2.07 in 1991, rise to $2.39 by 1994, and then drop to about $2.14 per bushel in 1997. Total carryover stocks for corn, estimated to drop to a low of 1.4 billion bushels in 1989, were forecast to increase to 2.7 billion bushels in 1997. Corn production that was estimated to be as low as 4.7 billion bushels in 1989 is projected to increase to 9.2 billion bushels in 1997.

[1] See chapter 1 for a description of the scenarios.

[2] The baseline projections are as of December 1988.

The provisions of the 1985-1990 farm program were assumed to continue after 1990. Generally target prices for grains were projected to continue their downward trend as was specified in the 1985 Food Security Act. The Acreage Reduction Program—set at 20 percent in 1988, idling about 14.6 million acres for corn—was by assumption set at 10 percent throughout our simulation period (1989-1997). The baseline projections assumed there was no Paid Land Diversion Program.

Modeling Procedure and Assumptions

To simulate impacts of increased ethanol production, we used WEFA's long-term projections to 1997 and incorporated the changes associated with the expansion of annual ethanol production to 2.2 and 3.3 billion (our low and high-growth scenarios). We separately adjusted the main (core) model and solved it for each scenario to measure the impacts on major crops and livestock sectors. The impact on farm income, prices received by farmers, and consumer prices were then simulated by using the WEFA's Summary Statistics sub-model.[3] The impact on federal program outlays were then estimated using a third, Lotus spreadsheet submodel by WEFA.

For each scenario, we assumed corn would be the only feedstock used in the production of additional ethanol. We first calculated the additional demand for corn due to the projected ethanol expansion and increased the overall demand for corn in the model by this amount. The additional supply of feed by-products—that result when corn is used to produce ethanol—was then converted (based on protein content) to its soybean meal equivalent and was added to the baseline soybean meal supply. We assumed the additional supply of feed supplements from ethanol production would replace soybean meal from domestic soybean processing and would be used to meet additional domestic and export demands. Domestic and export demands for soybean meal were then adjusted using appropriate elasticity measures provided by WEFA.

The WEFA model treats some variables exogenously—i.e., the values of which were determined outside the model and then put into the model. However, when we believed these variables should be responsive to changes due to our scenarios, we used measures of elasticities or developed additional mathematical equations to determine their values exogenously. For example, we used measures of export-demand elasticity

[3]Our expansion scenarios start from the fourth quarter of 1989 and continue through the third quarter of 1997. All crop numbers and subsequent averages are based on the crop year and all livestock and income or expense numbers are in the calendar year and are averaged on the calendar year basis.

from WEFA and USDA publications to make necessary adjustments in export demand for key crops. Numerous iterations of the models were needed to produce the final results for each scenario. Where appropriate, we also adjusted some livestock variables to ensure sensible results. All our modeling changes were based on consultation with, and the recommendation of, WEFA's agricultural modeling specialists.

Federal farm program outlays for our simulations were estimated using a Lotus spreadsheet sub-model and projections for crop prices, domestic demand, and exports from the core model. To develop program outlays for major crops affected by ethanol production, we assumed that provisions of the 1985 farm bill would continue through 1997. That is, target prices would be set to continue a gradual decline and crop loan rates would be set at 85 percent of the average market price from the previous 5 years--excluding the year with the highest and lowest price[4]. We also assumed that, throughout our simulation period, Acreage Reduction Program requirements would be set at 10 percent for feed grains other than oats, 5 percent for oats, and 5 percent for wheat.

Finally, we also allowed the farmers' participation rate in programs to change from the baseline as tighter markets and higher grain prices reduced producers' incentives to put their crops under the program. By allowing changes in the participation rate, we, in effect, assumed that the additional acreage needed for corn production would come from the acreage switched from other crops (primarily soybeans) and set-aside acreage.

[4]We assumed that target prices for feed grains would decline through the 1994-1995 crop year and then stay at that same level for the remaining years. Wheat target prices were set at the 1990 level for the entire simulation period. To measure the sensitivity of our simulation results to this assumption we also ran the model with target prices for feed grains (including corn) fixed at the expected 1990 level. Under this alternative, federal program outlay savings increased by over 150 percent—from an average of about $1.4 to $3.5 billion per year. On the other hand, a more rapid decline in target prices than shown in our baseline could limit or entirely eliminate the potential program outlay savings.

Federal Farm Support Programs[1]

The 1985 Food Security Act defines the framework within which the Secretary of Agriculture will administer agriculture programs for the years 1986 to 1990. This appendix describes the provisions of the act that would be affected by an expanded ethanol production. Increased ethanol production will primarily affect three types of agriculture programs and costs—price support programs, income support programs, and programs to manage agricultural supplies.

To become eligible for federal income or support programs, farmers register with their local Agricultural Stabilization and Conservation Service (ASCS) offices. Once enrolled, the farmer is assigned a base acreage, which is the amount of land used to farm eligible crops over the past years. The farmer is then eligible to participate in nonrecourse loan and deficiency payments programs. Participating farmers may also be required to participate in acreage reduction and/or paid land diversion programs, which involve setting aside a predetermined percentage of the farmer's base acres and not planting any cash crops on that land. Also, farmers using nonrecourse loans usually become eligible for the Farmer-Owned Reserve Program, if available. Participation in any of these programs does not exclude the farmers from participating in the other programs.

Price Support Programs

The Commodity Credit Corporation (CCC)[2] nonrecourse loan program is the main part of the price support programs. By registering with ASCS, farmers can place certain crops—including wheat, feed grains, soybeans, cotton, and rice—as collateral under this loan program.[3] Farmers receive a loan based on a per unit support price or loan rate for respective commodities. The loan rate is established by law, although the Secretary of Agriculture has limited discretion to adjust loan rates.[4] Farmers can reclaim their crops by repaying the loan principal and interest (the interest rates are established by CCC) or they can forfeit

[1]The information in this appendix is drawn primarily from USDAdocuments.

[2]CCC is a federally owned corporation within the Department of Agriculture.

[3]To become eligible for the loans, the producers of wheat, feed grain, cotton, and rice must first agree to acreage reduction program (ARP) requirements, where available. The ARP will be discussed later.

[4]For 1987-1990, basic loan rates—prior to any discretionary reduction by the Secretary—were set at 75 to 85 percent of the average prices received by producers during the 5 preceding market seasons, excluding the high and low price years. Any discretionary reduction in the loan rate may not lower the rate more than 5 percent from the rate in the previous year. The regular loan rate—a national average—for crop year 1989 was $2.06 for wheat and $1.65 for corn and other feed grains.

their crops to the government and keep the loan proceeds.[5] Loans are nonrecourse because CCC has no option except to assume ownership of the collateral crops if farmers choose to default. The loan rate, net of storage costs, is in effect a support price since farmers can receive that price even when market prices are lower. Nonrecourse loans provide farmers with interim financing for 9 months, after which the loan is to be repaid or the crops forfeited to the government. However, the farmers can repay the loan, with interest, at any time during this period. When the crops are forfeited, the government takes title and assumes any storage costs. However, at the end of 9 months farmers have the option to join the Farmer-Owned Reserve Program, if it is available.[6]

The Farmer-Owned Reserve Program allows farmers participating in the nonrecourse loan program to extend their loans beyond the initial 9 months by putting their crops in storage. The program allows eligible wheat and feed grain producers to store the crops they used as loan collateral for 3 additional years and to receive annual storage payments from the government.[7] Program provisions also allow the Secretary to waive interest charges after the first year in reserve.

The Farmer-Owned Reserve Program attempts to stabilize prices by taking the commodities off the market when prices are low and by putting them back on the market when prices rise. Once the crop is in this reserve program, it cannot be sold for at least three years or until the market price reaches a specified level—commonly known as the release or reserve trigger price.[8]

Program provisions also specify stock levels that determine the size of the Farmer-Owned Reserve. Currently, the minimum reserve level is 300 million bushels for wheat and 450 million bushels for feed grains. If reserve stock levels fall below these limits, and if the market price for the commodity falls below the release price level, the Secretary must

[5]When corn is used for loan collateral, it is placed in a storage with either the farmer/lender or a commercial storage company and the storage cost is paid by the farmer.

[6]With the availability and issuance of generic certificates, farmers have yet another option—they can exchange certificates for loan commodities. For a detailed discussion on how these certificates affect government costs, see Benefits and Costs of Trading in USDA Commodity Certificates, (GAO/RCED-88-142BR, June 2, 1988).

[7]For the 1989 crop year, the storage rate for corn, wheat, sorghum, and barley was 26.5 cents per bushel—it was 20 cents per bushel for oats.

[8]The 1989 crop year release prices for wheat and corn were $4.10 and $2.84 per bushel, respectively.

encourage producers' participation by offering increased storage payments, interest waivers, or other incentives.

Ethanol production will reduce the loan program costs because it will increase crop prices, particularly the price of corn. A higher price can affect farmers' participation in the loan program, and lower loan defaults and government surpluses. If prices are above the loan rate (plus interest) there will be little incentive for farmers to default on their loans. They can sell their crops, pay off their loans, and keep the difference. Higher prices can also decrease large surpluses of government-owned commodities, reduce storage costs for these crops, and reduce the volume and expenses of the loan program.

Income Support Program

The main income support program for eligible crops (wheat, rice, feed grains, and cotton) is the deficiency payment program. In accordance with the 1985 Food Security Act, the deficiency payment is authorized if the national weighted average market price received by farmers during the first five months of the market year is below the target price for that crop year. In this case, the program provides farmers with a payment rate equal to the difference between target price and either (1) the national weighted average market price or (2) the basic loan rate, whichever is higher.[9] When crop prices do not meet the legislatively-set target prices, participating farmers can receive cash or in-kind payments as an income supplement. Deficiency payments for the 1986-90 crops are determined by multiplying (1) the payment rate times (2) the individual farm program acreage times (3) the yield established for the farm by the government. The program acreage is the base acres a farmer has normally planted for a particular crop over the past years, excluding any required set-aside acreage. Payments received under the wheat, feed grain, cotton, and rice programs are limited to $50,000 per person each year for all payments, except for disaster payments. The limit does not include several payments such as CCC crop loans or deficiency payments that resulted from the 1985 act's reduction of basic loan rates for wheat and feed grains. Total payments, including those exempt from the $50,000 limit, can reach up to $250,000 per farmer per

[9] For the 1989-90 crop year, the target price for wheat is $4.10 per bushel and for corn $2.84 per bushel. The deficiency payment rate was set at $1.53 per bushel for wheat and at $1.10 per bushel for corn. Deficiency payments for both these crops have dropped significantly for the 1989-90 crop to $.89 and $.50 per bushel, respectively.

year. In-kind payments may be used to cover up to 5 percent of the deficiency payments.[10]

A major part of the program outlay savings resulting from increased ethanol production will come from reduced deficiency program payments. The expanded ethanol production will increase the market price for corn, reducing the deficiency payment rate—the difference between the target price and either the loan rate or the market price for corn. Furthermore, the higher market prices for corn and other crops will reduce the farmers' incentive to participate in the program, thereby reducing the amount of crops eligible for deficiency payments.

Other Acreage Management Programs

The goals of the 1985 act, to manage the production of agricultural commodities, are carried out with other programs to reduce the acreage under production. The Secretary is authorized to require reductions in the acreage planted for wheat and feed grains, if it is determined that the total supplies of these crops will be excessive.

Acreage Reduction Program

Under the Acreage Reduction Program, farmers must set-aside or idle a percentage of their base acres to be eligible for loans and deficiency payments applicable to wheat and feed grains. The USDA determines the acreage that may be planted (permitted acreage) by uniformly reducing the allowable crop acreage base of each farm. In recent years, USDA has varied the base acreage reduction requirements in order to manage the supplies and stocks of eligible crops and to raise the market prices.[11]

[10] In-kind payments are commonly made with generic certificates that have a fixed dollar value and an 8-month life. They are a claim on CCC assets and backed by commodities owned by CCC. They are generic, as they can be exchanged for a variety of commodities under loan in CCC inventories. See GAO report Cost and Other Information on USDA's Commodity Certificates, (GAO/RCED-87-117BR, Mar. 26, 1987) for more information on the commodity certificates programs.

[11] For the 1988-1990 period, USDA allowable acreage reductions for wheat was 0 to 20 percent for carryover stocks of 1 billion bushels or less, and 20 to 30 percent for stocks greater than 1 billion bushels. The allowable reductions for feed grains was 0 to 12.5 percent for carryover stocks of 2 billion bushels or less and 12.5 to 20 percent for larger stock levels. There is an additional 2.5 percent paid land diversion requirement if carryover stocks exceed the lower limits—i.e., 1 billion bushels for wheat, 2 billion bushels for corn. For the 1989-1990 crop year, the announced acreage reduction was 10 percent for wheat and feed grains and 5 percent for oats.

Paid Land Diversion Program

The Paid Land Diversion Program, as authorized by the Secretary, pays farmers for the foregone production from their base acreage in exchange for idling their land. For example, in the 1988-89 crop year, corn producers participating in the program were required to reduce their base acreage by an additional 10 percent, and they were compensated at the rate of $1.75 per bushel, based on diverted land and the farm program yield.

0-92 Program

Another supply control provision of the 1985 act is the 50-92 Program. This program allows farmers to plant as little as 50 percent of their permitted acreage and earn deficiency payments on 92 percent of the permitted acreage. The Omnibus Budget Reconciliation Act of 1987 authorized a 0-92 supply management program. The 0-92 Program allows wheat and grain producers to still earn deficiency payments on 92 percent of their permitted acres, while planting none of the acres.

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