

Withdrawal/Redaction Sheet

Clinton Library

DOCUMENT NO. AND TYPE	SUBJECT/TITLE	DATE	RESTRICTION
001. email	Todd Stern to Roger S. Ballentine, David B. Sandalow, Janet Anderson, Julie M. Anderson, Elliot J. Diringer, Martha L. Wofford at 18:06:54.00. Subject: Dirk. (1 page)	04/15/1999	b(6)
002. email	Todd Stern to Joseph P. Lockhart at 13:31:00.00. Subject: Re: Most important business. (1 page)	04/19/1999	b(6)
003. email	Todd Stern to Joseph P. Lockhart at 10:32:48.00. Subject: Most important business. (1 page)	04/19/1999	b(6)

COLLECTION:

Clinton Presidential Records
Automated Records Management System [Email]
WHO ([From Todd Stern])
OA/Box Number: 500000

FOLDER TITLE:

[04/15/1999 - 04/20/1999]

2013-0914-F

ab1331

RESTRICTION CODES

Presidential Records Act - [44 U.S.C. 2204(a)]

Freedom of Information Act - [5 U.S.C. 552(b)]

P1 National Security Classified Information [(a)(1) of the PRA]
P2 Relating to the appointment to Federal office [(a)(2) of the PRA]
P3 Release would violate a Federal statute [(a)(3) of the PRA]
P4 Release would disclose trade secrets or confidential commercial or financial information [(a)(4) of the PRA]
P5 Release would disclose confidential advice between the President and his advisors, or between such advisors [(a)(5) of the PRA]
P6 Release would constitute a clearly unwarranted invasion of personal privacy [(a)(6) of the PRA]

b(1) National security classified information [(b)(1) of the FOIA]
b(2) Release would disclose internal personnel rules and practices of an agency [(b)(2) of the FOIA]
b(3) Release would violate a Federal statute [(b)(3) of the FOIA]
b(4) Release would disclose trade secrets or confidential or financial information [(b)(4) of the FOIA]
b(6) Release would constitute a clearly unwarranted invasion of personal privacy [(b)(6) of the FOIA]
b(7) Release would disclose information compiled for law enforcement purposes [(b)(7) of the FOIA]
b(8) Release would disclose information concerning the regulation of financial institutions [(b)(8) of the FOIA]
b(9) Release would disclose geological or geophysical information concerning wells [(b)(9) of the FOIA]

C. Closed in accordance with restrictions contained in donor's deed of gift.
PRM. Personal record misfile defined in accordance with 44 U.S.C. 2201(3).
RR. Document will be reviewed upon request.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:15-APR-1999 19:29:41.00

SUBJECT: Re: Presidential memorandum on CO2

TO: Janet Anderson (CN=Janet Anderson/OU=WHCCTF/O=EOP @ EOP [WHCCTF])

READ:UNKNOWN

TEXT:

No, but I knew it was coming soon. Did we screw up? tds

RECORD TYPE: PRESIDENTIAL (NOTES READ RECEIPT)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:15-APR-1999 10:09:50.00

SUBJECT: RECEIVED: Enviro letter

TO: Phillip Caplan (CN=Phillip Caplan/OU=WHO/O=EOP [WHO])

READ:UNKNOWN

TEXT:

RETURN RECEIPT

Your Document:

Enviro letter

was successfully received by:

CN=Todd Stern/OU=WHO/O=EOP

at:

04/15/99 10:04:19 AM

Withdrawal/Redaction Marker

Clinton Library

DOCUMENT NO. AND TYPE	SUBJECT/TITLE	DATE	RESTRICTION
001. email	Todd Stern to Roger S. Ballentine, David B. Sandalow, Janet Anderson, Julie M. Anderson, Elliot J. Diringer, Martha L. Wofford at 18:06:54.00. Subject: Dirk. (1 page)	04/15/1999	b(6)

COLLECTION:

Clinton Presidential Records
Automated Records Management System [Email]
WHO ([From Todd Stern])
OA/Box Number: 500000

FOLDER TITLE:

[04/15/1999 - 04/20/1999]

2013-0914-F
ab1331

RESTRICTION CODES

Presidential Records Act - [44 U.S.C. 2204(a)]

- P1 National Security Classified Information [(a)(1) of the PRA]
- P2 Relating to the appointment to Federal office [(a)(2) of the PRA]
- P3 Release would violate a Federal statute [(a)(3) of the PRA]
- P4 Release would disclose trade secrets or confidential commercial or financial information [(a)(4) of the PRA]
- P5 Release would disclose confidential advice between the President and his advisors, or between such advisors [(a)(5) of the PRA]
- P6 Release would constitute a clearly unwarranted invasion of personal privacy [(a)(6) of the PRA]

C. Closed in accordance with restrictions contained in donor's deed of gift.

PRM. Personal record misfile defined in accordance with 44 U.S.C. 2201(3).

RR. Document will be reviewed upon request.

Freedom of Information Act - [5 U.S.C. 552(b)]

- b(1) National security classified information [(b)(1) of the FOIA]
- b(2) Release would disclose internal personnel rules and practices of an agency [(b)(2) of the FOIA]
- b(3) Release would violate a Federal statute [(b)(3) of the FOIA]
- b(4) Release would disclose trade secrets or confidential or financial information [(b)(4) of the FOIA]
- b(6) Release would constitute a clearly unwarranted invasion of personal privacy [(b)(6) of the FOIA]
- b(7) Release would disclose information compiled for law enforcement purposes [(b)(7) of the FOIA]
- b(8) Release would disclose information concerning the regulation of financial institutions [(b)(8) of the FOIA]
- b(9) Release would disclose geological or geophysical information concerning wells [(b)(9) of the FOIA]

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:15-APR-1999 11:11:30.00

SUBJECT: USDA's Economic Analysis of the Kyoto Protocol on U.S. Agriculture

TO: Meagan M. Earley (CN=Meagan M. Earley/OU=WHO/O=EOP @ EOP [WHO])

READ:UNKNOWN

TEXT:

----- Forwarded by Todd Stern/WHO/EOP on 04/15/99 11:11
AM -----

E. Holly Fitter 04/15/99 10:49:11 AM

Record Type: Record

To: See the distribution list at the bottom of this message

cc: Robert J. Tuccillo/OMB/EOP

Subject: USDA's Economic Analysis of the Kyoto Protocol on U.S.
Agriculture

Please review the attached (lengthy) documents and provide comments to Bob
Tuccillo. If you would like a hard copy sent to you - please call Bob at
395-5609.

LRM ID: EHF76

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
Washington, D.C. 20503-0001

Thursday, April 15, 1999

LEGISLATIVE REFERRAL MEMORANDUM

TO: Legislative Liaison Officer - See Distribution
below

FROM: John D. Burnim (for) Assistant Director for
Legislative Reference

OMB CONTACT: Robert J. Tuccillo

PHONE: (202)395-5609 FAX: (202)395-5836

SUBJECT: REVISED - - AGRICULTURE Report on Economic Analysis of
the Impacts of the Kyoto Protocol on U.S. Agriculture

DEADLINE: 2:00 pm Tuesday, April 20, 1999

COMMENTS: This revised report and may include comments that were provided
to USDA on earlier drafts.

DISTRIBUTION LIST

AGENCIES:

32-ENERGY - Bob Rabben - (202) 586-6721
33-Environmental Protection Agency - John Reeder - (202) 260-5414
118-TREASURY - Richard S. Carro - (202) 622-0650
25-COMMERCE - Michael A. Levitt - (202) 482-3151
114-STATE - Paul Rademacher - (202) 647-4463
19-Council on Environmental Quality - Judy Jablow - (202) 456-6448
Council of Economic Advisers - Liaison Officer - (202) 395-5084
95-Office of Science and Technology Policy - Jeff Smith - (202) 456-6047

- APRIL12.WPD
- appall.wpd

Message Sent

To:

Todd Stern/WHO/EOP
Julie M. Anderson/WHCCTF/EOP
Ronald Minsk/OPD/EOP
Joseph E. Aldy/CEA/EOP
Rosina M. Bierbaum/OSTP/EOP
Linda Lance/CEQ/EOP
Judy Jablow/CEQ/EOP
OSTP LRM
meni.reynold @ epamail.epa.gov @ inet
epalrm @ epamail.epa.gov @ inet
clrm @ doc.gov @ inet
llr @ do.treas.gov @ inet
karen.dorsey @ do.treas.gov @ inet
rademachpr @ state.gov @ inet
rademachpr @ ssonwpob.us-state.gov @ inet

===== ATTACHMENT 1 =====

ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:

Unable to convert ARMS_EXT:[ATTACH.D51]ARMS16016202H.136 to ASCII,
The following is a HEX DUMP:

FOR REVIEW PURPOSES ONLY: NOT TO BE CITED
This manuscript has been reproduced in this form for
the purpose of review. It has not been approved as an
official publication of the U.S. Department of Agriculture

April 12, 1999

Economic Analysis of the Impacts of the Kyoto Protocol on U.S. Agriculture

**This analysis was prepared by the Roy Darwin, Robert House, Jan Lewandrowski,
Howard McDowell, and Marc Peters of the Economic Research Service (USDA) under the
direction of the USDA's Global Change Program Office.**

Table of Contents

Executive Summary	ii-iii
Introduction.....	iv-viii
Chapter I. Climate Change and Agriculture	
The Effects of Climate Change on Agriculture.....	1-8
Agriculture's contribution to GHG emissions	8-9
Chapter II. Climate Change Policies and U.S. Agriculture: Economic Impacts.....	10-18
Chapter III. USDA's Economic Analysis of the Kyoto Protocol on U.S. Agriculture	19-34
IV . Opportunities for Agriculture:	
Carbon Sequestration	35-41
Mitigation Opportunities	41-42
Tables	43-56
References.....	57-62
Appendix 1. Impacts Under Alternative Carbon Prices.....	63-67
Appendix 2. Energy Use in Agriculture	68-77
Appendix 3. USMP Regional Agricultural Model	78-81

Executive Summary

USDA's analysis of the economic impacts of the Kyoto Protocol on agriculture concludes that the impacts are relatively small. Our core analysis is consistent with the Kyoto Protocol and the Administration's estimation of the impacts on energy prices when all the key provisions including emission trading, a multi-year commitment period, allowance for forestry carbon sinks, joint implementation, and the Clean Development Mechanism are taken into consideration. Other analyses may arrive at larger impacts but these analyses fail to model energy price increases that are consistent with the Kyoto Protocol's cost-reducing provisions or the resulting adjustments to these increases made by farmers and consumers

The Kyoto Protocol will primarily effect U.S. agriculture through its effect on energy prices. Rising energy prices will cause the cost of agricultural production to rise slightly as input costs (fuel, fertilizer, chemicals and other energy intensive inputs) increase. This will in turn cause production and net farm income to fall. As production falls commodity prices will increase partially offsetting the increase in the cost of production. At the same time the increase in prices reduces the quantity demanded. The extent of these changes and their impact on farm income will depend on the magnitude of the increase in energy prices, farmers ability to reduce energy use, and the demand for agricultural commodities. Some regions, particularly those more dependent on energy-intensive irrigation, could be more negatively affected than others

For carbon prices consistent with the Kyoto Protocol, agricultural production declines from 0.1 percent for soybeans to 0.9 percent for rice. Prices increases range from about two cents per bushel for feedgrains, one cent per bushel for wheat, and 11 cents per hundredweight for rice. Rice prices increase more than other crops owing to its greater energy and carbon intensity in production. Soybean, silage and hay prices rise less than 1 percent owing to lesser carbon intensity in production. Livestock would be affected negligibly, with prices increasing about a half percent or less and production declining a twentieth of a percent or less.

Farmers' expenditures on energy related inputs increase by 2.3 percent. Expenditures of fuel increases 4.6 percent and expenditures for fertilizers increase by 2.1 percent. About 75 percent of the changes in fertilizer expenditures are attributed to nitrogen, which is higher in carbon content than potash and phosphates. Chemical expenditures increase by 1.2 percent while expenditures on electricity increase by 2.6 percent. The significant increases in energy related costs cause farmer's total variable costs to increase by 0.6 percent.

The increase in commodity prices partially offset the increase in production costs and as a result, net cash returns to farmers fall by only 0.5 percent or \$371 million and consumer welfare declines 0.05 percent. Declines in regional net cash returns to farmers range from 0.3 percent in the Corn Belt to 2.3 percent in the Southern Plains. Most regions experience declines in net farm income near the national average. The exceptions are the Southern and Northern Plains which experience declines in net farm income greater than one percent.

The USDA analysis uses the U.S. Regional Agricultural Sector Model (USMP), which predicts how changes in energy prices will affect the supply of crops and livestock, commodity prices,

consumer demand, use of production inputs, farm income, government expenditures, participation in farm programs, and environmental indicators. USMP is linked with regularly-updated USDA production practices surveys, the USDA multi-year baseline, and geographic information system databases such as the National Resources Inventory. USMP covers 10 crops, livestock, as well as several dozen processed and retail products. Impacts are estimated by commodity for 10 farm production region, and 45 land resource regions

Some have expressed concerns that increasing the costs of fossil fuels only in Annex-I countries will increase the likelihood that agricultural production will shift to non-Annex-I regions. But this is inconsistent with the Administration's position. The Protocol will not even be delivered to the Senate unless it includes meaningful participation from developing countries. With developing country participation—and one major competitor, Argentina is already committed to taking on a emission reduction target—energy prices will increase similarly across regions.

We also look at how the agricultural sector is affected for every \$50 increase in carbon prices. But even under higher carbon prices—which are not consistent with the Administration's position on climate change—we do not find significant negative impacts of American farmers. Why? Because farmers respond to slightly higher input prices by changing the mix of inputs, reducing output, and shifting to other commodities. Other analyses that show much larger impacts allow no such adjustment to take place.

The effects of the Kyoto Protocol on U.S. agriculture depend on other factors still under negotiation, such as whether certain types of agricultural and forestry activities are ultimately included in the Protocol. Equally important is the economic potential of carbon sequestration: while there may be significant physical potential to sequester carbon on agricultural lands, the cost of actually sequestering must be taken into consideration. U.S. agriculture could benefit if terrestrial carbon sinks are eventually included in the Protocol.

Introduction

The international community is addressing climate change through the United Nations Framework Convention on Climate Change, which the United States ratified in 1992 and has over 170 member countries. The Convention seeks to stabilize atmospheric concentrations of greenhouse gases at safe levels. The Kyoto Protocol, which requires the advice and consent of the Senate, formalizes this commitment and calls for the industrialized nations to reduce their average national emissions over the period 2008-2012 to about five percent below 1990 levels.

Key elements of the Protocol include: 1) a multi-year commitment period; 2) the inclusion of all six greenhouse gases (enabling reductions of one gas to be used to substitute for increases in emissions of another); 3) allowing international emissions trading and joint implementation among countries that take on binding targets; 4) a clean development mechanism that allows industrial countries or firms to earn credits for projects in the developing world; and 5) the inclusion of limited set of activities that sequester carbon (with provisions to expand the list of carbon sequestering activities to include forestry and agricultural management practices). These elements, particularly emissions trading, can significantly reduce the costs of meeting emissions reductions targets.

Land-use change and forestry is an important element of the Kyoto Protocol. Net changes in greenhouse gases and removals by sinks resulting from direct human-induced land-use change and forestry activities, limited to afforestation, reforestation, and deforestation since 1990, are to be used to meet emissions target commitments. The Protocol also provides that additional human-induced activities related to change in greenhouse gas emissions by sources and removals by sinks in the agricultural soils and the land-use change and forestry categories can be added by the Parties to the Protocol.

The potential effects of the Kyoto Protocol on U.S. agriculture depend, in part, on the degree of energy price increases, the energy intensity of agricultural production, the ability of the sector to adjust to changes in energy prices, and the degree to which international competitiveness is affected by changes in energy costs.

In this analysis of the economic impact of the Kyoto Protocol on agriculture, we first discuss how agriculture will be affected by climate change. We conclude that while climate-induced changes are unlikely to impair the ability of the United States to produce enough food to feed itself through the next century there are several limitations in the current understanding of the impacts of climate change on agriculture. First, water resources are poorly linked with agronomic and economic processes so that our understanding of climate-related impacts on flooding, water-logging of soils, and the availability of irrigation water is limited. Changes in climate variability and extreme weather events are also poorly understood. And many of the climate-sensitive relationships between crops and livestock with pests and diseases are excluded from current models. Consequently, there is still much we do not know about the impacts of climate change on agriculture and our estimates will likely change as more research is undertaken.

We also examine how agricultural activities contribute to greenhouse gas emissions. In the United States, contributions result from emissions of methane (CH_4), nitrous oxide (N_2O), and carbon dioxide (CO_2) due to biomass burning, ruminant animals, decomposition of soil organic carbon from tillage practices, rice cultivation, fertilizer application, use of manure, and degradation of wetlands. Indirect effects, which account for most of agricultural GHG emissions, are attributed to emissions of nitrous oxides and other gases from concentrated livestock operations and from microbial activities in soil and water following applications of fertilizers and manures.

We then turn to a discussion of economic analyses of the Kyoto Protocol. We review recent analysis on the impacts of the Kyoto Protocol on agriculture noting that these studies reach unreasonable conclusions either due to assumptions regarding carbon prices that are inconsistent with the Kyoto Protocol or because agricultural markets are not modeled appropriately.

We analyze the effects of the Kyoto Protocol on agriculture in several steps. For our core scenario, we use the Administration's Economic Analysis (1998) carbon price of \$23 per metric ton (we also estimate the effects for every \$50 increase in carbon prices). To accurately capture the effects of carbon prices on agricultural inputs, we estimate the carbon embodied in agricultural inputs for crop and livestock production by region. We then introduce the changes in input prices into a detailed model of the U.S. agricultural sector, which estimates the corresponding impacts on agricultural commodity price, supply, demand, income, erosion, nitrogen loss, and other important agriculture sector indicators. We do not examine how the sector might be affected by domestic policy actions to encourage reductions of emissions from agricultural sources. While agricultural sources are an important source of some greenhouse gases, it is premature to anticipate what policy options may be implemented to address these sources.

We use the U.S. Regional Agricultural Sector Model (USMP) which is designed for general purpose economic, environmental, and policy analysis. USMP is linked with USDA production practices surveys, the USDA multi-year baseline, and geographic information system databases such as USDA's National Resources Inventory. USMP predicts how changes in farm, resource, environmental, or trade policy, commodity demand or technology will affect regional supply of crops and livestock, commodity prices and demand, use of production inputs, farm income, government expenditures, participation in farm programs, and environmental indicators. USMP incorporates agricultural commodity supply, use, and policy measures, and a wide range of

production practices: natural resource and environmental impacts are derived through biophysical models.

USMP is a medium term model. We hold the energy efficiency of available production technology constant which means that farmers are not assumed to respond to increased energy costs by adopting new, currently unavailable, technology. Farmer can switch among a wide range of tillage practices, crop rotations, etc. We consider this an appropriate, although conservative, assumption given the medium term nature of the USMP model. Because producers are routinely observed to economize on scarce or more expensive inputs, over the longer term we would expect to see increases in the adoption of more energy efficient production practices. We assume that the prices of fuels, electricity, agricultural chemicals, and other inputs will increase by the value of the carbon embedded in each input unit. This in effect assumes a perfectly elastic supply function for each of the inputs. While conservative, our model is not yet capable of modeling the input sector more precisely.

We take as a starting point that energy prices increase the equivalent of \$23 per metric ton of carbon. These rising energy prices increase the costs of production, which increases commodity prices. Higher prices in a market with inelastic demand result in increased revenues with a smaller quantity demand. While the net effect of net farm income depends on the relative supply and demand elasticities in the input and commodity markets, higher farm production costs are likely to at least be partially offset by higher revenues given the inelastic demand for food.

We find the \$23 per ton carbon price leads to production declines ranging from 0.1 percent for soybeans to 0.9 percent for rice. Prices increases range from about two cents per bushel for feedgrains, one cent per bushel for wheat, and 11 cents per hundredweight for rice. Rice prices increase more than other crops owing to its greater energy and carbon intensity in production.

Soybean, silage and hay prices rise less than 1 percent owing to lesser carbon intensity in production. We find that the Kyoto Protocol would affect livestock products negligibly, with prices increasing about a half percent or less and production declining a twentieth of a percent or less.

Fertilizers, particularly nitrogen, and chemicals are energy intensive inputs. Under the Kyoto Protocol, farmers' expenditures for fertilizers increase by 2.1 percent. About 75 percent of the changes are attributed to nitrogen, which is higher in carbon content than potash and phosphates. Chemical expenditures increase by 1.2 percent while expenditures on electricity increase by 2.6 percent.

We also look at how the agricultural sector is affected for every \$50 increase in carbon prices. But even under higher carbon prices—which are not consistent with the Administration's position on climate change—we do not find significant negative impacts of American farmers. This is because farmers respond to slightly higher input prices by changing the mix of inputs, reducing output, and shifting to other commodities.

Our analysis briefly looks at the potential for including agricultural carbon sequestration activities in the Kyoto Protocol, the role of biomass and other greenhouse gas mitigation options.

CHAPTER I. CLIMATE CHANGE AND AGRICULTURE

The Effects of Climate Change on U.S. Agriculture

Global changes in climate and the level of atmospheric carbon dioxide (CO₂) could affect the location and level of agricultural production in the United States (Adams *et al.*, 1988, 1990, 1995, and 1999; Darwin, 1999; Darwin *et al.*, 1994 and 1995; Easterling *et al.*, 1992; Kaiser *et al.*, 1993; Kane, Reilly, and Tobey, 1991; Mendelsohn, Nordhaus, and Shaw, 1994) or the world (Darwin, 1999 and 1998a; Darwin *et al.*, 1995; Rosenzweig and Parry, 1994). These studies and others conclude:¹ Climate-induced shifts in agricultural possibilities and other effects of rising concentrations of atmospheric CO₂ are unlikely to impair the ability of the United States to produce enough food to feed itself through the next century. Climate-induced shifts are likely, however, to reduce the ability of some communities to obtain their livelihoods from agriculture.

Climate Change and Agriculture. Climate is a major factor in agricultural productivity and farming is located in those areas where potential agricultural productivity is consistently high. The two most important climate-related indicators of agricultural productivity are length of growing season and temperature regime (Food and Agriculture Organization of the United Nations, 1996). Length of growing season is the length of time during the year that soil temperature and soil moisture conditions are continuously suitable to crop growth. Temperature regime is the average temperature during the growing season. Crops vary in their requirements for these two variables, which depend on local temperature, precipitation, and solar radiation. In areas where the timing and intensity of precipitation limits soil moisture, irrigation may be used to extend the length of the natural growing season. The source of the water used in such localities

¹Other recent summaries include Adams, Hurd, and Reilly (1999), Intergovernmental Panel on Climate Change (IPPC, 1996), Lewandrowski and Schimmelpfennig (1999), and Schimmelpfennig, *et al.* (1996).

may depend on local precipitation, precipitation in some distant location, or precipitation from the distant past. Climate also affects livestock production. Temperatures that are too high or too low can generate stress that lowers livestock productivity. Livestock also require a daily source of drinking water, which like irrigation water depends on precipitation. Livestock production also depends on the availability of crop feeds, such as hay or grain.

Climate is also related to extreme weather events such as floods, wind storms, and droughts; to seasonal variability of frost-free periods, cold temperatures, and rainfall patterns; and to the incidence and distribution of pests and pathogens. Changes in these variables also affect agricultural productivity. Extreme weather events involving heavy precipitation are especially important. They are responsible for most water-related soil erosion and for offsite deposition of agricultural pollutants such as livestock wastes and chemicals leached from agricultural lands. Global changes in climate, therefore, could affect the location and level of agricultural production in many areas.

Direct CO₂ Effects. The level of CO₂ in the atmosphere also affects agricultural productivity directly. Plants combine solar energy with water (generally from the soil) and CO₂ from the air to photosynthesize glucose, a simple sugar. Stomata, primarily on the leaves, control the passage of water vapor and other gases to and from the plant to the atmosphere and vice versa.

The size of the stomatal openings are negatively correlated with the atmospheric concentration of CO₂, that is, the higher the level of CO₂, the smaller the stomatal openings and the slower the rate of transpiration (the loss of water vapor from the plant). Hence, elevated CO₂ increases plant water use efficiency and would tend to reduce water requirements and yield loss due to water stress. Leaf temperatures also rise. Crops are generally divided into two groups—C3 or C4—depending on the number of carbon atoms in the first compound into which CO₂ is

incorporated during photosynthesis. Experimental yield responses for C3 crops (e.g. wheat, rice, barley, oats, potatoes, and most other crops) to a doubling (700 ppmv) of atmospheric CO₂ averages +30%, with a range of -10% to +80% (IPCC, 1996). Factors known to affect the magnitude of the response include the crop species, availability of water and plant nutrients, environmental factors such as temperature, and differences in experimental technique. The yield response of C4 crops (corn, millet, sorghum, and sugar cane) to a doubling of atmospheric CO₂ is lower (IPCC, 1996). A commonly used estimate for corn's yield response to a doubling (555 ppmv) of atmospheric CO₂ is 7 percent (Rosenzweig *et al.*, 1993).

There remains considerable debate about whether such CO₂-induced increases will be observed under commercial conditions. First, estimates of CO₂ enhancement are from controlled experiments and might be lower in a farmer's field. Second, incorporating yield changes into economic models inappropriately also leads to overestimates of CO₂'s benefits (Darwin, 1997 and 1998b). Also, although higher levels of atmospheric CO₂ may have a beneficial effect on plant growth, other gases released by burning fossil fuels (particularly ozone, sulfur dioxide, and nitrogen dioxide) have detrimental effects on plant growth. In addition, differential effects on C3 versus C4 crops could alter the competitive advantage between crops and weeds—C3 weeds could become more competitive with C4 crops. Finally, reduced transpiration and higher leaf temperatures could affect climate, i.e., temperatures could be higher and precipitation lower than those projected by general circulation models (Sellers *et al.*, 1996).

Analyses of climate change cover a wide range of temperature and precipitation changes. Some studies (Adams *et al.*, 1995; Darwin *et al.*, 1995; Rosenzweig and Parry, 1994) rely on results from equilibrium climate change scenarios in which atmospheric CO₂ is doubled (2xCO₂ scenarios). Global mean changes in temperature (2.8 °C to 5.2 °C) and precipitation (7.8 percent

to 15.0 percent) are relatively large when compared with more recent IPCC conclusions on how climate is likely to change through 2100. Darwin (1998a) relies on results from transient climate change scenarios that are consistent with emissions of greenhouse gases and tropospheric aerosols projected by the IPCC business-as-usual scenario, IS92a, assuming a 2.5°C increase in global mean surface temperature in response to a doubling of atmospheric CO₂ (Greco *et al.*, 1994; Schlesinger *et al.*, 1997). In these scenarios, increases in global mean temperature range from 1.0°C to 1.8°C in 2050 relative to 1990, while increases in global mean precipitation range from 1.3 percent to 2.8 percent. Adams, *et al.* (1999) study the effects of scenarios that combine four temperature changes (e.g., 0.0, 1.5, 2.5, and 5.0°C) with four precipitation changes (e.g., -10, 0, 7, and 15 percent) and four levels of atmospheric CO₂ (e.g., 355, 440, 530, and 600 ppmv) on 1990 and 2060 agricultural economies.

Agricultural Impacts. Global analyses of climate change indicate that agricultural productivity is likely to increase at higher latitudes and in alpine areas where climate temperatures are relatively cool, but is likely to decrease in tropical areas where temperatures are relatively warm or in dry areas where precipitation is relatively low (Rosenzweig and Parry, 1994; Darwin *et al.*, 1995; Darwin, 1998a). This means that reduced production potential in some areas is likely to be offset somewhat by increased potential in other areas. Losses in productivity are also offset by the direct effects of rising concentrations of atmospheric CO₂ (Rosenzweig and Parry, 1994; Darwin, 1998a). The net effects on world agricultural production, accordingly, have been shown to be relatively small and often positive, i.e., plus or minus 3 percent for world cereal production in 2xCO₂ scenarios with limited adaptation and CO₂ fertilization (Rosenzweig and Parry, 1994), plus or minus one percent for crop production and livestock production in 2xCO₂ scenarios with extensive adaptation and no CO₂ fertilization (Darwin, 1995), and less than plus

four percent for crop and livestock production in transient scenarios with moderate adaptation and CO₂ fertilization (Darwin, 1998a). As expected, world prices generally move in the opposite direction of production, increasing when production decreases and decreasing when production increases (Rosenzweig and Parry, 1994; Darwin *et al.*, 1995; Darwin, 1998a). Prices are lower when CO₂ fertilization is included in the scenarios (Rosenzweig and Parry, 1994; Darwin, 1998a)

The effects of climate change on U.S. agricultural productivity are similar to those on world productivity—agricultural productivity is likely to increase at higher latitudes and in alpine areas, but may decrease in relatively warm or dry areas (Adams *et al.*, 1995; Darwin *et al.*, 1995; Adams *et al.*, 1999; Darwin, 1998a). The net effects on U.S. production, however, are larger than those on global production, i.e., from 0 to -11 percent for agricultural commodities in 2xCO₂ scenarios with limited adaptation and CO₂ fertilization (Adams *et al.*, 1995), from -0.8 to -3.4 percent and from -0.5 to -1.3 percent for crop and livestock production, respectively, in 2xCO₂ scenarios with extensive adaptation and no CO₂ fertilization (Darwin *et al.*, 1995), from -0.7 to 27.1 percent and from -4.7 to 32.3 percent for crop and livestock production, respectively, in 2.5°C and 5.0°C temperature increase scenarios with moderate adaptation and CO₂ fertilization (Adams *et al.*, 1999), and from -1.3 to 4.2 percent and from -1.1 to -10.0 percent for crop and livestock production, respectively in scenarios with moderate adaptation and CO₂ fertilization (Darwin, 1998a).

U.S. prices, too, are more variable than world prices under global climate change. They also tend to move in the opposite direction of production, increasing when production decreases and decreasing when production increases (Adams *et al.*, 1995 and 1999; Darwin *et al.*, 1995). In Darwin (1998a), however, U.S. prices, like world prices, generally decline. U.S. prices, like

world prices, are lower when CO₂ fertilization is included in the scenarios (Adams *et al.*, 1995 and 1999, 1998; Darwin, 1998a). These lower prices may be associated with lower returns to land, labor, and capital employed in the agricultural sector as well (Darwin, 1998a).

Climate-induced impacts at the regional level are linked to shifts in agricultural productivity. Under transient climate change scenarios, for example, reductions in soil moisture could shorten growing seasons in one or more of the U.S.'s highly productive agricultural regions such as the Corn Belt, Lake States, Northern Plains, and Southern Plains by 2050 (Darwin, 1998a). In other regions, however, growing seasons are likely to increase. Given these changes in growing season, U.S. production of grains declines, while U.S. production of non-grains increases. These results are consistent with the crop yield changes (in general declining for grain crops and increasing for non-grain crops) used to simulate climate change by Adams, *et. al* (1999). Adams, *et al.* (1999), also report decreases in crop production in the Northeast, Appalachia, Delta States, and Southern Plains as well as in the Lake States, Corn Belt, and Southeast regions depending on the scenario².

Implications. These results suggest that, barring any unforeseen catastrophic events, climate-induced shifts in agricultural possibilities and other effects of rising concentrations of atmospheric CO₂ are unlikely to impair the ability of the United States to feed itself through the

² These regional and sectoral changes are also likely to interact with changes in the international competitiveness of U.S. agricultural products. In the absence of any effort to mitigate climate change, Canada and northern Europe, for example, may become relatively more competitive in grain and livestock production, while agricultural production in tropical regions, which tend to specialize in non-grains products, is likely to decline. U.S. competitiveness in the production of grains and livestock may decline, while U.S. competitiveness in the production of non-grains is likely to increase (Darwin, 1998a). Adams *et al.* (1999) conclude that the demand for U.S. farm commodities in foreign markets will increase under global climate change.

next century. Much depends, however, on how well farmers will be able to adapt to new climatic conditions by selecting the most profitable mix of inputs and outputs on existing cropland as well as by changing the amount of land under cultivation. The ability of U.S. farmers to adapt, however, will be determined by how well they can foresee the climatic future, the costs of adapting, and government programs. In the studies evaluated here, farmers and other economic agents are assumed to know what the future climate will be at all locations and movement toward that climate is assumed to proceed in a slow and smooth manner. In fact, we do not know what the future climate will be in a given location, changes could occur relatively rapidly, and the transition may be erratic, (i.e., locations that might be wetter in, say, 2050 might become drier at some point before then). We know even less about future changes in seasonal variability and extreme weather events. Given that U.S. farmers continuously adjust to interannual weather variability and extreme events, however, these uncertainties are unlikely to significantly hamper adaptation.

The studies evaluated here also generally ignore adjustment costs. It takes resources, for example, to convert forest land into agricultural land, to add or expand irrigation and flood control systems, or to establish new cropping systems. The costs associated with these adaptations will be negligible only if changes in climate occur slowly enough so that the rate of capital turnover assumed under some base case scenario is sufficient to make climate-induced adaptations without incurring additional costs. If not, then adaptation might be hampered. Adjustment costs are likely to be greater, however, in regions where the only viable adaptation would be to abandon farming.

Government policies and programs ranging from crop insurance and disaster assistance to acreage reduction programs, tariffs and quotas, and the level of agricultural research and extension

will influence the farm sector's response to climate change by providing the economic incentives (or disincentives) for farmers and other economic agents to adapt and by expanding the number of technological options with which they can adapt. Given the greater uncertainty about weather variability under global climate change, farmers need as much flexibility in choices of farming practices and crops as possible.

Limitations. There are several limitations in the current understanding of the impacts of climate change on agriculture.. First, water resources are poorly linked with agronomic and economic processes. The major unknowns pertain to erosion, flooding, water-logging of soils, and the availability of irrigation water. A related unknown pertains to sea level rise. Second and somewhat related to the first, changes in climate variability and extreme weather events are not explicitly included in existing models. This limits our knowledge of how climate change might effect the probability of crop failure in a given area. Third, many of the climate-sensitive relationships between crops and livestock with pests and diseases are excluded from current models. It is important to recognize that current understanding of climate change and agriculture will probably be modified as research on these topics becomes available.

Agriculture's contribution to GHG emissions

Agricultural activities contribute to GHG emissions directly and indirectly. Direct contributions result from emissions of CH₄, N₂O, and CO₂ are due to deforestation, biomass burning, ruminant animals, decomposition of soil organic carbon (SOC) from tillage practices, rice cultivation, fertilizer application, use of manure, and degradation of wetlands. Plowing or soil turnover is the major cause of CO₂ emissions from cropland. Indirect effects, which account for most of agricultural GHG emissions, are attributed to emissions of nitrous oxides and other gases from concentrated livestock operations and from microbial activities in soil and water following

applications of fertilizers and manures.

In 1996, U.S. agricultural activities were responsible for 125.6 million metric tons of carbon equivalent (MMTCE) or about 7 percent of total U.S. greenhouse gas emissions. (Table I.1)

Agricultural activities contribute carbon dioxide (CO₂), emissions through combustion of fossil fuels, soil organic carbon (SOC) decomposition, and biomass burning. Although the farm sector is energy-intensive, total energy use is small compared to other major industries. In the U.S. carbon dioxide emissions from deforestation are small. Emissions of methane (CH₄) from agricultural activities are primarily from enteric fermentation in ruminant animals, rice cultivation, and biomass burning. The principal sources of nitrous oxide emissions (N₂O) are soils, fertilizers and manures, and biomass burning.

Not included in the annual inventories are net emissions of carbon dioxide from agricultural soils (croplands, rangelands, and pasture lands). Methane emissions from wetlands, grassland and forest lands are also not included in the current inventory due to an inadequate scientific abases for estimating net emissions from these sources. Further research and methodological research is needed to accurately include these source in the national inventory of greenhouse gas emissions..

CHAPTER II. CLIMATE CHANGE POLICIES and U.S. AGRICULTURE: ECONOMIC IMPACTS

This section reviews several studies that focus on the economic impacts of the Kyoto Protocol on U.S. agriculture. In evaluating the potential impacts of the Kyoto Protocol on U.S. agriculture, the common approach is to exogenously specify a carbon price (either arbitrarily or selected from a macroeconomic or energy model), and estimate the effects on energy intensive farm inputs, agricultural production costs, supply, prices and farm income. Three recent studies examine how energy price increases affect the agricultural sector: Francel (1997), McCarl, Gowen, and Yeats (1997), and Sparks Companies, Incorporated (1999). The key features, assumptions, and results of these studies are summarized in Table II.1. Input prices estimated by these studies appear in Table II.2.

The studies reviewed here (as well as the subsequent USDA analysis) do not actually estimate the carbon charges that would be necessary to reduce U.S. GHG emissions to those specified in the Kyoto Protocol. Sparks Commodities, Inc., (1999) use a carbon charge estimated by the DRI/McGraw Hill (1997) macroeconomic model while McCarl, Gowen, and Yeats (1997) and Francel (1999) simply assume a range of different carbon prices and estimate the impacts for various values within that range. The USDA analysis (Chapter III) uses the carbon permit price reported consistent with the Kyoto Protocol as analyzed in the Administration's Economic Analysis (AEA) (1998).³

Because the analyses focus on agricultural energy use, it is important to review how energy is used in the sector (see Appendix 2 for a more detailed discussion of energy use in the sector). Agricultural energy use is comprised of on-farm direct uses of fuels and electricity to operate vehicles, machinery, irrigation, and drying systems; indirect

³ The Administration's Economic Analysis (1998) is discussed in more detail in Chapter III.

uses of energy in manufactured fertilizers and pesticides; and uses of energy in hired or purchased services. Energy is included in smaller proportion in other expenses such as commodity transportation, hired custom and machine work, and purchased feed.

Increased input prices that result from a permit price on carbon or energy use would increase these variable costs of production. The effect on agricultural supply, market prices and farm income depend critically on: 1) the extent to which input prices increase, which in turn depends on the ability of input suppliers to pass on higher energy prices to their agricultural customers; 2) the degree to which farmers adjust to higher energy prices by reducing output and/or adopting less energy intensive cropping systems; 3) the degree to which consumers respond to higher output prices; and 4) the degree to which revenues transferred out of the agricultural sector by the carbon charge are recycled back agricultural producers. Consequently, the incidence of the carbon permit price depends on the supply and demand elasticities for primary, intermediate, and final goods, which can vary over the short, medium and longer term. Assumptions made regarding carbon prices, elasticities of supply and demand, technological change, and market adjustments are crucial to an accurate assessment of the Kyoto Protocol on the agricultural sector.

Sparks Companies, Inc. (1999) and Francel (1997) are reviewed together because of their similarity in the use of partial budgeting technique in analyzing the agricultural sector. Partial budgeting focuses on an enterprise's revenue components, cost components, and calculates the difference between these to compute net returns. It is partial in the sense that if cost component changes—such as an increase in fuel costs—net returns are simply recomputed without taking into consideration any farm level or market adjustments. Partial budgeting assumes that the full cost of an input price increase is passed on to farmers from input suppliers, and that farmers are unable to pass on any increase in costs and do not respond to changes in production costs. Partial

budgeting is a reasonable approach when looking at a single production period (producers have limited flexibility to make changes once crops are planted, for example) but will overstate the impacts because adjustments are not taken into account. Partial budgeting also assumes that changes in the firm or enterprise are so small as to not affect the market.

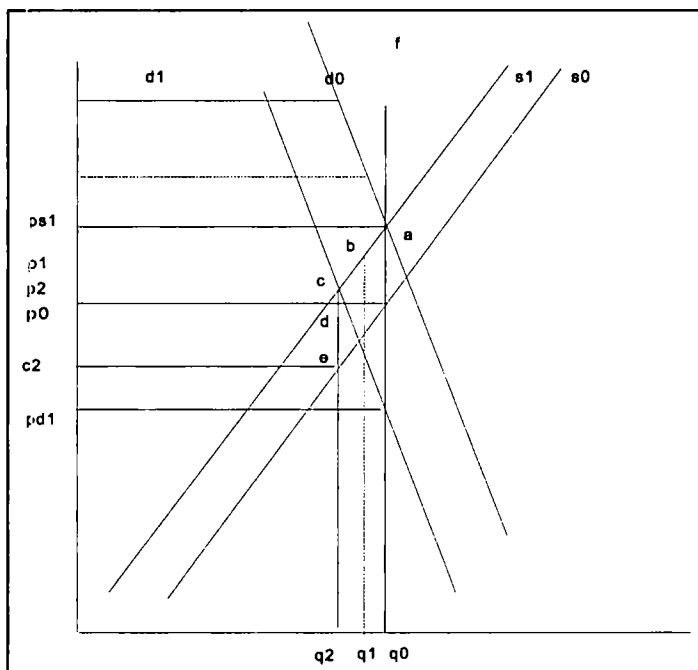
However, it is generally accepted that faced with rising production costs, producers reduce quantities supplied which leads to increased market prices. In the case of many agricultural commodities, demand is “inelastic” with the result that increases in production costs can actually lead to increases in net returns. Because farmers would likely respond to higher energy prices by and reducing output and/or shifting resources to other uses, commodity markets would clear at higher prices for the reduced quantities. Consequently, partial budgeting approaches are likely to overstate the actual effects of input price increases on the agricultural sector.

Francel (1997) estimates Kyoto Protocol impacts on farm income by calculating and summing the increased costs of production and comparing them with average farm revenues. Sparks (1999) estimates Kyoto Protocol impacts on farm income by calculating and summing up the increase in 1998 costs of production and the declines in 1998 revenues due to shifts in demand. Both Sparks (1999) and Francel (1977) substantially overestimate the impacts because they leave out important farmer and market responses. By employing partial budgeting techniques to the sector, Sparks (1999) and Francel (1977) invalidate their results.

The Sparks (1999) analysis is shown graphically in Figure 1. Agricultural markets are initially in equilibrium at point *a* where the aggregate supply function, s_0 , intersects the aggregate demand function d_0 . The price level is p_0 and the quantity is q_0 . Increased input prices increase the variable costs of production and the agricultural supply function shifts from s_0 to s_1 . Farmers adjust to the higher cost structure by producing less and the market reaches a new equilibrium at point *b* with a higher price (p_1) and lower quantity (q_1).

Demand could shift (as assumed in the Sparks's analysis) in response to both income declines and reductions in export demand. As demand shifts from $d0$ to $d1$, a new equilibrium is reached at point c , or at $p2$ and $q2$ where the new supply and demand functions intersect. The relative shifts in supply and demand in this case result in a new price above the original.

The change in farm income is the sum of revenue and cost changes. Because the domestic demand for agricultural commodities is generally inelastic, revenues increase when quantity declines, and partially offset cost increases, and the change in income is the area $c2p0ae$.⁴ The increased costs are distributed between producers and consumers according to their relative price elasticities.



The Sparks (1999) analysis does not include any adjustment to quantity supplied by farmers and the market to reach an equilibrium solution such as c . Sparks (1999)' quantity remains at $q0$ while supply and demand shift, thus Sparks (1999) includes the area $p0ps1fa$ in the cost component, approximately doubling the income loss estimation.

The Sparks (1999) cost increase of $ps1c2eaf$ does not correspond to a market result or an income loss that would result from the Kyoto Protocol.

⁴ The increase in revenues for up to quantity $q2$ is $p0p2cd$, the increase in cost is $c2p2ce$, and the net loss is $c2p0de$. For the remaining quantity up to $q0$, the revenue loss $adq2q0$, the cost reduction is $aeq2q0$, for a net loss of ade . Adding the net income losses yields $c2p0ae$.

Francel (1997) assumes that costs increase would be represented by the upward shift in the supply function from s_0 to s_1 in Figure 1. But by assuming that revenues are a past average, producers are assumed to not respond to higher input prices, and the quantity is not adjusted from q_0 . Thus, Francel (1977) assumes that revenues remain at p_0q_0 , and that the cost increase of p_1s_1/p_0af is the decrease in net farm income, roughly doubling the net income loss. Francel's (1977) analysis is virtually no different from Sparks (1999), coming to the same basic result.

Sparks (1999) estimates that farm revenues would decline \$5.3 billion (2.3 percent). \$1.7 billion is estimated as a decline in domestic agricultural revenue in response to income declines⁵, and \$3.6 billion is from assuming U.S. agricultural export demand declines due to developing countries expanding production and U.S. production costs increasing.⁶ Sparks (1999) estimates that farm input expenditures would increase by \$16.2 billion (8.8 percent).⁷ Sparks (1999) estimates that manufactured input (chemicals, fuels, & electricity) expenditures increase by \$13.0 billion (46 percent). Expenditure changes in the other input categories increase by a total of \$3.2

⁵ Sparks (1999) estimates that domestic food expenditures would decline by \$1.7 billion, by applying an assumed income elasticity of 0.35 percent and 2010 income loss of 2.4 percent to projected 1998 crop and livestock receipts of \$202.7 billion. This \$1.7 billion estimate is overestimated by about \$0.8 billion due to the choice of income elasticity. Sparks (1999) cited income elasticity estimates by Huang for individual items in Table 15 of their report, but did not use Huang's estimated aggregate food income elasticity of 0.28 for this calculation. If they had used the DRI/McGraw Hill (1977) estimate of 1.6 percent GDP loss in 2010 (Sparks (1999) Table 3) and Huang's estimated aggregate food income elasticity of 0.28, their income effect would be \$0.9 instead of \$1.7 billion.

⁶ Sparks (1999) assumes that increased U.S. production costs relative to those in Latin America, Asia, and Africa would result in export losses of 6 to 7 percent. Applied to forecast 1998 U.S. agricultural exports of \$55.0 billion, a loss of \$3.6 billion is estimated. This is inconsistent with the Kyoto Protocol which will not be delivered for ratification unless there is participation from developing countries.

⁷ Sparks (1999) used energy price increases from DRI/McGraw Hill (1977), assumes input energy component and price response (with citations), and calculates net input cost changes. The exception is electricity, or which Sparks (1999) assumes a cost change of 100 percent instead of the DRI/McGraw Hill (1977) increase of 54 percent, thereby increasing the cost impact from \$1.3 billion to \$2.9 billion.

billion.

Sparks (1999) arrives at an estimated income loss of \$21.5 billion (38.9 percent of net cash income) by summing their estimated increases in input expenditures and losses in revenues.

Sparks (1999) analyzes the problem as if it were a one period problem, as if farmers would not adjust resource allocation in the face of input price changes and shifts in demand that would lower prices. Sparks (1999) extends the estimated input price increase to typical farms using farm budgets from U.S. Department of Agriculture, Economic Research Service (ERS) and the University of Florida. Sparks (1999) assumes that price reductions of 2.4-2.5 percent would occur for corn, soybeans, hogs, milk, cattle, and tomatoes. The estimated impacts are flawed in the same way the aggregate analysis is flawed, over-stating impacts.

Francel (1977) estimates the effects of higher energy prices on farm input costs, and applies the estimated input cost increases to 1995 U.S. farm production expenses to estimate cost increases of \$10.251 billion (5.8 percent) under the “low” scenario and \$20.537 billion (11.7 percent) under the “high” scenario. Dividing these cost increases by the average 1991-95 U.S. net farm income of \$42.7 billion, Francel estimated decreases in net farm income of 24 percent in the “low” scenario and 48 percent in the “high” energy price increase scenario. Francel does not indicate which method he used to compute input price increases

In contrast to the partial budgeting approaches employed by Francel and Sparks (1999), McCarl, Gowen, and Yeats (1997) use the Agricultural Sector Model (ASMSOIL) to assess the farm sector impacts of carbon permits prices of \$25, \$50, and \$100 per short ton (2,000 lbs) implemented in years 2000, 2005, 2010, 2015, 2020⁸. ASMSOIL is a spatial equilibrium

⁸ The carbon price increases used by McCarl, Gowen, and Yeats (1997) are illustrative and not the result of a macroeconomic analysis, such as DRI/McGraw Hill (1977) or AEA (1998).

nonlinear programming model with multiple input and output regions and thousands of production related variables. The model assumes that economic agents have sufficient time to adjust consumption and production decisions in response price or policy shocks (i.e. adjustment paths are not modeled). The simulation results reflect movements between market equilibriums.

Impacts of carbon permits on the costs of fertilizers and other chemicals are calculated using information in the transactions matrix of the IMPLAN input-output model and incorporating price increases for key energy inputs in the production of farm chemicals. McCarl, Gowen, and Yeats (1997) estimates of energy price increases for diesel, gasoline, and natural gas are consistent with the DRI/McGraw Hill (1977) energy price estimates used in the Sparks (1999) analysis. For various farm chemicals, however, McCarl, Gowen, and Yeats (1997) estimate prices increases that are all less than one percent. Hence, for farm chemicals, the cost increases associated with carbon permits in McCarl, Gowen, and Yeats (1997) are significantly less than would be suggested by the embodied fuel or carbon content of the inputs.

McCarl, Gowen, and Yeats (1997) report that the major farm sector adjustment to higher energy costs would be a shift to less energy intensive practices such as conservation tillage. In the \$100 carbon permit simulation, for example, quantities used of cropland, water, and labor all decline by less than one percent as do expenditures for nitrogen, potassium, and phosphorous; expenditures for other chemicals increase less than one percent.

McCarl, Gowen, and Yeats (1997) present welfare impacts associated with the various carbon permit prices in terms of changes in consumer, producer, and foreign surplus relative to a scenario where no taxes are imposed. The results indicate that consumers will pay a significantly larger absolute share of any carbon/energy tax, while producers will pay a larger relative share. For example, the loss in producer surplus associated with a \$100 carbon permit

begun in 2000 is \$256 million, while the loss in consumer surplus is \$1.134 billion. In percentage terms, however, the loss in producer surplus is about five times larger than the loss in consumer surplus (0.09 percent vs 0.50 percent). Producer surplus declines 0.17 percent with \$500 carbon and increases 0.03 percent with \$25.00 carbon.

With respect to the U.S. farm sector, McCarl, Gowen, and Yeats (1997) estimate that carbon permit prices of \$25, \$50, and \$100 per ton would cost (total surplus loss), respectively, \$450 million, \$850 million, and \$1.6 billion annually, for years 2000 through 2020. Given that 1996 gross farm income was \$49 billion, they conclude U.S. agriculture would be relatively insensitive to carbon taxes or permits aimed at reducing U.S. GHG emissions. Additionally, McCarl, Gowen, and Yeats (1997) (unlike Francel (1997) and Sparks (1999)) note that these costs could be largely offset by returning carbon tax revenues collected from the farm sector to producers in the form of lump-sum transfers. For carbon permit prices of \$25, \$50, and \$100 per ton, these revenues are estimated at \$450 million, \$800 million, and \$1.5 billion, respectively.

Summary. Francel (1997) and Sparks (1999) conduct partial budgeting analyses of the effects of carbon permits on the U.S. agriculture sector, and conclude that annual net farm income will decline by 46-48 percent. Sparks (1999) analyzes the effects of carbon permit prices at \$177-\$193 per metric ton. The large projected decline in net farm income is largely the result of assuming that farmers do not respond to changes in input costs and net returns. It is more likely that rising input costs lead to reduced quantities supplied which leads to rising market prices and value of production. The effects of carbon permits on farm income are likely to be overestimated by these studies. McCarl, Gowen, and Yeats (1997) use an agricultural sector model to analyze the effects of carbon permit prices. Their calculation of effects of carbon prices on fuel costs

appear to be reasonable, but their calculation of carbon price effects on fertilizer and pesticide costs less than one percent rise, which appears to be low given our knowledge of energy embodied in these inputs. McCarl, Gowen, and Yeats (1997) allow producers and markets to respond to higher input costs, and project that income declines—about 0.5 percent with a \$100/mt carbon price—would be minimal. They further note that the income effects could be largely offset by returning carbon revenues to the farm sector. Because this analysis seems to underestimate chemical cost increases, their estimated shifts of crop acreage into chemical intensive conservation tillage is likely to be overestimated.

CHAPTER III. USDA ECONOMIC ANALYSIS OF THE KYOTO PROTOCOL ON U.S. AGRICULTURE

Energy-economic models have evaluated the effects of the Kyoto Protocol on energy sectors and the subsequent effect throughout the economy. These models have assumed that a permit trading systems will impute a price for emitting carbon dioxide, which will be translated into changes in energy prices. Producers and consumers will be affected according to how much carbon they are absorbing in production and consumption. Products and inputs containing relatively more carbon are likely to decline in use as producers and consumers respond to price signals.. All sectors of the economy would likely be affected, including agriculture, as the cost of fuels, electricity, fertilizers and chemicals, and transportation services would all be affected.

Because USDA's analysis of the Kyoto Protocol relies on the AEA (1998) carbon price estimates, we provide a review of the AEA (1998): key features, assumptions, and results of the AEA study appear in Table III.1.⁹ The AEA provides a discussion of the flexibility embodied in the Kyoto Protocol across several dimensions. The Protocol's flexibility can be characterized as "when", "what", and "where" flexibility. "When" flexibility refers to freedom in the timing of emissions reductions. For example, the averaging over the five-year commitment period reflects

⁹ It is worth noting that results reported in the AEA are consistent with results reported in several other macroeconomic assessments of the reducing GHG emissions to levels at or near that required by the Kyoto Protocol. For example, assuming unrestricted international trading of emissions permits Charles River Associates (1998) replicates the AEA carbon permit price of \$14 per mt, while Edmonds et al. (1997) and the Energy Information Agency (1997) obtain prices of \$38 and \$40 per mt, respectively (the latter two studies consider reducing emissions to a level of 1990 minus 10 percent). Other studies, such as DRI/McGraw Hill (1977) and WEFA (1998) do not take into the consideration the flexibility mechanisms and result in larger impacts on energy prices. The energy-economic modeling literature has pointed out the importance of flexibility in abating GHG emissions at least cost (Jacoby *et al.* 1997; Manne and Richels 1997; Interagency Analytical Team 1997).

this kind of flexibility. “What” flexibility refers to the opportunities to substitute emissions reductions or sequestration of one kind of GHG for another GHG. “Where” flexibility refers to opportunities to reduce emissions where it is least expensive to do so, for example, through international trading and the Clean Development Mechanism. While no one model can incorporate fully all of these flexibilities, the AEA (1998) did include parts of all three kinds of flexibility. Regarding “when” flexibility, the Administration used the Second Generation Model (SGM) which can evaluate the effects of emissions trading on the economy in 2010 and implicitly averages out the effects of business cycles and weather-induced energy use fluctuations on permit prices and subsequent economic effects. This smoothing out of short-term phenomena is consistent with the averaging provided over 2008 to 2012 in the Protocol. Regarding “what” flexibility, the AEA (1998) included all six GHGs in evaluating emissions targets and abatement opportunities. However, the Administration did not quantitatively assess carbon sequestration. Regarding “where” flexibility, the Administration evaluated various trading blocs and participation by developing countries through the Clean Development Mechanism and trading. It should also be noted that the AEA (1999) analysis did not incorporate the effects of several Administration policies, including proposed electricity restructuring legislation, the Climate Change Technology Initiative, and other Administration initiatives, which could further reduce the cost of meeting greenhouse gas targets.

The AEA (1999) analysis provides a set of scenarios representing various trading blocs. An assessment using the SGM model that accounts for an efficient international trading system and developing country participation yields permit price estimates ranging between \$14/ton and \$23 per metric ton, and resource costs between \$7 billion and \$12 billion per year. The low permit price assumes that the European Union does not engage in international trading, while the high

permit price assumes that all Annex I and some key developing countries engage in international trading.

The key assumption distinguishing the various economic impacts is the degree of international trading in the emissions obligations. Among and within studies, costs are highest when trading does not occur, lowest when all countries participate in emissions trading, and somewhere in between when trading is limited to Annex I countries. The Protocol explicitly provides for trading of emissions obligations among Annex I countries (Article 17) and for project-based agreements between Annex I and non-Annex I countries through the Clean Development Mechanism (Article 12). While the structure and procedures of an international emissions trading system are still under negotiation, scenarios that assume no trading will occur are overly pessimistic regarding the costs of implementing the Kyoto Protocol.

We analyze the effects of the Kyoto Protocol on agriculture in several steps. For our core scenario, we use the AEA (1999) carbon price of \$23 per metric ton (we also estimate the effects for every \$50 increase in carbon prices; these results appear in Appendix 1.) To accurately capture the effects of carbon prices on agricultural inputs, we estimate the carbon embodied in agricultural inputs for crop and livestock production by region. We then introduce the changes in input prices into a detailed model of the U.S. agricultural sector, which estimates the corresponding impacts on agricultural commodity price, supply, demand, income, erosion, nitrogen loss, and other important agriculture sector indicators. We do not examine how the sector might be affected by domestic policy actions to encourage reductions of emissions from agricultural sources. While agricultural sources are an important source of some greenhouse gases, it is premature to anticipate what policy options may be implemented to address these sources.

Input Prices. The increase in input prices due to a \$23 per metric ton carbon price is

calculated by multiplying the carbon embodied in each input by the carbon price. Using the Economic Research Service's Cost of Production (COP) survey data (<http://www.econ.ag.gov/briefing/fbe/car/car.htm>), we calculated the physical quantity of each input used in a production activity and then multiplied this quantity by estimates of the amount of carbon embodied per unit of input. This approach is superior to the more arbitrary approaches used by Francl (1977), Sparks (1999), and McCarl, Gowen, and Yates (1977). Embodied carbon and input price increases are presented in (Table III.2).

Direct carbon costs for crops include expenditures on diesel, gasoline, LP gas, natural gas, lubricants, and electricity used for the operation of machinery, vehicles, irrigation systems, and crop drying. The most important categories of indirect carbon costs are "fertilizer, lime, and gypsum", "chemicals" (pesticides), and "custom operations". "Custom operations" includes custom field and other operations (and often involving machinery that farmers contract for), technical services, and commercial drying. Other important indirect carbon costs categories are "other variable cash expenses" which can include purchased irrigation water, baling, etc. Remaining indirect carbon costs categories include "ginning" for cotton and "drying" for rice (see Appendix 2 for a more detailed discussion of energy use in the sector).

Direct energy costs for livestock include expenses for diesel, gasoline, LP gas, natural gas, lubricants, and electricity used for machinery, vehicles, equipment, manure handling systems, feed systems, housing, and dairy parlor operation. Indirect energy cost sources include "hauling," "marketing," and "custom services and supplies."

Modeling Carbon Price Impacts. To capture the full effects of carbon prices on the agriculture sector we employ the USMP model which represents agricultural markets and production enterprises in considerable detail with commodity, spatial, production practice and

other particulars of the model validated to the latest baseline, geographic, and cost of production data sources available (see Appendix 3, for a more detailed description). The USMP model accounts for the most important effects of the carbon charges on U.S. agriculture.¹⁰

USMP models production of 10 crops: corn, sorghum, oats, barley, wheat, rice, cotton, soybeans, hay and silage (fruits and vegetable are not included in the USMP model) accounting for **XX percent** of farm income and **XX percent of farm output. (SOURCE)**. Some 16 primary livestock production enterprises are included, the principal being dairy, swine, beef cattle, and poultry. Several dozen processed and retail products such as dairy products, pork, fed and nonfed beef, poultry, soy meal and oil, livestock feeds, and corn milling products are included. The model incorporates domestic use, imports, exports, and inventory/stock product markets. USMP includes government conservation, acreage, price, and income programs. Production, consumption (demand), trade, and price levels for crop and livestock commodities and most processed or retail products are endogenously determined within the model structure with domestic consumption, commercial stock, export and other demand elasticities from the **FAPSIM model (SOURCE)**.

USMP is a medium term model. We hold the energy efficiency of available production technology constant which means that farmers are not assumed to respond to increased energy costs by adopting new, currently unavailable, technology. Farmer can switch among a wide

¹⁰ The model results are "partial equilibrium" because they omit effects on agriculture which pertain to interaction between the agriculture sector and the rest of the U.S. economy. These interaction effects are minor enough that they are routinely ignored when evaluating policy impacts on agriculture. They would include, for example, effects of changes in consumer good and production input prices which result from how the carbon permit scenarios affect agriculture and non-agriculture sector producers and consumers. If carbon permits reduce non-agriculture sector income somewhat, specific examples might include declines in non-agriculture sector purchases of, e.g., food and fertilizer for non-agriculture use. These changes would reduce agriculture sector product sales revenue and input expenses somewhat, but the magnitudes are so small relative to the direct impacts that they may be safely ignored.

range of tillage practices, crop rotations, etc. We consider this an appropriate, although conservative, assumption given the medium term nature of the USMP model. Because producers are routinely observed to economize on scarce or more expensive inputs, over the longer term we would expect to see increases in the adoption of more energy efficient production practices. We assume that the prices of fuels, electricity, agricultural chemicals, and other inputs will increase by the value of the carbon embedded in each input unit. This in effect assumes a perfectly elastic supply function for each of the inputs. While conservative, our model is not yet capable of modeling the input supply sector more precisely to determine the degree to which energy price increases are passed on the farm customers.

We apply the estimated input prices increases discussed above to each of the nearly 1,000 production systems contained in USMP. We then solve the model to return commodity and input markets to a new equilibrium. The supply, use, acreage, price and other market indicators which result then form the basis for determining the impacts of Kyoto on the agriculture sector. We evaluate the impacts of the emissions reduction policy in 2010, the midpoint of the 2008-2012 period established for compliance with the Kyoto Protocol.

U.S. agriculture sector conditions in 2010 are based on the USDA Long-Term Agricultural Baseline (February 1998). The official USDA baseline provides projections through the year 2007; for this analysis we extended the baseline estimates to 2010 with linear trends (of acreage planted, prices, and other market variables).¹¹ The USMP model is then calibrated to crop and livestock supply, demand, production, acreage, government program, input cost and other conditions for 2010. USMP employs crop multi year rotation system enterprises and livestock

¹¹ This procedure to extend the baseline to 2010 was based on recommendations from ERS baseline analysts.

enterprise budgets based on the 1996 Economic Research Service's Cost of Production (COP) survey data (<http://www.econ.ag.gov/briefing/fbe/car/car.htm>). These costs are indexed to baseline projections of variable costs for 2010.

The analysis is "comparative static" which means that it compares conditions in the initial, base year, equilibrium situation with conditions after the economy has had several years to adjust to a new, medium-run, equilibrium. This analysis follows the Baseline assumptions that no other policy or market changes take place, so we can isolate the unique effects of implementing carbon permit prices. Farmers respond to carbon prices by changing production levels or quantities, by changing products produced, and by shifting among current production practices actually observed in agricultural survey data. Producer response to changes in product and input prices is ultimately determined by all producers adjusting so that the revenue and returns from their last commodities produced just equal one another. Shifts among production practices—for example reducing acreage under conventional tillage and increasing acreage under reduced tillage—incur costs of acquiring new implements and learning new management practices which all enter into the process of adjusting to the new equilibrium¹².

Effects on Crop Prices, Production, and Domestic Use. Increases in carbon prices causes crop costs of production to rise, which reduces quantity demanded, increases crop price and leads to declines in production. Relative crop impacts are influenced on the supply side by carbon intensity in production. The \$23 per metric ton carbon price leads to crop price increases

¹² Conventional Tillage : use of disc in planting preparation. Moldboard Tillage: conventional plus use of moldboard plow. No-till (slot planting): Soil is left undisturbed prior to planting; weed control is usually accomplished with a combination of herbicides and cultivation. Ridge-till: soil is left undisturbed prior to planting; about one third of the soil surface is tilled with sweeps or row cleaners at planting time; planting is completed on ridges; weed control with herbicides and cultivation. Mulch-till: -total surface is tilled, using tools such as chisels, field cultivators, disks, sweeps, or blades; weed control with herbicides and cultivation.

of less than three cents per bushel for feedgrains (corn, sorghum, barley, oats) and wheat (Table III.3). Relative changes among feedgrains on the supply side depend on the relative energy and carbon intensity in production, and on the demand side depend on their relative protein and energy content in constituting animal feed rations. Rice price increase more than other crops (about 11 cent per hundredweight) owing to its greater energy and carbon intensity in production. Soybean prices increase about one cent per bushel owing to lesser carbon intensity in production. Soybean production, in the Corn Belt for example, uses only about 40 percent of the carbon per acre (134 lbs) relative to corn (309 lbs).

Declines in crop production are also relatively small. Production of all 10 USMP crops declines by less than 1.0 percent. Again, soybean production impacts are below those of feedgrains owing to the lesser carbon intensity in production, while rice production declines (about 0.9 percent) are greater due to its greater carbon intensity in production.

Effects on Crop Acreage. Charging a carbon permit price increases crop costs of production and will tend to reduce acreage planted across crops, regions, and cropping practices in proportion to how much carbon is embodied in the production process. The increase in the price of carbon leads to a decline of 1.3 million acres planted to the 10 major field crops (Table III.4). Feedgrain acreage declines about 400 thousand acres, while wheat and hay acreage decline 300 thousand acres each. Soybean acreage declines about 100 thousand acres. Proportionally, acreage declines are larger than average in the Mountain and Pacific regions and are the largest in the South Plains—regions with substantial irrigated acreage. Virtually all of the acreage decline occurs in acres farmed under conventional tillage as opposed to conservation tillage.

Effects on Livestock Price and Production. Charging a carbon permit price affects livestock production on the supply side both through direct energy cost impacts and indirect cost impacts

including higher feed costs. Increased carbon prices affect livestock products negligibly, with prices increasing less than a half percent and production declining a tenth of a percent or less (Table III.5).

Income and expense effects. The value of production and total variable costs are the major components of farm income affected by the carbon charge scenarios. Charging for carbon increases the costs of production, which

+	Value of Production
+	Conservation Reserve Payments
+	Production Flexibility Payments
-	Total Variable Costs
=	Net Cash Returns

increases commodity prices. Higher prices increase value of production, but also reduce quantity demanded and hence produced, which serves to reduce value of production. The net effect on value of production depends on input supply and commodity demand markets, but—given inelastic demand—agricultural product values typically rise when production costs rise.

Total variable costs of production rises 0.6 percent (\$821 million), while value of production increases .2 percent (\$450 million), netting out to a net cash returns decline of 0.5 percent (\$371 million) (Table III.6) assuming that carbon permit revenues are not returned to the agriculture sector.¹³ Regional net cash returns range from a decline of 0.3 percent in the Corn

¹³ The redistribution of income resulting from a domestic carbon reduction policy would depend on how the policy was designed and implemented. The value of tradeable carbon permits auctioned by the government, or the revenues collected from sale of permits could be returned entirely to the economy. For example, permit values or revenues could be redistributed to agricultural producers according to historical carbon use, or according to some environmental or stewardship “good,” or on some other basis. Thus, the ultimate impact of the different mechanisms on consumer and producer welfare would depend on how the revenues were employed (returned to consumers or producers, or otherwise used). The specific emissions reduction mechanism used will also affect the calculation of changes in agriculture sector net benefits. We currently treat the increase in input costs paid by agriculture producers as a transfer payment from farmers to the government or permit holders completely outside agriculture. The design of a carbon pricing program goes beyond the agriculture sector. It is possible that under a

Belt to 2.3 percent in the Southern Plains.

Effects on Agricultural Inputs A system of carbon permits will increase the prices of agricultural inputs proportionally with carbon content. Farmers' responses to higher input prices will determine the shifts in input uses and the ultimate effects of carbon charges on farmer expenditures. Increased input prices result in reduced input use and reduced carbon embodied in inputs and agricultural production. Over time, carbon charges would stimulate development of new technology that would reduce the energy requirements for agricultural production and its embedded carbon.

The effects of carbon permits on carbon content and energy-intensive input use and on energy expenses by input are reported in Table III.7. Crop and livestock expenses for all energy increase by 2.3 percent. The input industry as a whole, using "crops and livestock all energy" as a proxy¹⁴, incurs a sales volume reduction of 0.6 percent.

Direct fuel and lubricant use by farmers and that embodied in custom use are affected most directly by carbon permits. Direct use of fuel and lubricants by farmers declines by 1.4 percent while custom service use declines by 4.4 percent. Fertilizers, particularly nitrogen, and chemicals are energy intensive inputs. About 1.625 pounds of carbon are embedded in each pound of nitrogen fertilizer and we estimate that about 5.633 pounds of carbon are embedded in each pound of chemical pesticide. Fertilizer use declines by 0.4 percent while chemical (pesticide) use

scheme where carbon permits are allocated to producers based on current carbon emission rates, that agriculture producers could receive transfer payments from other sectors of the economy. These payments could be greater than the associated increases in energy costs, resulting in an increase rather than decrease in producer net benefits.

¹⁴ For this analysis the carbon content of inputs used in the available technologies (production practices) is fixed, enabling reductions in carbon to be used to estimate reductions in input use. The percent changes in each input's use can be approximated by its percent change in embedded carbon.

declines by 0.5 percent. Electricity use increases by 1.1 percent reflecting electricity's smaller carbon content relative to fossil fuels.

Changes in surplus measures and net social benefit. An increase in carbon prices causes net social benefit from agriculture to decline, along with consumer and producer surpluses, reflecting the adverse effects the resulting increases in production costs and food prices have on both consumers and agricultural producer welfare (Table III.8).¹⁵ Under the Kyoto Protocol, losses to both consumers and agricultural producers decline by \$791 million (0.04 percent). The losses are split fairly evenly between consumers and producers, with consumer surplus declining by \$374 million and producer surplus declining by \$417 million. Net domestic benefit (consumer surplus plus producer surplus plus revenues transferred out of sector) which measures the net impact on agriculture or deadweight loss, declines by \$67 million. This is considerably less than the direct losses to consumers and agricultural producers, and indicates the potential for significantly reducing agriculture sector losses by recycling revenues transferred out of the sector by the carbon charge back to consumers and agriculture producers in the form of a lump sum transfer.

Changes in environmental indicators. The imposition of carbon permit prices leads to very slight reductions in soil erosion (sheet, rill and wind) and nitrogen loss to water (surface runoff and leach) (Table III.9). The reductions are brought about primarily by declines in acreage

¹⁵The various surplus and social benefit measures used in this analysis represent only partial gains or losses from the imposition of carbon charges. They represent changes in consumer and social welfare caused by changes in the agriculture sector alone. They don't take into account the effect of increased energy prices on consumer income or the prices consumers pay for other goods. As a result, the demand for agriculture products is only affected by changes in agricultural prices. It also assumes that all input prices, excepting land and those directly affected by changes in energy prices remain unchanged. It also leaves out any environmental benefits which may result from reductions in acreage planted and conventional tillage and reduction in GHG emissions.

planted, rather than substitution of less carbon intensive conservation tillage practices for conventional practices. Both erosion and nitrogen loss decline imperceptibly (less than 0.5 percent) and these losses are fairly uniform across production regions. The insignificant changes in the indicators reflects the negligible impact low carbon prices have on acreage planted and technology (tillage practices) used.

Societal benefits (improved water quality) from reductions in erosion and nitrogen loss largely accrue downstream (off-site)¹⁶ from the agricultural production activities causing them. As a result, they are not included in calculations of consumer surplus, producer surplus or net social benefits. Declines in the estimated offsite damages from soil erosion are estimated at about \$4 million. These estimates suggest that the added environmental benefits, while important, will not offset the loss to consumers and producers caused by the carbon charge.

Exports and Competitiveness Effects. Commodity exports are determined by the intersection of the supply and demand curves for U.S. agricultural products in international markets. When one or both of these curves shift, there is typically a change in the quantity of U.S. commodities exported. Among the factors that can shift the supply curve of U.S. commodities in world markets are changes in the domestic prices of agricultural inputs. Increases in these prices generally raise the marginal cost of farm production—shifting the supply curve of U.S. commodity exports upwards and decreasing the quantity of commodities exported. Among the factors that can shift the demand curve for U.S. commodities in world markets are changes in the

¹⁶ Reduced water quality has negative effects on navigation, recreational and commercial fishing, and water for drinking, industrial, and irrigation uses. Reduced quality results in costs incurred by individuals in avoiding or treating sub-quality water. Damage in dollar terms per ton of erosion for these categories by agricultural region have been estimated by analysts at ERS using procedures which approximate the physical, chemical, biological and economic links between soil erosion and water quality. The estimates of off-site damage used in this report were derived by multiplying the estimated damage per ton of erosion times tons of erosion for each production region.

relative costs of crop and livestock production elsewhere in the world. Decreases in the relative costs of farm production in other global regions generally enhance the competitiveness of commodities from these regions resulting in a downward shift of the demand curve of foreign consumers for U.S. agricultural products and a decrease in U.S. commodity exports.

Under the Kyoto Protocol, the prices of energy intensive inputs such as diesel fuel, gasoline, electricity, fertilizers, and pesticides will increase. For the agricultural sector, a key question is whether the carbon price would cause input prices to rise sufficiently to affect domestic production and export levels and the degree to which carbon prices increase in the rest of the world. USMP, which accounts for both the effects of increasing input prices and the responses of foreign producers to higher world commodity prices, estimates that exports would decline by less than 2.1 percent (for rice) or less (Table III.2)¹⁷

The USMP model evaluates market impacts over a medium-run time frame. If the higher input prices associated with a carbon charge persist over time, the longer-run impacts could include decreases in the relative costs of farm production in other global regions—particularly vis-a-vis regions that do not implement a carbon charge. Conceptually, this cost advantage could eventually manifest itself in the form of lower prices for commodities from these regions, which in turn would reduce the demand for U.S. commodities in world markets. The USMP model does not account for shifts in demand due to changes in production costs elsewhere in the world.

Whether or not the long-run competitiveness of U.S. farmers in world commodity markets would be hurt by the implementation of a domestic charge on carbon is, at present, speculative. As

¹⁷ Changes in crop exports in USMP are determined by the price change evaluated and the export demand elasticities specified in the model. The export demand elasticities used in this analysis are: corn, -0.53; sorghum, -1.17; barley, -0.65; oats, -0.65; wheat, -1.44; rice, -2.41; soybeans, -0.73; and cotton, -1.26. These capture the medium-run impacts of a shock occurring 10 years in the future.

noted by AEA (1998), energy prices already vary significantly among Annex 1 countries and between Annex 1 and non Annex 1 countries and yet there has not been any large scale migration of energy-intensive industries to take advantage of the potential cost savings. While the prices of some key farm inputs are likely to rise, the long-run effects of a carbon charge on U.S. agriculture would be affected by many factors, most of which are beyond the scope of the present assessment.

These factors include differences in the rates and magnitudes of technical change, the relative impacts of the carbon charge on other economic sectors, how long Annex 1 countries accept a carbon charge, how long the global economy takes to fully adjust, and whether or not Annex 1 countries restrict the international migration of key industries.

If, as a result of implementing the Protocol, foreign producers incur smaller carbon charges than domestic producers, U.S. agricultural commodities could become less competitive in global markets and U.S. commodity export demands would fall. On the other hand, if foreign producers incur higher production costs under the Protocol, U.S. competitiveness would be enhanced and U.S. commodity export demands would increase. Lacking accurate estimates of the likely effects of implementing the Protocol on the competitiveness of U.S. agricultural products, we do not shift U.S. export demands from the levels projected in the extended USDA Long-Term Baseline.

At the same time, we acknowledge the concerns that some have expressed about the possibility that increasing energy prices only in Annex-I countries will increase the likelihood of agricultural production (primary and/or processing) shifting to non-Annex-I regions. Recent evidence, however, suggests that the validity of such concerns may depend on the time-frame being considering – specifically, whether or not one is allowing for limited or full adjustments on the part of regional and world economies to the higher energy prices (i.e. a partial versus a general equilibrium framework).

Summary and conclusions. USDA's analysis is consistent with the Kyoto Protocol and the Administration's estimation of the impacts on energy prices when all the key provisions including emission trading, a multi-year commitment period, allowance for forestry carbon sinks, joint implementation, and the Clean Development Mechanism are taken into consideration. Other analyses may arrive at larger energy price impacts but we believe these analyses do not model energy price increases that are consistent with the Kyoto Protocol's cost-reducing provisions.

We use the U.S. Regional Agricultural Sector Model (USMP), which predicts how changes in energy prices will affect the supply of crops and livestock, commodity prices, consumer demand, use of production inputs, farm income, government expenditures, participation in farm programs, and environmental indicators. USMP is linked with regularly-updated USDA production practices surveys, the USDA multi-year baseline, and geographic information system databases such as the National Resources Inventory. USMP covers 10 crops, livestock, as well as several dozen processed and retail products. Impacts are estimated by commodity for 10 farm production region, and 45 land resource regions.

We take as a starting point that under the Kyoto Protocol, energy prices increase the equivalent of \$23 per metric ton of carbon. These rising energy prices cause the cost of agricultural production to rise slightly and increase crop prices. Higher crop prices increase the value of production, but also reduce quantity demanded of food and fiber. That leads to slightly lower production. So we have a little less production being sold at a little higher prices. The net effect on farm income is a slight decline. Some regions, particularly those more dependent on energy-intensive irrigation, will be more negatively affected.

We also look at how the agricultural sector is affected for every \$50 increase in carbon prices. But even under higher carbon prices—which are not consistent with the Administration's position

on climate change— we do not find significant negative impacts of American farmers. This is because farmers respond to slightly higher input prices by changing the mix of inputs, reducing output, and shifting to other commodities. Other analyses that show much larger impacts allow no such adjustment to take place.

We find the \$23 per ton carbon price leads to production declines ranging from 0.1 percent for soybeans to 0.9 percent for rice. Prices increases range from about two cents per bushel for feedgrains, one cent per bushel for wheat, and 11 cents per hundredweight for rice. Rice prices increase more than other crops owing to its greater energy and carbon intensity in production. Soybean, silage and hay prices rise less than 1 percent owing to lesser carbon intensity in production. We find that the Kyoto Protocol would affect livestock products negligibly, with prices increasing about a half percent or less and production declining a twentieth of a percent or less.

Fertilizers, particularly nitrogen, and chemicals are energy intensive inputs. Under the Kyoto Protocol, farmers' expenditures for fertilizers increase by 2.1 percent. About 75 percent of the changes are attributed to nitrogen, which is higher in carbon content than potash and phosphates. Chemical expenditures increase by 1.2 percent while expenditures on electricity increase by 2.6 percent.

Our analysis suggests that effects on producers and consumers are quite small when the flexibility mechanisms of Kyoto are used. Assuming no income from carbon sequestering activities, net cash returns decline 0.5 percent, and consumer welfare would decline 0.05 percent.

IV. Opportunities for Agriculture

Carbon Sequestration. Land-use change and forestry is an important element of the Kyoto Protocol. Net changes in greenhouse gases and removals by sinks resulting from direct human-induced land-use change and forestry activities, limited to afforestation, reforestation, and deforestation since 1990, are to be used to meet emissions target commitments (Article 3.3). The Protocol also provides that additional human-induced activities related to change in greenhouse gas emissions by sources and removals by sinks in the agricultural soils and the land-use change and forestry categories can be added by the Parties to the Protocol (Article 3.4)¹⁸. The studies described in section II do not account for the potential use of these additional activities in helping the U.S. to meet its emissions reduction target under the Kyoto Protocol.

The potential effects of the Kyoto Protocol on U.S. agriculture depend on many factors, including whether certain types of agricultural and forestry activities are ultimately included by the parties and how the Parties decide to handle definitional issues related to sinks. Equally important is the economic potential of carbon sequestration: while there may be significant physical potential to sequester carbon on agricultural lands, the cost of actually sequestering must

¹⁸ The process of including additional human-induced activities occurs under the UN Framework Convention on Climate Change (<http://www.unfccc.de/>). In addition to annual negotiating sessions of the Conference of Parties and the twice yearly sessions of the Subsidiary Bodies that advise the Conference of Parties, there are several technical venues for addressing land use change and forestry issues. The Intergovernmental Panel on Climate Change (IPCC) is tasked with preparing a Special Report on Land Use, Land Use Change, and Forestry (<http://www.uscgrp.gov/ipcc>), which will be released in May, 2000. The Subsidiary Body on Scientific and Technological Advice organized two workshops on land use change and forestry. One workshop was held in Rome (September, 1998). Another workshop was held in Indianapolis, Indiana (April, 1999). Both workshops addressed methodological and technical issues related to Article 3.4 of the Kyoto Protocol.

be taken into consideration. U.S. agriculture could benefit if terrestrial carbon sinks are eventually included in the Protocol.

Carbon Sequestration Potential. Cropland and grassland pasture and range account for almost half of all land in the contiguous 48 states and significant areas could be managed to increase the quantity of carbon stored in the soils and above ground biomass. Numerous studies of agricultural and rangelands sites in North America have documented changes in soil carbon levels with changes in management practices (see Paustian *et al.* (1996); Reicosky, 1995; Reicosky *et al.*, 1995; Kern and Johnson, 1993). For undisturbed soils first brought into production using conventional tillage practices, soil carbon losses typically range from 30–50 percent over the first 20 years of cultivation, after which, soil carbon levels generally stabilize at a new equilibrium. In the Great Plains, soil carbon losses due to cultivation have been estimated to range from 24–60 percent and take as long as 30 to 43 years to stabilize. In studies of sites that have been shifted out of conventional tillage and into permanent grasses or no-till systems, results show rates of soil carbon buildup between 0 and 2,000 lbs. per acre with accumulation typically taking 5 to 12 years to become measurable. Studies of former cropland sites either abandoned or reseeded with natural grasses indicate that about 50 years is needed to return soils to their maximum carrying capacity (Gephart *et al.*, 1994; and Lal *et al.*, 1998).

The rate of carbon accumulation/release in agricultural soils varies with many site specific factors—including chemical and physical characteristics of the soil, precipitation, above- and below-ground biology, temperature, solar radiation, atmospheric chemistry and processes, landscape characteristics, site history (including past management practices), time, and current land use (Johnson and Kern, 1991). Developing a framework that accounts for these influences in a systematic and verifiable fashion across national and international regions is an important step

in including agricultural soils under Article 3.4 of the Kyoto Protocol.

Soils having the greatest potential to sequester carbon are those that are below their carbon carrying capacity, meaning young soils and soils that have been depleted of carbon due to management practices (Johnson and Kern, 1991). Because the large majority of U.S. cropland has been in production for several decades, their large initial releases of carbon have already occurred and current releases are now very low—estimates range between 2.7 and 15 MM mt annually (Gephart *et al.*, 1994; and Lal *et al.*, 1998). Collectively then, U.S. agricultural soils have a relatively high potential for being managed to store additional carbon.

Converting agricultural lands to forests. For 1996, EPA estimates that due to improved management practices and regeneration, U.S. forests represented a net carbon sink of about 208.6 MM mt. This is about 14 percent of total U.S. carbon emissions and 12 percent of total emissions of gases (in carbon equivalents) covered in the Kyoto Protocol. The potential to further offset U.S. GHG emissions by shifting millions of acres of marginal cropland and pasture into forests has been analyzed by Moulton and Richards (1990), Adams *et al.* (1993), Parks and Hardie (1995 and 1996), and Stavins (1998). We focus here on the works by Parks and Hardie (1995 and 1996) and by Stavins (1998) because the studies by Moulton and Richards (1990), and, Adams *et al.* (1993), while frequently cited, are now understood to have significantly overstated the amount of carbon sequestered in new forests (Richards, 1992).

Table III.1 (part A) presents selected results from Parks and Hardie (1995). These results suggest that a land retirement program like the current Conservation Reserve Program (CRP), funded at a level of \$456.2 million annually, would sequester about 48.6 MM tons of carbon per year (or 44.2 MM mt) and require some 22.2 million acres. The carbon sequestered is a little over 3 percent of current U.S. carbon emissions and about 7.9 percent of the emissions reduction AEA (1998)

estimates will be required to meet our obligations under the Kyoto Protocol in 2010. Also clear in Table III.1 is that most of the land converted to forests would be pasture land—note that when only cropland is considered, acres enrolled fall to 9.4 million, carbon sequestered drops to 21.6 MM tons, and per acre costs more than double (to \$48.53). Parks and Hardie (1996), consider the goal of sequestering 10 percent of U.S. carbon emissions in new forests. Achieving this level of sequestration by converting marginal croplands and pasture to new forests is estimated to require 116.1 million acres and cost \$8.31 billion annually.

Stavins estimates a marginal cost function for carbon sequestration through forestry that extends to 342 million acres of land sequestering 518 million tons (470 million metric tons) of carbon per year. Stavins' results at lower levels are similar to those of Parks and Hardie. But upon reaching 342 million acres of land, annual average costs are \$106 per acre and \$70 per ton (\$77 per metric ton) of carbon, and marginal costs are \$200 per acre and \$136 per ton (\$150 per metric ton) of carbon. Stavins estimates that marginal costs are roughly linear until reaching about \$66 per ton (\$73 per metric ton) or \$100 per acre, after which marginal costs increase rapidly. Thus, Stavins demonstrates the need for caution in extrapolating costs from relative low levels of land conversions to higher levels.

While forests generally have more primary production and above ground biomass than grasslands, grassland soils often have more carbon than forest soils (Johnson and Kern, 1991). This is because soil carbon in grasslands is mostly a function of root mortality and because the roots of grasses are thin, compact, and often extend to a depth of a meter or more. Carbon in forest soils, on the other hand is primarily a function of fine root turn-over near the surface and tree litter. For areas that were once prairie or are otherwise poorly suited to forests, conversion of cropland to grasses may be a more efficient carbon sink than conversion to trees.

Paustian *et al.* (1996) look at soil carbon accumulation on 25 million acres of CRP land in

Great Plains. Over the 10 year contract period they estimate an aggregate increase in below ground soil carbon (i.e. carbon in soil organic matter, roots, and soil litter) of 57.6 MM mt—or 5.76 MM mt per year. For CRP acres put into grasses at five locations in the Great Plains, Gephart *et al.* (1994) estimate carbon accumulation in the top 120 inches at 1,000 lbs. per acre per year—implying a 25 million acre program would sequester a total of 11.36 MM mt of carbon per year. For the most recent CRP enrollment period, average annual rental payments for land in the Great Plains ranged between \$32 and \$40 per acre. At these rental rates, a land retirement program that shifts 25 million acres of cropland to grasslands would cost between \$0.8 to \$1.0 billion.

Managing crop and pasture lands can also increase soil carbon levels. Management practices include conservation tillage, use of winter cover crops, adding organic amendments to soils, rotational grazing, and re-seeding pastures with improved varieties.¹⁹ Economic analysis on the potential costs and benefits of these practices to mitigate GHG emissions is limited although new analysis is currently underway at USDA and at several universities. Kern and Johnson (1993) estimate changes in soil carbon and energy use for various levels of adoption of minimum tillage and no-till systems for the period 1990-2020. Their results suggest that in moving from 60 million acres in no-till to 80 million acres, soil carbon would increase between 206 MM mt (million metric tons of carbon) and 339 MM mt over a 30 year period. (Table III.1, part B) This suggests that shifting 20 million acres into no-till would result in between 6.9 MM mt and

¹⁹ Many of these practices are linked to a variety of environmental benefits such as improved water quality and reductions in soils erosion. For example, the benefits of reduced erosion from switching 22.4 million acres of highly erodible land now under conventional tillage to conservation tillage at is estimated at between \$30.5 million and \$99.1 million U.S. Department of Agriculture, Economic Research Service. 1998a.

11.3 MM mt of carbon being sequestered annually—or between 1.2 percent and 2.0 percent of the U.S. target for complying with the Kyoto Protocol in 2010.²⁰

If shifting lands from commodity production to forests or grasses, or moving from conventional tillage to conservation tillage are to be considered carbon sinks in the context of the Kyoto Protocol, the affected lands will have to stay in their new uses for extended periods of time (perhaps a minimum of 20 years). That is, managing land to sequester carbon for a few years and then returning it to production, or resuming conventional tillage in the case of land put into no-till, would quickly release any carbon that had been added to soils or biomass by sequestration activities (Paustian *et al.*, 1996; U.S. Department of Agriculture, Economic Research Service, 1998). A key focus then of policies to promote agricultural carbon sinks will need to be ensuring that conditions exist under which producers are willing to enter relatively long-run commitments regarding the management of land resources.

To assess how government policies might facilitate and encourage such commitments, it is helpful to view land ownership as a bundle of separate interests, each conveying the right to use a parcel of land in a particular way (Weibe, 1996). The set of interests associated with any given parcel may be held by one agent or may be distributed among multiple agents (public and private).

From this perspective, the market value of any subset of interests reflects expectations about the present value of all current and future uses that subset allows the holder to legally undertake.

²⁰ To put this in perspective, conservation tillage increased from 2 percent of U.S. cropland in 1968 to 36 percent in 1996, while acreage over the period 1992-1996 was almost constant—although acres under no-till increased from 9.9 percent of all cropland to 14.5 percent (USDA, ERS, 1998). Conservation tillage is used mostly on soybeans, corn, and small grains, which indicates that conservation compliance has probably been a major factor affecting adoption rates (USDA, ERS, 1997). This suggests that economic incentives would probably be a significant component of any effort to mitigate GHG emissions via the expanded use of conservation tillage.

Hence, the effect of establishing agricultural GHG sinks within the framework of the Kyoto Protocol would be create a new economic interest in farm land—namely the right to manage it for increased carbon content. Giving sequestered carbon a positive market value would mean farmers could treat it as another commodity. Profit maximizing producers would then choose to sequestered carbon when the present value of its net returns exceeded similar streams associated with other commodities over some relevant time horizon.

At present, the details of any future market for carbon sequestration are largely uncertain since many of the factors that would define this market are still being debated by the Parties to the Kyoto Protocol. Possibilities include: firms with high emissions reductions costs would mitigate the environmental impacts of their emissions by contracting with farmers to engage in specific sequestration activities. The government's role in this case could be limited to maintaining the legal environment in which sinks are defined, measured, verified, and sequestration contracts enforced.

Other mitigation opportunities. In addition to converting marginal agricultural lands to forests and permanent grasses and adopting production practices that enhance soil carbon levels, a number of other opportunities may exist for agriculture to help mitigate U.S. GHG emissions. These include managing existing forests on U.S. farm lands for increased carbon storage, reducing agricultural methane emissions (via changes in methods of handling animal wastes and changes in livestock feeds), reducing agricultural emissions of nitrous oxide (via altering the use of nitrogen fertilizers and other farm chemicals) and producing biomass crops for energy generation.. Little formal economic analysis has addressed the potential of these opportunities to cost effectively mitigate U.S. GHG emissions (see Bluhm, Conway, Ronigen, and Shapouri, 1995; Brown, Rosenberg, Easterling, and Hays, 1998; and Ternary, Winnett, Shackleton, Hohenstein, 1995

for discussions on the economics of biomass)

Whether or not these alternative GHG mitigation options prove to be economically viable will depend largely on the set of sinks and mitigation practices ultimately permitted in Kyoto Protocol and the set of government policies implemented to achieve U.S. emissions reductions obligations. For example, expanding production of biomass crops could help mitigate U.S. GHG emissions in two ways. First, as discussed above, farmers could produce biomass utilizing practices that increase soil carbon levels. Second, where the energy generated by burning biomass replaces energy generated by fossil fuel combustion, it would represent a shift to recycling atmospheric carbon and thus, over time, a reduction in *net* emissions. Additionally, because of the substitutability between biofuels and fossil fuels in energy generation, any carbon-based charge on fossil fuels would enhance the competitiveness of biofuels. The economic viability of biofuels as a GHG mitigation option then will depend on whether or not agricultural soils are allowed as a carbon sink in the Kyoto framework, whether or not shifting to practices that recycle atmospheric carbon will be counted as a reduction in net emissions, and the magnitude of the carbon charge needed to meet U.S. emissions reductions obligations.

Table I.1: Greenhouse Emissions from the Agriculture Sector, million metric tons of carbon equivalent (MMTCE), 1990-96

Gas/Source	1990	1991	1992	1993	1994	1995	1996
Total U.S. Emissions	1632.₇	1620.₂	1645.₇	1678.₀	1715.₃	1731.₁	1788.₀
Methane (CH ₄)	169.9	171. ₁	172.5	171. ₉	175. ₉	179. ₂	178. ₆
Nitrous Oxide (N ₂ O)	92.3	94.4	96.8	97.1	104. ₉	101. ₀	103. ₇
Carbon	1348. ₃	1333. ₂	1353. ₂	1385. ₆	1408. ₅	1419. ₂	1471. ₁
Total Ag. Emissions	105.7	107.₅	109.3	110.₉	114.₈	114.₄	114.₀
CH₄	50.3	50.9	52.2	52.5	54.4	54.8	53.7
Enteric Fermentation	32.7	32.8	33.2	33.6	34.5	34.9	34.5
Manure Management	14.9	15.4	16.0	16.1	16.7	16.9	16.6
Rice Cultivation	2.5	2.5	2.8	2.5	3.0	2.8	2.5
Agricultural Residue	0.2	0.2	0.2	0.2	0.2	0.2	0.2
N₂O, total	55.4	56.5	57.1	58.5	60.4	59.7	60.3
Manure Management	3.3	3.5	3.5	3.6	3.7	3.6	3.7
Ag. Soil Management	52.0	52.9	53.5	54.8	56.6	55.9	56.5
Ag. Residue Burning	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Agricultural Emissions as percent of Total U.S.	6.5	6.6	6.6	6.6	6.7	6.6	6.4

Source: U.S. Environmental Protection Agency. 1998. *Inventory of U.S. Greenhouse Gas Emission and Sink: 1990-1996*. (USEPA 236-R-98-006, March 1998), Washington, DC.

Table II.1: Assumptions, Features, and Results of Selected Farm-Level Studies on Reducing U.S. Carbon Emissions

Study	Emissions targets*	Price of Carbon (\$ permit)	Key Assumptions and Features	Key Results
Franci (1997) results in 1994 \$'s	1990	Low scenario: \$0.25 per gallon of fuel. High scenario: \$0.50 per gallon of fuel.	1. Estimates how fuel taxes would affect input prices and production cost of selected commodities. 2. Tax rates based on a literature review 3. All price changes occur in year 1. 4. Effects relative to 1994 5. No producer supply response that would raise commodity prices.	1. Total farm production expenses increase 5.8% in the low scenario and 11.7% in the high scenario. 2. See Table II.4 for impacts on agricultural input prices
Sparks (1999): results in 1995 \$'s	See DRI study (table II.2)	See DRI study.	1. Uses DRI model to define baseline and assess macroeconomic impacts of each scenario. No phase-in period. 2. Estimates how carbon tax would affect the prices energy intensive farm inputs. 3. Input cost increase reflects producer response to higher prices, domestic consumer response limited to income effect. 4. Technology, commodity production patterns, and systems of food processing and marketing assumed constant through 2010. 5. No producer supply response that would raise commodity prices.	1. Higher energy costs would: a. increase farm production costs \$16.2 billion (8.8%) and food processing and marketing costs \$18 billion (2.6%). b. reduce domestic food demand 0.8% c. decrease farm income nearly 53% from 1998 d. increase farm consolidation e. increase food imports and decrease food exports.
McCarl et al. (1997)	No specific target	Considers taxes of 25, 50, and \$100 per short ton of carbon	1. taxes put in place all at once & all economic adjustments occur immediately 2. Changes in relative prices of diesel, natural gas, fertilizer and electricity are estimated exogenously and imposed on the model. 3. Considers imposing carbon tax in 2000, 2005, 2010, 2015, and 2020.	1. U.S. agriculture is not very sensitive to carbon taxes. 2. Carbon taxes of \$25, \$50, and \$100 / ton would cost the farm sector, respectively, \$450, \$850, and \$1,600 million annually. Annual tax revenues from the farm sector would be \$450, \$800, and \$1,500 million. 3. Farmers would pass most of any input price increases on to consumers.

Table II.2: Agricultural Input Cost Increases Estimated in Various Studies, by Carbon Tax Scenario

Study	Input	Policy Scenario		
Franci		Fuel Price Increase Scenario		
		Low	High	
		--percent--		
	Fuel and electricity	25	50	
	Pesticides/chemicals	20	40	
	Fertilizer	15 to 20	30 to 40	
	Custom operations/hauling	15	30	
	Other Expenses	5	10	
Sparks, Inc.		Emissions Permit Price (1997 \$'s per metric ton of Carbon)		
		\$177-193		
		--percent--		
	Fuels and Oil	30		
	Electricity	100		
	Fertilizer and lime	100		
	Pesticides	50		
McCarl et al.		Carbon Permit Price (1997 \$'s per short ton of Carbon)		
		\$25	\$50	\$100
		--percent--		
	Gasoline	4.52	9.04	18.08
	Diesel	8.26	16.53	33.06
	Natural Gas	13.13	26.26	52.53
	Electricity	8.26	16.53	33.06
	Nitrogen	0.22	0.44	0.87
	Phosphorous	0.08	0.16	0.33
	Potassium	0.22	0.44	0.87
	Chemicals	0.08	0.16	0.33

Table III.1: Summary of AEA (1998) Analysis of Implementing the Kyoto Protocol**Emissions Target:**

U.S. greenhouse gas (GHG) emissions target is set 7% below 1990 levels between 2008 and 2012. Gases covered are carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆).

Methodology :

1. Construct regional "business as usual" (BAU) GHG emissions scenarios for 2010.
2. Develop regional marginal abatement cost curves for reducing GHG emissions.
- Use the Second Generation Model (SGM) to calculate the world GHG permit prices that equates marginal abatement costs across regions for various trading scenarios. For each scenario, assess the impacts on U.S. energy prices, energy consumption, GDP, investment, and consumption. (SGM is a 12 region - 9 sector computable general equilibrium model designed to analyze energy markets).

Key Assumptions:

1. Efficient trading of emissions allowances within regions and across specified trading blocs
2. Carbon sinks not considered
3. Autonomous gain in energy efficiency for the US economy set at 0.96% annually
4. No banking of emissions allowances for later periods
5. No emissions mitigation related to electricity sector restructuring, the Climate Change Technology Initiative, the Energy Efficiency Initiative, or voluntary industry actions
6. GHG emissions target is, on average, 600 MMTCE below projected "business as usual" emissions levels for 2008-2012.
7. Specified trade blocs:
 - Annex 1: Unrestricted trade of emissions credits among Annex 1 countries.
 - Umbrella 1: Unrestricted trade of emissions credits among Annex 1 countries minus Eastern Europe and the European Union (EU).
 - Umbrella 2: Unrestricted trade of emissions credits among Annex 1 countries minus the EU.
 - CDM: Developing countries sell emissions credits via Clean Development Mechanism.
 - KDC: Key developing countries adopt emissions targets equal to their 2010 baseline and participate in normal trading:

Scenario results (% reductions relative to case where all countries reduce emissions domestically):

Scenario	reduction in permit price	reduction in U.S. economic cost	Permit Price (1996 \$/t)	U.S. Economic Cost (1996 \$/yr)
Annex1	72%	57%		
Umbrella1	75%	61%		
Umbrella2	85%	74%		
Annex1+KDC	88%	80%	\$23/metric ton	\$12 billion/year
Umbrella1+KDC	91%	83%		
Umbrella2+KDC	93%	87%	\$14/metric ton	\$ 7 billion/year
Annex1+CDM	79%	66%		
Umbrella1+CDM	82%	71%		
Umbrella2+CDM	88%	80%		

Results for permit price = \$14 per metric ton (relative to the BAU scenario in 2010)

- a. raise household energy prices 3% and annual household energy costs \$70,
- b. raise both electricity and gasoline prices 3% (for gasoline this is about 4 cents per gallon);

Results for permit price = \$23 per metric ton (relative to the BAU scenario in 2010)

- a. raise household energy prices 5% and annual household energy costs \$110.
- b. raise electricity prices 5% and gasoline prices 4% (about 6 cents per gallon)

Source: AEA (1998)

Table III.2: Inputs under the Kyoto Protocol : embodied carbon and input prices

Item	Unit	Input Price (2010) \$/ unit	Carbon Content pounds / unit	Input Price Increase* \$/ unit percent	
Fuels			1.2/		
Diesel fuel	Gallon	1.21	6.026	0.063	5.2
Gasoline	Gallon	1.65	5.233	0.055	3.3
LP gas	Gallon	1.06	3.200	0.033	3.2
Natural gas	100 Cu.Ft.	0.45	3.300	0.034	7.7
Electricity			3/		
Northeast	Kwh.	0.11	0.087	0.001	0.9
Lake States	Kwh.	0.06	0.150	0.002	2.6
Corn Belt	Kwh.	0.06	0.150	0.002	2.8
Northern Plains	Kwh.	0.06	0.150	0.002	2.8
Appalachian	Kwh.	0.08	0.105	0.001	1.4
Southeast	Kwh.	0.06	0.129	0.001	2.3
Delta	Kwh.	0.05	0.135	0.001	2.9
Southern Plains	Kwh.	0.05	0.127	0.001	2.5
Mountain	Kwh.	0.06	0.127	0.001	2.4
Pacific	Kwh.	0.07	0.042	0.000	0.6
Chemicals			4/		
Nitrogen	Pound	0.38	1.420	0.015	3.9
Phosphate	Pound	0.29	0.296	0.003	1.1
Potash	Pound	0.17	0.236	0.002	1.4
Pesticides	Pound	3.49	5.633	0.059	1.7

* Input price change in USMP model run with carbon permit price of \$23 per metric ton.

Sources:

1/ USDOE/EIA. 1997. *Annual Energy Outlook*, p. 222. (Volume/Btu conversions)

2/ USDOE/EIA, 1997. *Emissions of Greenhouse Gases in the United States -1996*, USDOE/EIA-0573(96), Oct. 1997. Table B1, p.100. Adjustments for incomplete combustion per personal communication with Susan Holte, EIA emissions specialist. (Btu/Carbon conversions)

3/ Wiese, AM. 1998. *Impacts of Market-Based Greenhouse Gas Emission Reduction Policies on U.S. Manufacturing Competitiveness*, Research Study #090 American Petroleum Institute. Citing USDOE, EIA. 1995. "Annual Electric Generator Report," in *The Electric Power Annual*, Vol.1, tables 6-8.

4/ Helsel, Z.R. 1992. "Energy and Alternatives for Fertilizer and Pesticide Use," Chapter 13 in *Energy in Farm Production*, ed. RC Fluck. Elsevier, 1992.

Table III.3: 2010 crop price, production, domestic use and exports under the Kyoto Protocol

Crop	Unit		Price		Production		Domestic use		Exports	
			Base 2010	\$23/mt	Base 2010	\$23/mt	Base 2010	\$23/mt	Base 2010	\$23/mt
			--dollars per unit--				--million units--			
Corn	Bushel		3.20	3.22	11,776.2	11756.5	1675.0	1674.3	3250.6	3240.0
		Change		0.02		-19.7		-0.7		-10.6
		% change		0.62		-0.2		0.0		-0.3
Sorghum	Bushel		3.00	3.02	770.0	766.1	35.0	34.8	335.0	331.9
		Change		0.02		-4.0		-0.2		-3.1
		% change		0.78		-0.5		-0.7		-0.9
Barley	Bushel		2.85	2.88	450.0	447.3	172.0	171.5	70.0	69.0
		Change		0.03		-2.7		-0.5		-1.0
		% change		1.13		-0.6		-0.3		-1.4
Oats	Bushel		1.90	1.91	293.7	292.8	102.0	101.9	2.0	2.0
		Change		0.01		-1.0		-0.1		0.0
		% change		0.65		-0.3		-0.1		-0.4
Wheat	Bushel		4.65	4.66	2,828.0	2821.6	1146.0	1145.8	1625.0	1619.3
		Change		0.01		-6.4		-0.2		-5.8
		% change		0.22		-0.2		0.0		-0.4
Rice	Hundred-weight		12.87	12.98	206.4	204.4	7.0	7.0	85.4	83.7
		Change		0.11		-2.0		0.0		-1.8
		% change		0.85		-0.9		-0.3		-2.1
Soybeans	Bushel		7.55	7.56	3,144.2	3140.9	152.2	152.1	1149.7	1149.0
		Change		0.01		-3.3		-0.1		-0.8
		% change		0.09		-0.1		0.0		-0.1
Cotton	Bale		NA ¹	NA	21.3	21.2	13.2	13.2	8.0	8.0
		Change		1.25		-0.1		-0.1		0.0
		% change		0.34		-0.4		-0.3		-0.4
Silage	Ton		21.66	21.67	95.6	95.4	27.5	27.4	0.0	0.0
		Change		0.01		-0.2		-0.1		0.0
		% change		0.04		-0.3		-0.3		0.0
Hay	Ton		60.53	60.61	155.6	154.9	79.2	78.7	0.0	0.0
		Change		0.08		-0.7		-0.6		0.0
		% change		0.13		-0.4		-0.7		0.0

¹USDA is prohibited from publishing cotton price projections.

Table III.4: 2010 acreage planted and acreage change under the Kyoto Protocol

	Base/ Change	North East	Lake States	Corn Belt	North Plains	Appa- lachie	South East	Delta States	South Plains	Moun-tain	Pacific	US Total
Selected crops												
-- million acres --												
Feed- grains	2010 base	3.97	15.49	43.59	24.55	4.78	2.18	1.00	6.39	4.36	1.42	107.72
	Change	-0.02	-0.02	-0.02	-0.13	-0.01	-0.01	0.00	-0.10	-0.05	-0.02	-0.38
	% change	-0.40	-0.10	0.00	-0.50	-0.20	-0.20	-0.40	-1.60	-1.20	-1.30	-0.30
Wheat	2010 base	0.73	3.89	6.46	28.97	1.45	0.38	0.71	21.42	10.69	2.83	77.50
	Change	0.00	-0.01	-0.01	-0.09	0.00	0.00	0.00	-0.18	-0.03	0.00	-0.31
	% change	-0.20	-0.10	-0.10	-0.30	-0.30	-0.20	-0.10	-0.80	-0.20	0.20	-0.40
Soybeans	2010 base	1.08	8.38	36.11	8.36	4.99	2.87	8.19	0.30	0.00	0.00	70.27
	Change	0.00	-0.01	-0.02	-0.02	-0.01	-0.01	-0.03	0.00	0.00	0.00	-0.09
	% change	-0.10	-0.10	0.00	-0.20	-0.20	-0.30	-0.30	-0.80	0.00	0.00	-0.10
Hay	2010 base	7.81	10.53	11.38	10.94	6.33	1.05	0.76	1.19	9.31	3.20	62.50
	Change	-0.01	-0.02	-0.01	-0.07	0.00	0.00	0.00	-0.02	-0.14	0.00	-0.26
	% change	-0.20	-0.20	-0.10	-0.60	0.00	0.00	0.00	-1.30	-1.50	0.10	-0.40
10 major crops	2010 base	15.04	40.04	98.61	74.29	19.00	7.61	17.01	36.40	25.14	9.00	342.15
	Change	-0.04	-0.07	-0.05	-0.31	-0.03	-0.02	-0.04	-0.44	-0.22	-0.05	-1.26
	% change	-0.20	-0.20	-0.10	-0.40	-0.20	-0.20	-0.20	-1.20	-0.90	-0.50	-0.40
Tillage Types												
Conven- tional	2010 base	3.28	16.01	45.20	37.24	7.66	6.56	15.55	27.97	13.51	5.39	178.37
	Change	-0.03	-0.05	-0.02	-0.34	-0.01	-0.02	-0.04	-0.43	-0.24	-0.05	-1.23
	% change	-0.90	-0.30	0.00	-0.90	-0.10	-0.20	-0.20	-1.50	-1.80	-0.90	-0.70
Mold- board	2010 base	8.31	13.34	12.22	15.03	6.17	1.05	0.80	6.41	8.78	3.37	75.47
	Change	0.01	-0.01	0.00	0.10	0.00	0.00	0.00	-0.07	0.03	0.00	0.06
	% change	0.10	-0.10	0.00	0.60	0.10	0.00	-0.10	-1.10	0.30	0.00	0.10
Mulch	2010 base	1.33	7.57	20.71	15.68	1.71	0.00	0.00	2.02	2.86	0.24	52.12
	Change	-0.01	-0.02	-0.03	-0.02	-0.01	0.00	0.00	0.06	-0.01	0.00	-0.03
	% change	-0.50	-0.20	-0.10	-0.20	-0.70	0.00	0.00	3.00	-0.30	0.70	-0.10
No-Till	2010 base	2.12	3.02	20.48	4.99	3.46	0.00	0.66	0.00	0.00	0.00	34.73
	Change	-0.01	0.01	-0.01	-0.05	-0.01	0.00	0.00	0.00	0.00	0.00	-0.07
	% change	-0.40	0.30	0.00	-0.90	-0.30	0.00	0.10	0.00	0.00	0.00	-0.20
Ridge-Till	2010 base	0.00	0.11	0.00	1.35	0.00	0.00	0.00	0.00	0.00	0.00	1.46
	Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	% change	0.00	0.10	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.10
All Tillage Types	2010 base	15.04	40.04	98.61	74.29	19.00	7.61	17.01	36.40	25.14	9.00	342.15
	Change	-0.04	-0.07	-0.05	-0.31	-0.03	-0.02	-0.04	-0.44	-0.22	-0.05	-1.26
	% change	-0.20	-0.20	-0.10	-0.40	-0.20	-0.20	-0.20	-1.20	-0.90	-0.50	-0.40

Conventional Tillage : use of disc in planting preparation. Moldboard Tillage: conventional plus use of moldboard plow. No-till (slot planting): Soil is left undisturbed prior to planting; weed control is usually accomplished with a combination of herbicides and cultivation. Ridge-till: soil is left undisturbed prior to planting; about one third of the soil surface is tilled with sweeps or row cleaners at planting time; planting is completed on ridges; weed control with herbicides and cultivation. Mulch-till: -total surface is tilled, using tools such as chisels, field cultivators, disks, sweeps, or blades; weed control with herbicides and cultivation.

Table III.5: Selected 2010 livestock price and production under the Kyoto Protocol

Item	Unit		Price		Production	
			Base 2010	\$23/mt	Base 2010	\$23/mt
			--dollars per unit--		--million units--	
Milk	Hundred-weight		15.25	15.29	1,705.0	1,703.2
		Change		0.03		-1.8
		% change		0.23		-0.1
Hog slaughter	Hundred-weight*		49.8	49.94	255.2	255.1
		Change		0.14		0.0
		% change		0.27		0.0
Beef yearlings	Hundred-weight*		90.64	91.17	185.9	185.7
		Change		0.53		-0.2
		% change		0.58		-0.1
Fed beef	Hundred-weight*		80.61	81.08	329.5	329.0
		Change		0.47		-0.5
		% change		0.58		-0.2
Broilers	Pounds		0.39	0.39	37,863.5	37,853.2
		Change		0		-10.3
		% change		0.22		0.0

* live weight.

Table III.6: 2010 Income and expenses: base level, change and percent change under Kyoto Protocol

	Base/ Change	North East	Lake States	Corn Belt	North Plains	Appa- lachie	South East	Delta States	South Plains	Moun-tain	Pacific	US Total
-- million dollars --												
Crops												
Value	2010 base	3,503	11,034	38,477	16,835	5,595	2,496	7,577	6,299	5,218	3,497	100,530
Of	Change	3	30	127	0	9	4	18	-29	-19	-9	135
Production	% change	0.10	0.30	0.30	0.00	0.20	0.20	0.20	-0.50	-0.40	-0.30	0.10
Conserva- tion	2010 base	5	104	268	214	29	30	20	118	108	38	933
Reserve	Change	0	0	0	0	0	0	0	0	0	0	0
	% change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Payments	2010 base	92	357	1,029	857	152	83	411	642	227	160	4,010
Production	Change	0	0	0	0	0	0	0	0	0	0	0
Flexibility	% change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Payments	% change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	2010 base	2,485	5,868	16,580	10,141	3,498	1,516	4,272	5,409	3,049	2,220	55,038
Variable	Change	13	60	208	86	31	15	48	2	-9	-6	448
Costs	% change	0.50	1.00	1.30	0.90	0.90	1.00	1.10	0.00	-0.30	-0.30	0.80
Net	2010 base	1,115	5,627	23,195	7,764	2,278	1,093	3,736	1,649	2,505	1,474	50,435
cash	Change	-10	-30	-81	-86	-23	-10	-30	-31	-10	-3	-314
Returns	% change	-0.90	-0.50	-0.30	-1.10	-1.00	-0.90	-0.80	-1.90	-0.40	-0.20	-0.60
Livestock												
Value	2010 base	8,816	11,676	17,889	18,416	8,488	8,156	5,741	19,701	8,901	9,545	117,329
Of	Change	6	10	157	87	4	2	2	-183	139	92	315
Production	% change	0.10	0.10	0.90	0.50	0.00	0.00	0.00	-0.90	1.60	1.00	0.30
Total	2010 base	5,163	7,882	15,398	18,306	6,293	5,082	3,558	17,370	8,035	6,464	93,550
Variable	Change	18	27	155	87	10	8	6	-122	112	71	373
Costs	% change	0.30	0.30	1.00	0.50	0.20	0.20	0.20	-0.70	1.40	1.10	0.40
Net	2010 base	3,653	3,794	2,491	109	2,195	3,074	2,184	2,331	866	3,081	23,780
cash	Change	-12	-17	2	0	-6	-7	-5	-60	26	21	-58
Returns	% change	-0.30	-0.40	0.10	-0.30	-0.30	-0.20	-0.20	-2.60	3.00	0.70	-0.20
Crops and Livestock												
Value	2010 base	12,319	22,710	56,366	35,250	14,083	10,652	13,318	26,000	14,120	13,042	217,859
Of	Change	9	40	285	87	12	6	20	-211	120	83	450
Production	% change	0.10	0.20	0.50	0.20	0.10	0.10	0.10	-0.80	0.80	0.60	0.20
Total	2010 base	7,648	13,750	31,977	28,447	9,790	6,598	7,830	22,778	11,084	8,685	148,587
Variable	Change	31	86	363	173	42	23	54	-120	103	65	821
Costs	% change	0.40	0.60	1.10	0.60	0.40	0.30	0.70	-0.50	0.90	0.70	0.60
Net	2010 base	4,768	9,422	25,686	7,874	4,474	4,167	5,919	3,981	3,371	4,555	74,215
cash	Change	-22	-47	-79	-87	-29	-17	-35	-91	17	18	-371
Returns	% change	-0.50	-0.50	-0.30	-1.10	-0.70	-0.40	-0.60	-2.30	0.50	0.40	-0.50

Table III.7: Carbon embedded and energy expenses under the Kyoto Protocol¹

Item		Carbon embodied in production		Energy expenses in production	
		Base2010	\$23/mt	Base2010	\$23/mt
-- Crops --		-- million mt --		-- million dollars --	
Fuel		11	10.8	5,210.9	5,404.0
	Change		-0.2		193.1
	% Change		-1.4		3.7
Electricity		0.5	0.5	446.3	453.8
	Change		0		7.5
	% Change		-0.7		1.7
Custom		1.4	1.3	655.5	657.9
	Change		-0.1		2.4
	% Change		-4.4		0.4
Fertilizer		13	12.9	12,275.3	12,528.1
	Change		-0.1		252.8
	% Change		-0.4		2.1
Chemicals		5.9	5.8	8,007.9	8,102.5
	Change		0		94.6
	% Change		-0.5		1.2
Crops all energy		31.7	31.4	26,595.8	27,146.2
	Change		-0.3		550.4
	% Change		-1		2.1
-- Livestock --					
Fuel		8.4	8.3	4,075.4	4,216.9
	Change		-0.1		141.4
	% Change		-1.4		3.5
Electricity		0.4	0.4	483.6	499.8
	Change		0		16.2
	% Change		1.1		3.4
Livestock all energy		8.8	8.7	4,559.0	4,716.7
	Change		-0.1		157.7
	% Change		-1.3		3.5
--Crops and livestock--					
Fuel		19.4	19.1	9,286.3	9,620.9
	Change		-0.3		334.6
	% Change		-1.4		3.6
Electricity		0.9	0.9	929.8	953.6
	Change		0		23.7
	% Change		0.2		2.6
Custom		1.4	1.3	655.5	657.9
	Change		-0.1		2.4
	% Change		-4.4		0.4
Fertilizer		13	12.9	12,275.3	12,528.1
	Change		-0.1		252.8
	% Change		-0.4		2.1
Chemicals		5.9	5.8	8,007.9	8,102.5
	Change		0		94.6
	% Change		-0.5		1.2
All energy		40.5	40	31,154.8	31,862.9
	Change		-0.4		708.1
	% Change		-1		2.3

¹ These estimates pertain to the 10 major field crops and major livestock enterprises included in the USMP model and cover most significant carbon use in agriculture. USMP does not model fruit, vegetable and other horticultural production which are energy intensive and use relatively more electricity than field crops. Horticultural electricity uses include irrigation, refrigeration and greenhouse operation.

Table III.8: Social benefit measures under Kyoto Protocol

Measure			U.S. Total
			million dollars
Producer Surplus	Base		1,096,957
	\$23/mt	Change	-417
		% change	-0.04
Net farm cash Returns ¹	Base		74,215
	\$23/mt	Change	-371
		% change	-0.5
Consumer surplus	Base		822,239
	\$23/mt	Change	-374
		% change	-0.05
Consumer and producer surplus	Base		1,919,196
	\$23/mt	Change	-791
		% change	-0.04
Revenue transfers out of agriculture sector²			N/A
	\$23/mt	Change	724
Net social benefit	Base		1,919,196
	\$23/mt	Change	-67
		% change	-0.00
Net foreign surplus	Base		54,409
	\$23/mt	Change	-127
		% change	-0.46

¹ Crop and live animal producers. Processing (food, feed and meat) not included.

² Revenues transferred out of agriculture sector based on carbon tax rate implied by carbon permit price.
Equal to tax revenues from imposition of a carbon tax.

_ Net social benefit = _ Consumer surplus + _ Producer surplus + Tax revenue

_ Net foreign surplus = _ Export surplus + _ Import surplus

Table III.9: Changes in erosion and water related nitrogen losses¹

Indicator			North East	Lake States	Corn Belt	North Plains	Appa- Lachia	South East	Delta States	South Plains	Moun- tain	Pacif ic	U.S. Total
			--- million tons---										
Soil	Base		48.9	224.3	471.7	307.1	102.2	47.0	85.3	285.2	326.4	89.5	1987.7
Erosion	\$23/mt	change	-0.073	-0.538	-0.200	-1.322	-0.174	-0.091	-0.157	-0.556	0.207	-0.027	-2.928
		% change	-0.149	-0.240	-0.042	-0.430	-0.170	-0.193	-0.184	-0.195	0.064	-0.031	-0.147
Nitrogen-	Base		0.23	0.36	1.96	1.10	0.46	0.17	0.47	0.63	0.17	0.09	5.63
Loss to	\$23/mt	change	0.000	0.000	-0.001	-0.005	0.000	0.000	-0.001	-0.005	0.000	-0.001	-0.016
Water		% change	-0.311	-0.249	-0.055	-0.428	-0.164	-0.199	-0.221	-0.842	-0.107	-1.376	-0.288
Nitrogen-	Base		0.019	0.075	0.664	0.229	0.046	0.021	0.037	0.273	0.049	0.041	1.453
Loss to	\$23/mt	change	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	-0.003	0.000	0.000	-0.006
Air ²		% change	-0.242	-0.114	-0.067	-0.467	-0.232	-0.160	-0.196	-1.276	-0.126	-0.779	-0.393
			--- million dollars---										
Offsite	Base		228.8	377.4	579.3	152.4	346.9	108.2	265.8	175.1	170.0	208.1	2612.0
Damages	\$23/mt	change	-0.339	-0.713	-0.199	-0.486	-0.590	-0.209	-0.489	-0.777	-0.025	-0.198	-4.024
From		% change	-0.148	-0.189	-0.034	-0.319	-0.170	-0.193	-0.184	-0.444	-0.015	-0.095	-0.154
Erosion													

¹ The environmental indicators reported in this table do not measure environmental quality, but rather changes in factors which influence environmental quality.

² Nitrogen loss to air includes nitrogen losses from denitrification and volatilization.

Table IV.1: Potential Carbon Sequestration on U.S. Agricultural Lands

A. Selected Features of a Land Retirement Program to Sequester Carbon on Marginal Cropland and Pasture

Lands Targeted:	---- Cropland and Pasture ----		----- Cropland -----	
Objective:	Minimize Cost per Acre	Minimize Cost per Ton C	Minimize Cost per Acre	Minimize Cost per Ton C
Total land enrolled (million acres)	23.1	22.2	10.3	9.4
Annual Carbon Sequestered (million metric tons)	40.9	44.2	15.3	19.6
Annual cost (\$/acre)	19.75	20.54	44.29	48.53
Annual cost (\$/metric ton)	11.15	10.33	29.88	23.23
Length of Program:	10 years (assumes forests would then be highest value use)			
Total Program Cost:	\$3.7 billion total			
Annual Program Cost:	\$456.2 million			

Source: Parks and Hardie (1995)

➤ **Estimated Changes in SOC and Fossil Fuel Use to the year 2020 for Select Changes in the Use of Minimum Tillage and No-Till systems in the United States**

Tillage System	----- Scenario 1 -----				----- Scenario 2 -----				----- Scenario 3 -----			
	Mean	Min.	Max.	Fuel	Mean	Min.	Max.	Fuel	Mean	Min.	Max.	Fuel
----- MMT C -----												
a. Conventional	-41	-31	-52	-121	-24	-18	-30	-87	-13	-9	-16	-67
b. Minimum	0	0	0	0	-30	0	0	0	-52	0	0	0
c. No-till	0	0	0	-6	105	80	129	-10	377	286	468	-13
d. Totals	-41	-31	-52	-157	80	62	99	-149	364	277	452	-146
Net gain/loss	-198	-188	-209		-69	-87	-50		218	131	306	

Scenarios:

1. 27% of current cropland is in conservation tillage 27% (20% in minimum till and 7% in no-till)
2. Conservation tillage increases to 57% of all cropland (=> 60 million acres in conserv- tillage).
3. Conservation tillage increases to 76% of all cropland (=> 80 million acres in conserv- tillage).

Source: Kern and Johnson (1993)

Table IV.2: Relative Carbon Gain and Potential Policy Actions for Selected Management Practices

Management Practice	Relative Carbon Possible Gain (per unit area)*	Policy Actions**
Cultivated Land		
Adoption of reduced- or no-till	M	CS, E&TA, CC
Use of winter cover crops	L	CS, E&TA
Elimination of summer fallow	M	CS, E&TA
Use of forages in rotations	M	CS, E&TA
Use of improved varieties	M	CS, E&TA
Use of organic amendments	M	CS, E&TA
Irrigation	H	CS
Set-Aside Lands		
Establish perennial grasses	H	CS, LR,
Soil/water conservation measures	H	CS, E&TA, CC
Establish forest	H	CS, LR
Restore wetlands	H	CS
Pastureland		
Improved grazing methods	M	CS, E&TA
Fertilizer applications	M	CS, E&TA
Use of improved species/varieties	M	CS, E&TA
Irrigation	M	CS

Source: Except for restoring wetlands, assessments of relative carbon gain are from Bruce et al. (1998)

* H = high, M = medium, L = low

** CS = cost share (paying all or part of the costs of implementing the practice – cost could be defined to include lost income). CC= conservation compliance (requires land owner to participate in a market transition, commodity support, or other government program with economic benefits). E&TA = education and technical support (requires that the practice be profitable). LR = land retirement (providing payments, usually annual, for land to be put into specific uses).

References

- Adams, R.M., B. McCarl, D. Dudek, and J. Glyer. 1988. "Implications of Global Climate Change for Western Agriculture," *Western Journal of Agricultural Economics* 13(2):348-356.
- Adams, R.M., C. Rosenzweig, R.M. Peart, J.T. Ritchie, B.A. McCarl, J.D. Glyer, R.B. Curry, J.W. Jones, K.J. Boote, and L.H. Allen. 1990. "Global Climate Change and US Agriculture," *Nature*, 345:219-223.
- Adams, R.M., D.M. Adams, J.M. Callaway, C.C. Chang, and B.A. McCarl. 1993. Sequestering Carbon on Agricultural Land: Social Cost and Impacts on Timber Markets. *Contemporary Policy Issues* 11(1):76-87.
- Adams, R.M., R.A. Fleming, C.-C. Chang, B.A. McCarl, and C. Rosenzweig. 1995. "A Reassessment of the Economic Effects of Global Climate Change on U.S. Agriculture." *Climatic Change* 30(2):147-167.
- Adams, R.M., B.H. Hurd, and J. Reilly. 1999. *A Review of Impacts to U.S. Agricultural Resources*. Pew Center on Global Climate Change, Arlington, VA.
- Adams, R.M., B.A. McCarl, K. Segerson, C. Rosenzweig, K.J. Bryant, B.L. Dixon, R. Conner, R.E. Evenson, and D. Ojima. 1999. "Economic effects of climate change on US agriculture," Ch. 2 in R. Mendelsohn and J. Neumann, eds.. *The Impact of Climate Change on the United States Economy*, Cambridge University Press, Cambridge, pp. 18-54.
- Administration Economic Analysis. 1998. *The Kyoto Protocol and the President's Policies to Address Climate Change: Administration Economic Analysis*. Washington, DC.
- Bluhm, George, C. , Roger K.Conway, Vernon O. Ronigen, and Hossein Shapouri.1995. The Economic of Biomass and Biomas-Derived Energy and Fuels. In: Proceeedings of the Second Biomass Conference of the Americas, Portland, OR. . NREL, Golden, CO. August .
- Brown, Robert, A., Norma J. Rosenberg, William E. Easterling III, and Cynthia Hays. *Potential Production of Switchgrass and Traditional Crops under Current and Greenhouse-Altered Climate in the "MINK" Regional of the Central United States*. Pacific Northwest National Laboratory, Report to Texas A&M under Subcontract 22203, April, 1998.
- Bruce, J.P., M. Frome, E. Haites, H. Janzen, R. Lal, and K. Paustian. 1998. *Carbon Sequestration in Soils*. Presented at the Soil and Water Conservation Society's Carbon Sequestration in Soils Workshop, Calgary, Alberta, Canada, May 21-22, 1998.
- Burfisher, M. E., R.M. House, S.V. Langley. 1992. "Effects of a Free Trade Agreement on U.S. and Southern Agriculture," *Southern Journal of Agricultural Economics*, July 1992:61-78.
- Charles River Associates. 1998. *How Much Could Kyoto Really Cost? A Reconstruction and Reconciliation of Administration Estimates*. Washington, DC.
- Darwin, R.F. 1999. "A FARMer's View of the Ricardian Approach to Measuring Agricultural Effects of Climatic Change." Forthcoming in *Climatic Change*.
- Darwin, R.F. 1998a. "Climate Change and U.S. Agriculture: Results from Transient Scenarios." Draft working paper.

Darwin, R.F. 1998b. "Economic Effects of CO₂ Fertilization of Crops." Draft working paper.

Darwin, R. F. 1997. "World Agriculture and Climate Change: Current Questions." *World Resource Review* 9(1):17-31.

Darwin, R.F., J. Lewandrowski, B. McDonald, and M. Tsigas. 1994. "Global Climate Change: Analyzing Environmental Issues and Agricultural Trade within a Global Context," in Sullivan, J., ed. *Environmental Policies: Implications for Agricultural Trade*. (Foreign Agricultural Economic Report Number 252). U.S. Department of Agriculture, Economic Research Service, Washington, DC.

Darwin, R.F., M. Tsigas, J. Lewandrowski, and A. Raneses. 1995. *World Agriculture and Climate Change: Economic Adaptations*. (Agricultural Economic Report Number 703). U.S. Department of Agriculture, Economic Research Service, Washington, DC.

DRI/McGraw Hill. 1997. *The Impact of Carbon Mitigation Strategies on Energy Markets, the National Economy, Industry, and Regional Economies*. Report prepared for UMWA-BCOA., Lexington, MA.

Easterling, W.E., P.R. Crosson, N.J. Rosenberg, M.S. McKenney, and K.D. Frederick. 1992. "Methodology for Assessing Regional Economic Impacts of and Responses to Climate Change: The MINK Study," Chpt. 10 in J.M. Reilly and M. Anderson, eds., *Economic Issues in Global Climate Change: Agriculture, Forestry, and Natural Resources*, Westview Press, Boulder, CO, pp. 168-199.

Edmonds, J.A., S.H. Kim, C.N. MacCracken, R.D. Sands, and M.A. Wise. 1997. *Return to 1990: The Cost of Mitigating United States Carbon Emissions in the Post-2000 Period*. Pacific Northwest National Laboratory, Battelle Memorial Institute for the U.S. Department of Energy under contract DE-AC06-76RLO 1830.

Faeth, P. 1995. *Growing Green: Enhancing the Economic and Environmental Performance of U.S. Agriculture*. World Resources Institute, Washington, D.C.

Francel, T. 1997. *Potential Economic Impact of the Global Climate Treaty on the Agricultural Sector*. American Farm Bureau Federation, Park Ridge, IL.

Gephart, D.L., H.B. Johnson, H.S. Mayeux, and H.W. Polley. 1994. "The CRP and increases in soil organic carbon." *Journal of Soil and Water Conservation* 49(5):488-492.

Greco, S., R.H. Moss, D. Viner, and R. Jenne. 1994. *Climate Scenarios and Socioeconomic Projections for IPCC WG II Assessment*. Intergovernmental Panel on Climate Change Working Group II, Washington, DC.

Green, R.C., and J.M. Price. 1987. "Estimates of Short-run Price Elasticities for Major U.S. Field Crop and Livestock Commodities Using FAPSIM." Unpublished manuscript. U.S. Department of Agriculture, Economic Research Service, Washington, DC.

Heimlich, R.E., K.D. Wiebe, R. Claassen, and R.M. House. 1997. "Recent Evolution of Environmental Policy: Lessons from Wetlands." *Journal of Soil and Water Conservation*. 52(3)(1997): 157-61.

Helsel, Z.R. 1992. "Energy and Alternatives for Fertilizer and Pesticide Use," Chapter 13 in Energy in Farm Production, ed. R.C. Fluck. Elsevier, New York.

- Holte, Susan. 1998. (DOE/EIA emissions specialist.) Personal communication for adjustments in Btu/Carbon conversions for incomplete combustion.
- Horner, G., Hatchett, S.A., House, R.M., and Howitt, R.E. 1990. "Impacts of San Joaquin Valley Drainage-Related Policies on State and National Agricultural Production," in *National Impact of Drainage-Related Policies*, University of California and San Joaquin Valley Drainage Program, University of California-Davis.
- House, R. M. 1987. "USMP Regional Agricultural Model." NED Working Paper, U.S. Department of Agriculture, Economic Research Service, Washington, DC.
- House, R., M. Peters, H. Baumes, and W.T. Disney. 1993. *Ethanol and Agriculture: Effect of Increased Production on Crop and Livestock Sectors*. (AIB-667, May 1993). U.S. Department of Agriculture, Economic Research Service, Washington, DC.
- Howitt, R.E., 1995. "Positive Mathematical Programming." *American Journal of Agricultural Economics*. 77(2):329-42.
- Huang, K.S. 1993. *A Complete System of U.S. Demand for Food*. (Technical Bulletin 1821). U.S. Department of Agriculture, Economic Research Service, Washington, DC.
- Interagency Analytical Team. 1997. *Economic effects of global climate change policies*. Draft. Washington, DC.
- Jacoby, H.D. et al. 1997. "CO₂ emissions limits: economic adjustments and the distribution of burdens." *Energy Journal* 18(3):31-58. [Full citation (all authors)]
- Johnson, M., and J. Kern. 1991. *Sequestering Carbon in Soils: A Workshop to Explore the Potential for Mitigating Global Climate Change*. Proceedings of workshop held February 26-28, 1990 in Corvallis Oregon. (EPA/600/3-91/031, April 1998) USEPA Environmental Research Laboratory, Corvallis, Oregon.
- Kaiser, H.M., S.J. Riha, D.S. Wilks, D.G. Rossiter, and R. Sampath. 1993. "A Farm-Level Analysis of Economic and Agronomic Impacts of Gradual Warming." *American Journal of Agricultural Economics* 75(2):387-398.
- Kane, S., J. Reilly, and J. Tobey. 1991. *Climate Change: Economic Implications for World Agriculture*. (Agricultural Economic Report No. 647) U.S. Department of Agriculture, Economic Research Service, Washington, DC.
- Kern, J., and M. Johnson. 1993. "Conservation Tillage Impacts on National Soil and Atmospheric Carbon." *American Journal of the Soil Science Society* 57(1):200-210.
- Lal, R., J.M. Kimble, R.F. Follett, C.V. Cole. 1998. *The Potential of U.S. Cropland to Sequester Carbon and Mitigate the Greenhouse Effect*. Ann Arbor Press. Chelsea, MI.
- Lewandowski, J., and D. Schimmelpfennig. 1999. "Economic Implications of Climate Change for U.S. Agriculture: Assessing Recent Evidence." Forthcoming in *Land Economics*.
- Manne, Alan and Richard Richels. 1997. "On stabilizing CO₂ concentrations – cost-effective emission reduction strategies." Working paper.
- McCarl, B., M. Gowen, and T. Yeats. 1997. *An Impact Assessment of Climate Change Mitigation Policies and Carbon Permit Prices on the U.S. Agricultural Sector*. (Draft Technical Memo) U.S.

Environmental Protection Agency.

McCarl, B.A. and T.H. Spreen. "Price Endogenous Mathematical Programming As a Tool for Sector Analysis," *American Journal of Agricultural Economics*, February 1980:87-102.

Mendelsohn, R., W. Nordhaus, and D. Shaw. 1994. "The Impact of Global Warming on Agriculture: A Ricardian Analysis." *American Economic Review* 84(4):753-771.

Miller, T., Sharples, J., House, R., Moore, C. 1985. *Increasing World Grain Market Fluctuations: Implications for U.S. Agriculture*, (AER-541, October 1985) U.S. Department of Agriculture, Economic Research Service, Washington, DC.

Moulton, R.J. and K.R. Richards. 1990. *Costs of Sequestering Carbon through Tree Planting and Forest Management in the United States*. (General Technical Report WO-58). U.S. Department of Agriculture, Forest Service, Washington, DC.

National Oceanic and Atmospheric Administration. U.S. Climate Division.
Temperature-Precipitation-Drought Data.

Paustian, K., J. Cipro, C.V. Cole, E.T. Elliott, K. Killian, and G. Bluhm. 1996. "The Contribution of Grassland CRP to C Sequestration and CO₂ Mitigation." Paper submitted to *Journal of Production Agriculture*.

Parks, P.J. and I.W. Hardie. 1995. "Least-Cost Forest Carbon Reserves: Cost-Effective Subsidies to Convert Marginal Agricultural Land to Forests." *Land Economics* 71(1):122-136.

_____, 1996. "Forest Carbon Sinks: Costs and Effects of Expanding the Conservation Reserve Program." *Choices*, Second Quarter:37-39.

Perry, Janet, David Banker, and Robert Green. 1999. *Broiler Farms' Organization, Management and Performance*. (March, 1999) USDA, Economic Research Service, Agricultural Information Bulletin 748. Washington, DC.

Peters, M.E., McDowell, F.H., House, R.M. 1997. "Environmental and Economic Effects of Taxing Nitrogen Fertilizer," Selected paper presented at the American Agricultural Economics Association annual meetings (July 1997), Toronto, Canada.

Reicosky, D.C. 1995. "Impact of Tillage on Soil as a Carbon Sink," in *Farming for a Better Environment: A White Paper*. Soil and Water Conservation Society. Ankeny, IA.

Reicosky, D.C., W.D. Kemper, G.W. Langdale, C.L. Douglas Jr., and P.E. Rasmussen. 1995. "Soil Organic Matter Changes Resulting from Tillage and Biomass Production." *Journal of Soil and Water Conservation* 50(1):253-261.

Richards, K.R. 1992. "Derivation of Carbon Yield Figures for Forestry Sequestration Analyses." Draft working paper.

Rosenzweig, C., and M. Parry. 1994. "Potential Impact of Climate Change on World Food Supply." *Nature* 367:133-138.

Rosenzweig, C., M. Parry, K. Frohberg, and G. Fisher. 1993. *Climate Change and World Food Supply*. (Research Report No. 3). University of Oxford, Environmental Change Unit, Oxford.

Schimmelpfennig, D., J. Lewandrowski, J. Reilly, M. Tsigas, and I. Parry. 1996. *Agricultural Adaptation to Climate Change: Issues of Longrun Sustainability*. (Agricultural Economic Report 740). U.S. Department of Agriculture, Economic Research Service, Washington, DC.

Schlesinger, M.E., N. Andronova, A. Ghanem, S. Malyshev, T. Reichler, E. Rozanov, W. Wang, and F. Yang. 1997. *Geographical Scenarios of Greenhouse-Gas and Anthropogenic-Sulfate-Aerosol Induced Climate Changes*. University of Illinois at Urbana-Champaign, Department of Atmospheric Sciences, Climate Research Group, Urbana-Champaign, IL.

Sellers, P.J., L. Bounoua, G.J. Collatz, D.A. Randall, D.A. Dazlich, S.O. Los, J.A. Berry, I. Fung, C.J. Tucker, C.B. Field, and T.G. Jensen. 1996. "Comparison of Radiative and Physiological Effects of Doubled Atmospheric CO₂ on Climate." *Science* 271:1402-1406.

Sparks Companies, Incorporated. 1997. *Carbon Emissions Constraints: Potential Impacts on US Agriculture*. McLean, VA.

Spinelli, F., W.T. Disney, J. Blackwell, and H. Metcalf. "U.S. Economic Impact of Uncooked Beef Imports from Argentina," Selected paper presented at the American Agricultural Economics Association annual meetings (July 1996), San Antonio, TX.

Stavins, R.N. 1998. "The Costs of Carbon Sequestration: A Revealed-Preference Approach." Forthcoming in *American Economic Review*.

Turnure, J., Winnett, S., Shackleton, R., and W. Hohenstein. 1995. Biomass Electricity: *Long-Run Economic Prospects and Climate Policy Implications*. In: Proceedings of the Second Biomass Conference of the Americas, Portland, OR. . NREL, Golden, CO. August .

U.S. Department of Agriculture, Economic Research Service. 1999. *Agricultural Outlook*. (April 1999), Washington, DC.

_____. 1998a. *Economic and Environmental Benefits and Costs of Conservation Tillage*. Report to Congress by the Economic Research Service, in collaboration with the Natural Resources Conservation Service, Washington, DC. **(we will need a 1998a, 1998b, and 1998c here)**

_____. 1998b. *Agricultural Outlook*. (March, July, and September 1998), Washington, DC.

_____. 1998c. Webpage <http://www.econ.ag.gov/briefing/fbe/car/car.htm>. Washington, DC.

_____. 1997d. *Agricultural Resources and Environmental Indicators, 1996-97*. Agricultural Handbook Number 712, Washington, DC.

_____. *Farm Costs and Returns (FCRS) and Agricultural Resource Management Study (ARMS) Data*.

_____. 1992. *Cropping Practice Survey Data*.

U.S. Department of Agriculture, National Agricultural Statistics Service. *Crops County Data*.

U.S. Department of Agriculture, Natural Resources Conservation Service. *1987 and 1992 National Resources Inventory Data*.

U.S. Department of Agriculture, World Agricultural Outlook Board. 1997. *Agricultural Baseline*

Projections to 2005, Reflecting the 1996 Farm Act. (Staff Report WAOB-97-1). Washington, DC

U.S. Department of Energy, Energy Information Agency. 1997. *Annual Energy Review*. Washington, DC.
(we will need a 1997a, 1997b, 1997c, and 1997d here)

_____. 1997. *Annual Energy Outlook 1998 with projections to 2020*. (DOE/EIA--0383(98), December 1997). Washington, DC.

_____. 1997. *Emissions of Greenhouse Gases in the United States -1996*, (DOE/EIA-0573(96), October 1997). Washington, DC.

_____. 1997. *Service Report: Analysis of Carbon Stabilization Cases*. Department of Energy, Office of Policy Analysis and Forecasting, Washington, DC.

_____. 1995. "Annual Electric Generator Report," in *The Electric Power Annual*, Vol. 1, tables 6-8. Washington, DC.

U.S. Environmental Protection Agency. 1998. *Inventory of U.S. Greenhouse Gas Emission and Sink: 1990-1996*. (USEPA 236-R-98-006, March 1998), Washington, DC.

Uri, Noel D. and M. Gill. The Agricultural Demand for Electricity in the United States, *International Journal of Energy Research*, Vol. 19, 145-157 (1995).

WEFA Inc. 1998. *Global Warming: The High Cost of the Kyoto Protocol—National and State Impacts*. WEFA Inc., Burlington, MA.

Wiebe, K., A. Tegene, and B. Kuhn. 1996. *Partial Interest in Land: Policy Tools for Resource Use and Conservation*. (Agricultural Economic Report No. 744). U.S. Department of Agriculture, Economic Research Service, Washington, DC. [wrong spelling of Wiebe in text]

Wiese, A.M. 1998. *Impacts of Market-Based Greenhouse Gas Emission Reduction Policies on U.S. Manufacturing Competitiveness*. Research Study #090 American Petroleum Institute. Washington, DC.

Williams, J.R., P.T. Dyke, W.W. Fuchs, V.W. Benson, O.W. Rice, and E.D. Taylor; and Sharpley, A.N. and J.R. Williams, eds. 1990. *EPIC- Erosion/Productivity Impact Calculator, Vols. 1 and 2*. USDA, Agricultural Research Service. (Technical Bulletin Number 1768). Temple, TX.

Appendix 1: Impacts under Alternative Carbon Prices

Several studies reported in Chapter 2 conclude carbon prices will be greater than those predicted in the Administration's Economic Analysis (AEA, 1998). While these analyses are not consistent with the provisions of the protocol, these higher carbon prices have been used in the several analysis of the agricultural sector. For comparison, we provide multipliers for interested readers to compute the agricultural sector impacts for a range of carbon prices. Appendix tables A1.1 to A1.4 report multipliers which can be used to calculate the economic impacts for selected variables for every \$50.00 increase in the price of carbon.

Using the multipliers. For example, in table A1.3, Net Cash Returns for Crops and Livestock projected to be \$74,214.9 million in 2010. Using the multiplier, Net Cash Returns with a \$50 carbon permit price would be \$73,450.9 million (which is the base level \$74,214.9 million plus the multiplier, -\$763.3 million). Or, assuming a \$10 carbon permit price we can estimate that Net Cash Returns would decline by \$152.66 million to \$74,062.24 million ($\$74,214.9 - (\$10/\$50) * \$763.3$ million). Multipliers are presented for crop prices and production, crop domestic use and exports, income, total expenses, and welfare measures.

While the impacts on the sector increase as carbon prices increase, even with higher carbon prices, the impacts on the agricultural sector remain far below those predicted in recent studies such as Sparks (1999). This is because our analysis more accurately reflects the carbon content in farm production inputs and takes into consideration market adjustments.

Stavins estimates a marginal cost function for carbon sequestration through forestry that extends to 342 million acres of land sequestering 518 million tons (470 million metric tons) of carbon per year. Stavins' results at lower levels are similar to those

of Parks and Hardie. But upon reaching 342 million acres of land, annual average costs are \$106 per acre and \$70 per ton (\$77 per metric ton) of carbon, and marginal costs are \$200 per acre and \$136 per ton (\$150 per metric ton) of carbon.

Stavins estimates that marginal costs are roughly linear until reaching about \$66 per ton (\$73 per metric ton) or \$100 per acre, after which marginal costs increase rapidly. Thus, Stavins provides demonstrates the need for caution in extrapolating costs from relative low levels of land conversions to higher levels.

Appendix 1, Table 1: 2010 key variables under Kyoto Protocol and multipliers for alternate carbon permit price

Item	Unit	2010 base level	\$23/ton permit price	change per \$50 permit price change ¹
Supply and Use Indicators				
Commodity Price		--dollars/unit--		
Corn	Bushel	3.20	3.22	0.04137
Sorghum	Bushel	3.00	3.02	0.04985
Barley	Bushel	2.85	2.88	0.04955
Oats	Bushel	1.90	1.91	0.02900
Wheat	Bushel	4.65	4.66	0.02717
Rice	Hundred-w eight	12.87	12.98	0.23135
Soybeans	Bushel	7.55	7.56	0.01361
Cotton	Bale	NA ²	NA	3.00029
Silage	Ton	21.66	21.67	0.01776
Hay	Ton	60.53	60.61	0.08300
Production		--million units--		
Corn	Bushel	11776.2	11756.5	-43.64565
Sorghum	Bushel	770	766.1	-8.46810
Barley	Bushel	450	447.3	-4.16688
Oats	Bushel	293.7	292.8	-2.28620

Item	Unit	2010 base level	\$23/ton permit price	change per \$50 permit price change ¹
Wheat	Bushel	2828	2821.6	-17.17149
Rice	Hundred-w eight	206.4	204.4	-4.14855
Soybeans	Bushel	3144.2	3140.9	-7.24297
Cotton	Bale	21.3	21.2	-0.20408
Silage	Ton	95.6	95.4	-0.52743
Hay	Ton	155.6	154.9	-0.83345
Domestic Use		--million units--		
Corn	Bushel	1675.04	1674.32	-1.5148
Sorghum	Bushel	35.00	34.77	-0.4892
Barley	Bushel	172.00	171.50	-0.7778
Oats	Bushel	102.00	101.93	-0.1559
Wheat	Bushel	1146.00	1145.77	-0.6035
Rice	Hundred-w eight	7.00	6.98	-0.0420
Soybeans	Bushel	152.17	152.12	-0.10410
Cotton	Bale	13.20	13.16	-0.1090
Silage	Ton	27.52	27.43	-0.2079
Hay	Ton	79.22	78.66	-0.59850

	Item	Unit	2010 base level	\$23/ton permit price	change per \$50 permit price change ¹
Exports					
	Corn	Bushel	3250.56	3239.95	-22.2636
	Sorghum	Bushel	335.01	331.94	-6.5183
	Barley	Bushel	70.00	69.00	-1.5433
	Oats	Bushel	2.00	1.99	-0.0240
	Wheat	Bushel	1625.04	1619.25	-15.32570
	Rice	Hundred-w eight	85.40	83.65	-3.73210
	Soybeans	Bushel	1149.74	1148.99	-1.5206
	Cotton	Bale	8.00	7.97	-0.0749
	Silage	Ton	0.00	0.00	0.0000
	Hay	Ton	0.00	0.00	0.0000
Income/expense Indicators					
--million dollars --					
-- Crops --					
	Value of Production		100,530.10	134.90	276.93
	Conservation Reserve		933.10	0.00	0.00
	Payments				
	Production Flexibility		4,009.70	0.00	0.00
	Payments				

Item	Unit	2010 base level	\$23/ton permit price	change per \$50 permit price change ¹
Total variable costs		55,037.70	448.40	940.42
Net cash returns		50,435.20	-313.50	-663.49
-- Livestock --				
Value of Production		117,329.30	314.70	657.34
Total variable costs		93,549.60	372.50	757.15
Net cash returns		23,779.70	-57.80	-99.81
-- Crops and Livestock --				
Value of Production		217,859.40	449.60	934.28
Total variable costs		148,587.30	820.90	1,697.57
Net cash returns		74,214.90	-371.40	-763.29
Welfare Measures				
Producer Surplus		1,096,957	1,096,540	-888.81
Net farm cash returns		74,215	73,844	-764.24
Consumer surplus		822,239	821,865	-798.90
Consumer and producer surplus		1,919,196	1,918,405	-1690.10
Revenue transfers out of agriculture		442	3,082	1511.33
Net social benefit		1,919,196	1,919,129	-189.18

Item	Unit	2010 base level	\$23/ton permit price	change per \$50 permit price change ¹
Net foreign surplus		54,409	54,281	-277.03

¹ Amount by which the selected variable changes for each \$50 change in carbon permit price.

² USDA is prohibited from publishing cotton price projections.

Appendix 2. Energy Use in Agriculture

Agricultural energy uses comprise on-farm direct uses of fuels and electricity to operate vehicles, machinery, irrigation, and drying systems; indirect uses of energy in manufactured fertilizers and pesticides; and uses of energy in hired or purchased services. Energy is included in smaller proportion in other expenses including commodity transportation, hired custom and machine work, and purchased feed. Agricultural fossil fuel use peaked in 1978, declining in response to the oil price shocks of the 1970s and early 1980s (TableA.1). By 1993, fossil energy use declined by 25 percent, but electricity use increased by about 17 percent (ERS, 1997).

Major factors in agricultural use of refined petroleum products and electricity use are planted acreage and irrigated acreage (ERS, 1997; and Uri and Gill;). Irrigated land in farms increased from 46.4 to 53.3 million acres between 1987 and 1996 (TableA.2). Planted acres in 1990-96 averaged 337 million acres with a low of 330 million acres in 1993 and a high of 346 million acres in 1996. More energy efficient diesel machinery and reduced tillage systems have allowed diesel use to be maintained at about 1978 levels while reducing gasoline use by over half. Estimated electricity use increases are consistent with increased irrigated acres. Uses of nitrogen fertilizer, the most energy intensive nutrient, increased by about 10 percent, phosphorous declined by a similar amount. Potash and pesticide use levels show little change until 1994, with pesticides increasing by 14 percent in one year.

U.S. Farm Sector Income and Energy Expenses. U.S. agriculture commodity cash receipts

are about \$203 billion (1996 through the 1998¹), about 53 percent from crops and 47 from livestock (Table A.3). The crop proportion is slightly higher than the 51 percent share from 1989 through 1998. Energy related expenses are about \$40-41 billion per year (1996 through 1998). The energy-related share of the U.S. farm sector cash expenses averaged about 24 percent from 1989 through 1998, showing a slight increase since 1994. This increase is consistent with the increases in planted and irrigated crop land.

Manufactured inputs include fuels, oils, and fertilizers and other agricultural chemicals. Annual manufactured input expenses are around \$29 billion (1996 through 1998). Manufactured inputs accounted for about 17 percent of U.S. farm cash expenses from 1989 through 1998, and with a slight increase since 1994. This increase is driven by rising expenditures for fertilizer and pesticides. The direct energy share of cash expenses has declined slightly since 1994 to about 5.5 percent. Expenditures for other energy intensive inputs have averaged about \$12 billion per year since 1994. This category includes "machine hire and custom operations" and "marketing, storage, and transportation."

Adjustments can be expected in input usage with long-run shifts in relative prices and changes in technology. Machine hire and custom work can substitute for farm owned and operated machinery and its attendant direct energy expenditures. Past and future shifts in custom expenditures could be associated with greater efficiency in the use of machinery, labor, and energy. The shift to reduced tillage has reduced direct energy expenditures and increased pesticide expenditures. The extent of irrigated acres and quantity of irrigation water applied is

¹Values for 1998 are USDA-ERS forecasts.

related to costs of pumping and the returns to irrigation, and over time efficiency gains have occurred with irrigation (ERS, 1997).

Crop Enterprises. Expenditures for direct energy, chemicals, and on other energy intensive inputs range between about 30 and 75 percent of total crop cash expenses (TableA.4). As a share of total cash expenditures, this sum is quite stable across each crop's reporting regions. Of three input groups, chemical expenditures show the least variation in expenditure shares, followed by direct energy. Corn and wheat are cases in point, with significant variation in direct energy and chemical expenditures, but with little variation in the energy-intensive share of total expenditures.

Irrigation accounts for higher magnitude expenses and revenues for Plains States corn and Pacific wheat, but the energy share of total cash expenses is similar to other regions. Revenues can be affected by both yields and regional price variation. The regional variation in direct energy and chemical expenditures and shares of total cash expenses reflect the differences in production techniques and possibilities across the country. Further, the data presented are regional averages--considerable variation would be expected within regions, driven by land quality, farm type, land tenure and other factors. The regional stability of the share of direct, chemical, and other energy including expenses of total cash expenses for each crop, is hypothesized to reflect competitive profit maximizing relationships among commodity and input prices and land productivity.

The complexity and the difficulty in using cost of production budgets and returns alone to predict the effects of energy price increases on regional crop production is illustrated by corn, wheat, and soybean production in the Southeast. The high Southeastern expenditures on

fertilizer and pesticides are offset by yields or prices, to generate average or higher ratios of expenses to revenues for wheat and corn. While the ratio is higher than average for soybeans (at least for 1996), Southeast soybeans are often double cropped with wheat in rotation with corn. Further, the livestock industry in the Southeast and the eastern ports contribute to higher grain prices than in the Midwest markets. Thus it is not at all clear from budgets alone what the effects of higher energy costs will be on regional production patterns.

Livestock Enterprises. Energy related expenses as a share of total cash expenses range between about 6 and 33 percent for livestock and poultry (Tables A.5). Energy related expenses include expenditures on fuel, lubrication, and electricity; marketing and hauling; and custom services and supplies. Feed expenditures, broken out separately in ERS cost of production tables, range from 50 to 75 percent of total cash expenses. Broiler farms stand out with energy expenses ranging from 28 to 33 percent of total cash expenses, attributed to heating and cooling requirements for broiler houses. The energy share of hog expenses is 6 percent, but the animal feed expenses are 73 percent of cash expenses. Hog feed is primarily composed of feed grains and soybeans, among the highest in energy expenses.

Dairy, with cooling and milking equipment power requirements, follows with energy shares averaging about 15 percent of total cash expenses. Northeast and Southeast energy shares stand out at 19 percent, resulting from higher marketing and hauling expenses. Feed expenses as a percent total cash expenses increase with reliance on feeding grains and concentrates as opposed to forage, with the upper Midwest and Pacific regions below average. The Pacific region stands out as well with lower direct energy expenditures, consistent with its lower feed expenditures.

Cow-calf regional feed expenditure differences are mainly due to harvested forage and pasture expenses, which in turn are related to direct energy, chemical and irrigation expenses. Somewhat offsetting the South's lower feed expenditures is a higher marketing and hauling expenditure. Similarly, lower direct energy expenses in the West are more than offset by higher feed expenses. Noting the losses per bred cow in 1996 and the cyclical nature of the cattle industry, the beef industry faces longer term competitive problems with respect to pork and broilers as background for any potential energy increases (ERS, 1998).

Appendix 3, Table 1: Use of Energy Inputs in U.S. Agriculture; 1978 and 1990-94.

Year	Gasoline billion gallons	Diesel billion gallons	LP gas billion kWh	Electricity billion kWh	Nitrogen	Phosphate million pounds	Potash	Pesticide
1978*	3.6	3.2	1.3	47.6	10	5.1	5.5	0.29
1990	1.5	2.7	0.6	48.9	11.1	4.3	5.2	0.27
1991	1.4	2.8	0.6	47.9	11.3	4.2	5	0.27
1992	1.6	3.1	0.9	54.6	11.5	4.2	5	0.29
1993	1.4	3.3	0.7	55.6	11.4	4.4	5.1	0.28
1994	1.4	3.5	0.9	56.2	12.6	4.5	5.3	0.32

* 1976 pesticide value; 1980 electricity value.

Sources:

Electricity: estimated from farm expenditures data in USDA, ERS (1997; table 3.3.3, p.138) and electricity price data for industrial users in USDOE, EIA (1996; table 8.11, p. 247).

All other inputs see USDA, ERS (1997, table 3.1.1, p. 100; table 3.2.2, p.119; and table 3.3.1, p. 136).

Appendix 3, Table 2: Factors in U.S. farm demand for refined fuel, electricity, fertilizer, and pesticides

Item	1978	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Cropland											
							million acres				
Cropland used for crops \1	na	331	327	341	341	337	337	330	339	332	346
Irrigated cropland \2	50.3	46.4	na	na	na	na	49.4	49.8	51.8	52	53.3
Farm Fuel Prices, U.S. Ave. \3											
							dollars per gallon				
Gasoline	0.6	0.92	0.93	1.05	1.17	1.19	1.15	1.14	1.08	1.11	1.26
Diesel	0.46	0.71	0.73	0.76	0.95	0.87	0.82	0.82	0.77	0.77	0.92
LP gas	0.4	0.59	0.59	0.58	0.83	0.75	0.72	0.78	0.72	0.73	0.8
							cents per Kwh.				
Electricity (Retail industrial rate) \4	2.8	4.8	4.7	4.7	4.7	4.8	4.8	4.8	4.8	4.7	4.6
Fertilizer \5											
							dollars per ton				
Anhydrous ammonia (82%)	177	187	208	224	199	210	208	213	243	330	303
N solutions (30%)	118	109	137	142	132	138	141	137	137	169	182
Urea (45-46%)	169	161	183	212	184	212	198	202	207	266	278
Ammonium Nitrate (33%)	140	157	166	189	180	184	178	186	196	223	233
Ammonium Sulfate (21%)	109	144	140	154	154	151	151	157	170	182	184
Superphosphate (44-46%)	151	194	222	229	201	217	206	190	212	234	258
Potassium chloride (60% pot.)	96	115	157	163	155	156	150	146	146	155	153
Chemicals \6											
							index (1990-92 = 100)				
Chemicals price indices						101	103	107	112	115	
Herbicides						101	102	106	110	113	
Insecticides						101	104	110	117	120	
Fungicides and others						101	105	111	109	117	

\1 USDA-ERS Ag. Resources and Environmental Indicators, 1996-97, Ag. HB 712 - Table 1.1.5 Major uses of cropland, U.S. 1986-96 , p6.; and Cropland Use in 1997, AREI update No. 5 Aug. 1997, Table 1.

\2 USDA-ERS Ag. Resources and Environmental Indicators, 1996-97, Ag. HB 712 -Table 2.1.3 Irrigated land in farms, by region and crop, selected years 1969-96, p.74.

\3 USDA-ERS Ag. Resources and Environmental Indicators, 1996-97, Ag. HB 712 - p. 137, Table 3.3.2 - Avg. U.S. farm fuel prices, 1974-95.

\4 Energy Info. Admn. Annual Energy Review - Table 8.11 Retail prices of Electricity Sold by Electricity Utilities, 1960-1996, p. 247.

\5 USDA-ERS Ag. Resources and Environmental Indicators, 1996-97, Ag. HB 712 - p.109, Table 3.1.8 - Average U.S. farm prices of selected fertilizers, 1960-96.

\6 USDA-ERS Ag. Resources and Environmental Indicators, 1996-97, Ag. HB 712 - p. 127, Table 3.2.6 Selected April pesticide prices, 1991- 1995.

**Appendix 3, Table 3: Income statement and energy-related expenses for U.S. farm sector
1989-1998**

Item	Unit	1989	1990	1991	1992	1993	1994	1995	1996	1997P	1998F	Ave.	St. Dev.
Cash income statement:													
1. Cash receipts	\$ Bil.	160.8	169.5	167.9	171.3	177.7	181.2	188.1	199.6	208.3	200.6	182.5	16.1
Crops 1/	\$ Bil.	76.9	80.3	82.1	85.7	87.5	93.1	101.0	106.6	111.7	105.8	93.1	12.4
Livestock	\$ Bil.	83.9	89.2	85.8	85.6	90.2	88.2	87.0	93.0	96.6	94.8	89.4	4.2
Livestock share	Pct.	52.2	52.6	51.1	50.0	50.8	48.6	46.3	46.6	46.4	47.3	49.2	2.5
2. Direct Government payments	\$ Bil.	10.9	9.3	8.2	9.2	13.4	7.9	7.3	7.3	7.5	7.4	8.8	2.0
3. Farm-related income 2/	\$ Bil.	8.6	8.2	8.2	8.2	9.0	9.2	10.1	10.9	11.8	11.5	9.6	1.4
4. Gross cash income (1+2+3)	\$ Bil.	180.3	187.0	184.3	188.7	200.1	198.3	205.4	217.8	227.6	219.5	200.9	16.4
Cash expenses 3/	\$ Bil.	127.5	134.2	134.0	133.6	141.2	147.6	153.6	161.4	166.9	166.2	146.6	14.7
Net cash income	\$ Bil.	52.8	52.8	50.3	55.1	58.9	50.7	51.8	56.4	60.7	53.4	54.3	3.5
Farm income statement:													
Total gross income 4/	\$ Bil.	192.0	198.2	191.9	200.5	203.7	215.8	210.1	235.8	237.9	230.0	211.6	17.6
Total expenses	\$ Bil.	146.7	153.4	153.3	152.9	160.5	167.4	174.0	182.3	188.0	187.4	166.6	15.5
Net farm income	\$ Bil.	45.3	44.8	38.6	47.6	43.2	48.3	36.1	53.5	49.9	42.5	45.0	5.2
Energy-related Expenses													
<u>Manufactured inputs</u>													
Fuels and oils	\$ Bil.	4.8	5.8	5.6	5.3	5.4	5.3	5.4	6.0	6.2	6.2	5.6	0.4
Electricity	\$ Bil.	2.6	2.6	2.6	2.6	2.7	2.7	3.0	3.2	3.0	2.9	2.8	0.2
Direct Energy Expenses	\$ Bil.	7.4	8.4	8.2	7.9	8.1	8.0	8.4	9.2	9.2	9.1	8.4	0.6
Share of Cash Expenses	Pct.	5.8	6.3	6.1	5.9	5.7	5.4	5.5	5.7	5.5	5.5	5.7	0.3
Share of Total Expenses	Pct.	5.0	5.5	5.3	5.2	5.0	4.8	4.8	5.0	4.9	4.9	5.0	0.2
Fertilizer & lime	\$ Bil.	8.2	8.2	8.7	8.3	8.4	9.2	10.0	10.9	10.9	11.0	9.4	1.2
Pesticides	\$ Bil.	5.0	5.4	6.3	6.5	6.7	7.2	7.7	8.5	8.8	8.8	7.1	1.4
Chemical Expenses	\$ Bil.	13.2	13.6	15.0	14.8	15.1	16.4	17.7	19.4	19.7	19.8	16.5	2.5
Share of Cash Expenses	Pct.	10.4	10.1	11.2	11.1	10.7	11.1	11.5	12.0	11.8	11.9	11.2	0.6
Share of Total Expenses	Pct.	9.0	8.9	9.8	9.7	9.4	9.8	10.2	10.6	10.5	10.6	9.8	0.6
Total Manufactured Inputs	\$ Bil.	20.6	22.0	23.2	22.7	23.1	24.4	26.2	28.7	29.0	28.9	24.9	3.1

Share of Cash Expenses	Pct.	16.2	16.4	17.3	17.0	16.4	16.5	17.1	17.8	17.4	17.4	16.9	0.5
Share of Total Expenses	Pct.	14.0	14.3	15.1	14.8	14.4	14.6	15.1	15.7	15.4	15.4	14.9	0.6
<u>Other expenses</u>													
Machine hire & custom work	\$ Bil.	3.4	3.6	3.5	3.8	4.4	4.8	4.8	4.7	4.9	4.9	4.3	0.6
Marketing ,storage, & transport.	\$ Bil.	4.2	4.2	4.7	4.5	5.6	6.8	7.2	6.8	7.0	7.1	5.8	1.3
Total Other expenses	\$ Bil.	7.6	7.8	8.2	8.3	10.0	11.6	12.0	11.5	11.9	12.0	10.1	1.9
Share of Cash Expenses	Pct.	6.0	5.8	6.1	6.2	7.1	7.9	7.8	7.1	7.1	7.2	6.8	0.8
Share of Total Expenses	Pct.	5.2	5.1	5.3	5.4	6.2	6.9	6.9	6.3	6.3	6.4	6.0	0.7
<u>Total Energy Related Expenses</u>		28.2	29.8	31.4	31.0	33.2	36.0	38.1	40.1	40.8	40.9	35.0	4.8
Share of Cash Expenses	Pct.	22.1	22.2	23.4	23.2	23.5	24.4	24.8	24.9	24.5	24.6	23.8	1.0
Share of Total Expenses	Pct.	19.2	19.4	20.5	20.3	20.7	21.5	21.9	22.0	21.7	21.8	20.9	1.0

P = preliminary. F = forecast.

1/ Includes commodities placed under CCC loans and profits made on loans redeemed.

2/ Income from custom work, machine hire, recreational activities, forest product sales, and other farm sources

3/ Cash expenses exclude capital consumption, perquisites to hired labor, and farm household expenses from total expenses.

4/ Total gross income includes gross cash income, nonmoney income, and value of inventory change.

Source: Adapted from Tables 29 and 34 Agricultural Outlook USDA-ERS March 1998 for 1989-1993, and ERS website July 1998 update for 1994-1998.

Appendix 3, Table 4: Cash Expenses that Include Energy for U.S. Field and Horticultural Crops, 1996

Commodity	Region	Direct Energy		Chemicals		Other Inputs ¹²		Dir., Chem., Oth.		T Cash	Revenue	Expense
		\$/plt. ac.	Percent of total	\$/plt. ac.	Percent of total	\$/plt. ac.	Percent of total	\$/plt. ac.	Percent of total	\$/plt. ac.	Expns./Revenue	Percent /Revenue
Corn	United States	21.14	12.9	82.95	50.7	9.76	6.0	113.85	69.5	163.77	388.73	42.1
	Northeast	13.07	8.9	75.34	51.2	9.03	6.1	97.44	66.2	147.27	252.73	58.3
	Southeast	15.38	8.7	97.86	55.6	4.23	2.4	117.47	66.7	176.07	385.29	45.7
	North Central	13.98	9.2	83.15	54.4	9.1	6.0	106.23	69.5	152.74	370.55	41.2
	Plains States	42.67	22.1	80.53	41.6	12.67	6.6	135.87	70.3	193.4	453.78	42.6
Wheat	United States	9.71	13.9	27.34	39.1	5.35	7.6	42.40	60.6	70.01	146.94	47.6
	North Central	5.77	6.8	46.26	54.5	4.04	4.8	56.07	66.0	84.95	141.90	59.9
	Southeast	6.51	6.9	45.63	48.6	7.35	7.8	59.49	63.3	93.97	219.66	42.8
	Northern Plains	7.12	12.0	23.9	40.4	2.72	4.6	33.74	57.0	59.18	143.56	41.2
	Cen. & So. Plains	10.95	17.5	19.78	31.6	7.79	12.4	38.52	61.5	62.59	105.09	59.6
	Pacific	22.34	17.0	50.74	38.7	7.9	6.0	80.98	61.7	131.25	332.18	39.5
Soybeans	United States	9.45	11.8	35.4	44.3	3.65	4.6	48.50	60.6	80	256.36	31.2
	North Central	8.22	10.5	35.88	45.7	4.04	5.1	48.14	61.3	78.54	265.55	29.6
	Northern Plains	12.51	18.2	23.61	34.3	2.41	3.5	38.53	55.9	68.87	254.69	27.0
	Southeast	10.55	10.7	50.35	50.9	2.38	2.4	63.28	64.0	98.88	214.76	46.0
	Delta	14.06	16.3	30.49	35.3	3.88	4.5	48.43	56.1	86.37	232.47	37.2
Cotton	United States	35.67	11.9	97.51	32.6	71.76	24.0	204.94	68.6	298.78	383.84	77.8
	Southeast	24.76	8.0	138.97	45.1	74.86	24.3	238.59	77.4	308.16	536.61	57.4
	Delta	30.17	8.2	145.47	39.6	88.15	24.0	263.79	71.8	367.16	566.19	64.8
	Southern Plains	39.33	18.4	50.1	23.4	41.12	19.2	130.55	61.0	214.04	189.19	113.1
	Southwest	48.98	8.3	139.38	23.5	168.42	28.4	356.78	60.1	593.2	634.70	93.5
Rice	United States	73.03	19.7	123.96	33.4	75.71	20.4	272.70	73.4	371.61	592.70	62.7
	Ark. Non-Delta	77.04	22.8	116.83	34.6	61.72	18.3	255.59	75.7	337.58	630.01	53.6
	Miss. River Delta	77.36	24.3	116.44	36.6	46.97	14.8	240.77	75.7	318.2	588.32	54.1
	Gulf Coast	69.03	18.7	120.87	32.7	70.39	19.0	260.29	70.4	369.79	543.08	68.1
	California	65.96	13.1	150.81	30.0	144.81	28.8	361.58	71.8	503.27	744.96	67.6
Sorghum	United States	17.95	21.9	30.27	37.0	5.26	6.4	53.48	65.3	81.85	170.91	47.9
	Central Plains	12.31	16.3	32.72	43.2	4.69	6.2	49.72	65.7	75.72	193.37	39.2
	Southern Plains	25.24	28.1	27.11	30.2	5.99	6.7	58.34	65.0	89.76	141.80	63.3
Oats	United States	7.41	14.2	18.87	36.2	4.33	8.3	30.61	58.7	52.17	128.26	40.7
	Northeast	12.38	15.1	33.26	40.7	4.91	6.0	50.55	61.8	81.77	125.37	65.2
	North Central	4.19	8.2	21.38	42.0	5.75	11.3	31.32	61.6	50.85	119.06	42.7
	Northern Plains	9.78	22.2	12.55	28.5	2.42	5.5	24.75	56.2	44.06	115.37	38.2
Peanuts	United States	40.31	11.6	143.83	41.6	25.73	7.4	209.87	60.6	346.1	635.14	54.5
	VA - NC	40.05	9.8	195.14	47.8	10	2.4	245.19	60.0	408.38	832.06	49.1
	Southeast	29.7	8.2	170.14	47.0	27.13	7.5	226.97	62.6	362.3	680.56	53.2
	Southern Plains	61.09	21.7	64.93	23.1	31.5	11.2	157.52	56.1	280.97	481.58	58.3
Sugar Beets	United States	41.64	9.6	144.8	33.3	42.15	9.7	228.59	52.5	435.18	746.61	58.3
	Great Lakes	22.77	7.7	131.49	44.2	28.35	9.5	182.61	61.4	297.2	439.68	67.6
	Red River Valley	21.87	6.7	112.8	34.7	24.88	7.6	159.55	49.0	325.43	698.52	46.6
	Great Plains	53.53	11.1	167.75	34.8	38.86	8.1	260.14	54.0	481.49	692.29	69.6
	Northwest	95.71	14.0	208.57	30.4	49.18	7.2	353.46	51.6	685.53	1017.37	67.4
	Southwest	65.27	8.1	197.3	24.4	195.95	24.3	458.52	56.8	807.69	1246.62	64.8
Sugarcane	United States	29.80	4.3	135.26	19.6	70.30	10.2	235.36	34.1	690.16	979.40	70.5
	Florida	23.79	3.1	119.15	15.7	104.81	13.8	247.74	32.6	760.95	1040.40	73.1
	Hawaii	93.51	3.7	450.15	17.8	62.57	2.5	606.23	24.0	2526.63	2645.37	95.5
	La/Texas	29.73	7.2	119.48	29.1	31.89	7.8	181.09	44.1	410.67	727.00	56.5
		\$ mil.	percent	\$ mil.	percent	\$ mil.		percent	percent	\$ mil.	\$ mil.	percent
Horticultural	United States	2386	9.8	2275	9.4	2874	11.8	7535.31	31.0	24308	38497	63.1

¹¹ Total cash expenses for commodities include cash expenses as reported in ERS Cost of Production tables.

¹² Other expenses that embody energy include custom costs for all commodities, cotton ginning, rice and peanut drying, and marketing, storage, and transport costs for horticultural products.

¹³ Expenses including energy as a proportion of cash expenses.

¹⁴ Revenue per acre is yield times price. Revenue for horticultural farms is gross cash income, of which \$38540.9 mil. (95 percent) is generated by vegetable, fruit, greenhouse, and nursery sales.

Sources: USDA-ERS webpage, <http://www.econ.ag.gov/briefing/1be/car/car.htm>, and USDA-ERS-RED-FSP.

Appendix 3, Table 5: Cash Expenses that Include Energy for U.S. Livestock Enterprises (1996) and Broiler Farms (1995)

Enterprise	Region	Fuel, Lub., & Elec.		Marketing & Hauling		Custom Serv. & Sup.		Energy\2	Animal Feed		Total Cash	Revenue
		Expense	Share of Total	Expense	Share of Total	Expense	Share of Total	Share of Total	Expense	Share of Total	Expenses	
Dairy		\$ per		\$ per		\$ per			\$ per		\$ per	\$ per
		cwt. milk	percent	cwt. milk	percent	cwt. milk	percent	percent	cwt. milk	percent	cwt. milk	cwt. milk
	United States	0.53	4.6	0.80	7.0	0.42	3.7	15.2	7.53	65.5	11.49	14.78
	Northeast	0.7	5.6	1.13	9.0	0.54	4.3	18.9	7.46	59.6	12.51	15.19
	Southeast	0.34	2.6	1.49	11.2	0.65	4.9	18.7	8.12	61.2	13.27	17.41
	Upper Midwest	0.62	5.5	0.50	4.5	0.34	3.0	13.0	7.17	64.1	11.19	14.74
	Corn Belt	0.58	4.7	0.74	5.9	0.38	3.0	13.6	8.35	67.0	12.47	14.88
	Southern Plains	0.49	4.0	0.85	6.9	0.31	2.5	13.4	9.09	74.1	12.27	15.10
Pacific	0.28	2.8	0.83	8.2	0.40	4.0	15.0	7.25	71.9	10.08	13.89	
Cow-calf		\$ per		\$ per		\$ per			\$ per		\$ per	\$ per
		bred cow	percent	bred cow	percent	bred cow	percent	percent	bred cow	percent	bred cow	bred cow
	United States	23	6.7	8.34	2.4	0.00	0.0	9.2	212.17	62.2	341.28	287.42
	North Central	28.2	10.0	5.28	1.9	0.00	0.0	11.9	157.99	56.1	281.41	281.43
	South	22.76	8.2	10.97	4.0	0.00	0.0	12.2	140.66	50.9	276.23	216.17
	Great Plains	24.95	6.8	7.45	2.0	0.00	0.0	8.9	232.23	63.6	365.30	319.70
West	17.54	4.5	8.93	2.3	0.00	0.0	6.9	266.69	69.1	386.12	298.98	
Hogs		\$ per		\$ per		\$ per			\$ per		\$ per	\$ per
		cwt. gain	percent	cwt. gain	percent	cwt. gain	percent	percent	cwt. gain	percent	cwt. gain	cwt. gain
	United States	1.83	3.8	0.59	1.2	0.51	1.1	6.1	35.48	74.1	47.86	60.16
	North	1.84	3.8	0.56	1.2	0.47	1.0	6.0	35.62	74.3	47.97	59.58
South	1.78	3.7	0.70	1.5	0.64	1.3	6.6	34.98	73.6	47.50	62.12	
Broiler Farms \3		\$ per farm \4	percent	\$ per farm \5	percent	\$ per farm	percent	percent	\$ per farm \6	percent	\$ per farm	\$ per farm
	Appalachia	9871	22.3	na	na	1450	3.3	25.6	na	na	44225	78543
	Southeast	17731	28.1	na	na	3213	5.1	33.2	na	na	63055	93076
	Delta	11024	26.0	na	na	2694	6.4	32.4	na	na	42325	77041
	Other regions	8515	13.5	na	na	917	1.5	15.0	na	na	63027	95165
	United States	12529	23.4	na	na	2713	5.1	28.5	na	na	53446	84048
with gross cash income > \$50,000												

\1 Total cash expenses for enterprises include cash expenses as reported in ERS Cost of Production tables for 1996.

\2 Energy-related expenses as a proportion of cash expenses.

\3 Broiler farm revenues are 1995 gross cash income, including other livestock and crop-related income.

Broilers comprise 74 percent of Appalachia gross cash income, 76 percent of Southeast, 89 percent of Delta, and 77 percent of U.S. farms with income over \$50,000.

\4 Broiler farm fuel, lub, and electricity includes telephone expenses.

\5 Marketing and hauling is included as "Other variable expenses", defined as "Supply, transportation, storage, and general business expenses, and registration fees."

For the U.S. farms, "Other variable cost" is \$2483 about 20 percent of fuel, lube, and electricity.

\6 Sufficient detail not available for feed cost presentation.

Sources: USDA-ERS webpage, <http://www.econ.ag.gov/briefing/lbe/car/car.htm>, and Perry, Janet, David Banker, Robert Green, Broiler Farms': Organization, Management, and Performance, AIB 748, USDA, ERS, March, 1999, Table 10.

Appendix 3. USMP Regional Agricultural Model

The U.S. Regional Agricultural Sector Model (USMP) is designed for general purpose economic, environmental, and policy analysis of the U.S. agriculture sector². USMP is linked with regularly-updated USDA production practices surveys, the USDA multi-year baseline (USDA, WAOB, 1997), and geographic information system (GIS) databases such as the National Resources Inventory (USDA, NRCS). USMP predicts how changes in farm, resource, environmental, or trade policy, commodity demand or technology will affect regional supply of crops and livestock, commodity prices and demand, use of production inputs, farm income, government expenditures, participation in farm programs, and environmental indicators (such as erosion, nutrient and pesticide loadings, greenhouse gases and others). An agriculture sector spatial equilibrium model (as described in McCarl and Sreen), USMP incorporates agricultural commodity supply, use, and policy measures (House), as well as natural resource and environmental impacts derived through biophysical models (Faeth).

² USMP is designed and maintained by Robert House, Mark Peters, and Howard McDowell of the USDA/Economic Research Service/Resource Economics Division. USMP is modeled in the General Algebraic Modeling Language (GAMS) as a nonlinear programming problem with solutions obtained using the MINOS nonlinear optimizer solver. USMP consists of some 2000 equations (of which 550 are nonlinear) and 5400 variables (900 nonlinear). Links with geographic information system (GIS) databases on the input data and output results sides of USMP further disaggregate the economic and environmental impact analyses supported by USMP.

Baseline validation; demand and supply response. USMP does not make dated forecasts or projections. Instead, acreage, supply/use, prices, production practices, environmental loadings and so forth are validated exactly to any USDA baseline year or recent historical year (e.g. between 1988 and 2005) and corresponding geographic information. For example, for scenario analysis with a 2001 base year, USMP's base U.S. corn acreage planted equals the USDA baseline's 2001 projection (80.5 million acres), and corn acreage in each model region/practice strata is determined by share information from NRI and USDA Cropping Practices Survey (CPS) regional data. From there, comparative static adjustments to the scenario "shock" (e.g. a policy change) explain how the sector changes (through both aggregate indicators such as U.S. farm income and detailed indicators such as acreage in corn-bean rotation using mulch tillage in the central Corn Belt) between the base period and several years later when the change has worked itself out and the sector returns to equilibrium. USMP acreage planted/commodity supply response uses a positive mathematical programming (PMP) formulation (Howitt) with U.S. aggregate commodity supply response calibrated to supply response elasticities from the FAPSIM econometric simulation model (Green and Price)³. Responses in individual region, tillage practice, rotation and other strata follow nested adjustment functions which are part of the PMP calibration, and sum up to aggregate response. No bounds or flexibility constraints are used.

Commodity coverage. USMP models production of 10 crops: corn, sorghum, oats, barley, wheat, rice, cotton, soybeans, hay and silage. Fruits and vegetables are not modeled in USMP.

³The Food and Agricultural Policy Simulator (FAPSIM) is an annual econometric model of the U.S. farm sector, designed and maintained by J. Michael Price of the USDA's Economic Research Service.

Some 16 primary livestock production enterprises are included, the principal being dairy, swine, beef cattle, and poultry. USMP commodity coverage comprises about 75 percent of the value of U.S. agricultural production, about 55 percent of the value of crop production, and about 95 percent of the value of livestock and poultry production (USDA, ERS, 1999). Several dozen processed and retail products are included in the model structure, the principal being dairy products, pork, fed and nonfed beef, poultry, soy meal and oil, livestock feeds, and corn milling products. Additionally, the model incorporates domestic use, imports, exports, and inventory/stock product markets. USMP includes government conservation, acreage, price, and income programs. Production, consumption (demand), trade, and price levels for crop and livestock commodities and most processed or retail products are endogenously determined within the model structure with domestic consumption, commercial stock, export and other demand elasticities from the FAPSIM model.

Integrated economic and resource/environmental analysis. USMP's crop production enterprises include both economic items (e.g. yield, nitrogen cost, etc.) and environmental indicator coefficients corresponding to the specific rotation and tillage practices (e.g. soil erosion, nitrogen leaching, etc.). Economic coefficients in the enterprise budgets were developed from USDA data including the National Resources Inventory, Cropping Practices Survey (USDA, ERS, 1992), the Farm Costs and Returns Survey (FCRS) and the Agricultural Resources Management Survey (ARMS) (USDA, ERS), and calculations (of e.g. machinery costs) standard to crop budget generators. Most environmental measures were estimated using the USDA Erosion/Productivity Impact Calculator (EPIC) model (Williams *et al.*) For each "baseline" solution or alternative scenario, the model tallies associated levels of selected agricultural

environmental indicators and acreage under various rotation/tillage practices. Impacts are determined within USMP for the national level, 10 farm production regions, and 45 land resource regions. Environmental impacts, using Geographic Information System databases such as the National Resources Inventory, are further disaggregated depending on the analysis.

USMP has been applied to project the effects on U.S. national and regional agriculture of changes in export levels and variability (Miller *et al.*), trade agreements (Burfisher *et al.*), imports (Spinelli *et al.*), input taxes (Peters *et al.*), irrigation policy (Horner *et al.*), ethanol production (House *et al.*), wetlands policy (Heimlich *et al.* 1997a), and various other policy and program scenarios.

Crop System Biophysical Calibration. Crop system calibration is performed to ensure that the EPIC simulations of each crop system in the model correctly represent yield and other characteristics. Representative soil type and weather conditions are inputs to the biophysical model, as are the crop(s) grown, multi-year rotation of crops, and cultural practices of production. A representative soil was selected for each region from the NRI and Soils5 databases using a multidimensional similarity measure to regional average Universal Soil Loss Equation variables capturing slope, hydrological, and erodability characteristics. Representative weather conditions are specified as distributional information on temperature, rainfall, and other variables (NOAA). County yield data for the 10 crops are aggregated into the 45 regions to estimate average crop yields (USDA, NASS).

Each crop system is specified as a sequence of crops with dated field operations including cultivation, planting, harvesting, and application of specific fertilizer formulas and pesticides. Biological parameters in the biophysical are validated in each production region to ensure

calibration of the model's simulated yield to regional yield statistics and to ensure the yield-nitrogen response is consistent with observed nitrogen application rates and rational use of nitrogen. The 60-year average results of the calibrated EPIC simulations are entered as environmental coefficients for the crop system in the USMP system budget.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:15-APR-1999 10:12:18.00

SUBJECT: oversight mtg - who's coming?

TO: Meagan M. Earley (CN=Meagan M. Earley/OU=WHO/O=EOP @ EOP [WHO])

READ:UNKNOWN

TEXT:

Let's discuss this morning. tds

----- Forwarded by Todd Stern/WHO/EOP on 04/15/99 10:12

AM -----

David B Sandalow

04/14/99 08:43:05 PM

Record Type: Record

To: Todd Stern/WHO/EOP

cc:

Subject: oversight mtg - who's coming?

Is this a WH/State deal, or are you inviting EPA/DoE/Treasury? (I'll get an earful if EPA's not there; DoE probably needs to be in light of Richardson; Treasury hasn't played much but no upside in excluding them.)

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:15-APR-1999 19:13:44.00

SUBJECT: industry paper

TO: Martha L. Wofford (CN=Martha L. Wofford/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

TO: John D. Gibson (CN=John D. Gibson/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

TEXT:

New edited version. Good to go. ===== ATTACHMENT 1 =====
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:

Unable to convert ARMS_EXT:[ATTACH.D6]ARMS26839622J.136 to ASCII,
The following is a HEX DUMP:

INDUSTRY AND CLIMATE CHANGE

April 1999

There is a growing awareness in the business community that the threats posed by climate change are real and a number of companies are stepping forward to assume leadership roles in efforts to address the problem. The Clinton Administration is working to facilitate these efforts through a range of voluntary programs. It also supports the principle of granting credit to firms that take early action to reduce greenhouse gas (ghg) emissions.

Growing Awareness and Support From Business. An increasing number of companies are committing to take real actions to cut their ghg emissions. In the past year alone:

British Petroleum pledged in September, 1998 to reduce its ghg emissions 10% below 1990 levels by 2010 across its global operations and to ramp up its solar business to \$1 billion in sales by 2007. The company later extended its pledge to include its newly acquired subsidiary, **Amoco**.

Royal Dutch Shell pledged to cut its global ghg emissions by 10% by 2002 and maintain that level of reduction through 2010. It will also spend \$500 million over the next 5 years on developing a new renewable energy business.

United Technologies -- producers of Otis elevators, Carrier air conditioners, Pratt & Whitney engines and Sikorsky helicopters -- announced a plan to cut emissions by improving energy efficiency 25% per unit of production by 2010.

IBM announced goals to improve energy efficiency by 4% per year and to reduce ghg emissions.

The new **Pew Center on Climate Change** launched a \$5 million campaign to build support for taking action on climate change. **Boeing, Dupont, Shell, Weyerhaeuser** and some 17 other major corporations joined the Center's *Business Environmental Leadership Council*, saying "enough is known about the science and environmental impacts of climate change for us to take actions to address its consequences."

Government-Industry Partnerships. A number of voluntary government-industry partnerships are supporting efforts to reduce emissions, including:

Partnership for a New Generation of Vehicles, a partnership with the **auto industry** to develop cars that get up to three times the fuel efficiency of today's cars;

Partnership for Advancing Technology in Housing, a partnership with the **building industry** to develop and deploy housing technologies to make new homes 50% more energy efficient and to retrofit 15 million existing homes to make them 30% more energy efficient within a decade; and,

Industries of the Future, a cooperative research program with the nation's most energy-intensive industries -- such as **aluminum, glass, chemicals, forest products, mining, petroleum refining, and steel** -- to develop energy efficient technologies.

Credit for Early Action. In this year's State of the Union address in January, President Clinton reiterated his commitment to providing credit to companies that take early, voluntary action to reduce ghg emissions or increase carbon sequestration. We look forward to working with Congress and stakeholders on a fair and workable program that rewards real environmental gain.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:15-APR-1999 18:00:36.00

SUBJECT: Red-line general tps

TO: John D. Gibson (CN=John D. Gibson/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

TO: Martha L. Wofford (CN=Martha L. Wofford/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

CC: Rosina M. Bierbaum (CN=Rosina M. Bierbaum/OU=OSTP/O=EOP [OSTP])
READ:UNKNOWN

CC: David B Sandalow (CN=David B Sandalow/OU=CEQ/O=EOP @ EOP [CEQ])
READ:UNKNOWN

CC: Roger S. Ballentine (CN=Roger S. Ballentine/OU=WHO/O=EOP @ EOP [WHO])
READ:UNKNOWN

CC: Elliot J. Diringer (CN=Elliot J. Diringer/OU=CEQ/O=EOP @ EOP [CEQ])
READ:UNKNOWN

TEXT:

Attached is a copy of tps with a few edits. I've redlined so you'll be
able to find them and enter them into the master. I'm good to go on
this. If anyone has comments, speak now or hold your piece. These have
to go into production first thing in a.m. tds===== ATTACHMENT 1
=====

ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:

Unable to convert ARMS_EXT:[ATTACH.D9]ARMS16294122P.136 to ASCII,
The following is a HEX DUMP:

MEETING THE CHALLENGE OF GLOBAL CLIMATE CHANGE

APRIL 1999

Global climate change is one of our greatest environmental challenges. The great weight of scientific authority tells us that the problem is real and that the threats it poses — such as severe storms and droughts, increases in respiratory and infectious diseases, and rising sea levels — are too serious to ignore.

The Clinton Administration is working at home and abroad to meet the challenge of climate change. Domestically, we are working on a wide range of initiatives to reduce greenhouse gas emissions by developing and deploying energy efficient technologies and spurring the broader use of renewable energy. Internationally, we are working to secure the meaningful participation of developing countries in addressing global warming and to complete the other unfinished business of the Kyoto Protocol.

THE SCIENCE OF CLIMATE CHANGE

Greenhouse gases trap heat from the sun to keep the Earth's temperature an estimated 60° Fahrenheit (F) warmer than it would be absent such gases, sustaining our existence on the planet. As a result of the burning of fossil fuels and deforestation, the concentration of carbon dioxide (CO₂), the principal greenhouse gas, has increased 30% since preindustrial times.

If we continue on a business-as-usual trajectory, this concentration is expected to reach almost twice current levels by 2100 -- a level not seen in 50 million years. The Intergovernmental Panel on Climate Change (IPCC), which represents the work of more than 2,000 of the world's leading climate scientists, estimates that this will lead to an increase in global temperature of 2 to 6.5° F. By way of comparison, the last ice age was only about 9°-10° F colder than today.

Over the past year, new data from satellites, tree rings, ice cores, and deep boreholes drilled in the Earth's surface have reinforced the broad scientific consensus that human activities have started to affect the climate and that continuing a "business as usual" course will lead to substantial warming in the next century. Studies have shown that the 20th century ~~to be~~ has been the warmest century in the past 1,000 years and that the 1990s have been the warmest decade in that period. — Since reliable instrument records were first kept more than a century ago, 7 of the 10 warmest years on record have all occurred since 1990, with, while 1998 being the has been the single warmest year on record.

POTENTIAL IMPACTS OF CLIMATE CHANGE

Scientists predict a range of likely effects from global warming:

Extreme weather. As temperatures increase, so does the rate of evaporation. This acceleration of the so-called hydrologic cycle is projected to increase the frequency and intensity of extreme weather events such as floods and droughts. Last year's El Nino — which produced warmer and wetter conditions akin to those anticipated from global warming — offered us a window on the type of extreme weather that climate change may bring, from heat waves and drought in Texas, to wildfires in Florida, Mexico and Indonesia, ice storms in the northeastern United States, and devastating floods in China and Bangladesh.

Human health. Warmer temperatures are projected to increase fatalities from heat stress and expand the geographic ranges

for diseases like malaria and dengue fever. Additional smog caused by warmer temperatures could increase the incidence of asthma and other respiratory illnesses, particularly among children and the elderly.

Sea level rise. Scientists project that the sea level will rise by an additional 6 to 37 inches by 2100, endangering island states and coastal areas. A 20-inch rise could inundate 7,000 square miles of the U.S. coastline, with Florida and the Gulf Coast at greatest risk.

Agricultural impacts. Changes in growing seasons, water availability, soil moisture, and precipitation are expected to cause significant regional shifts in food productivity, with decreased production in many of the world's poorest regions. Water supplies and water quality may also be affected, posing threats to irrigation, fisheries, and drinking supplies.

Damage to ecosystems. Many species are highly adapted to particular climate conditions and may not survive substantial climate shifts. For example, the United States may lose beech trees and sugar maples, and western conifer forests are likely to shrink, as the tolerable climate zones for these species shift hundreds of miles to the north.

PRESIDENT CLINTON'S DOMESTIC PLAN

Since 1993, President Clinton has put into place dozens of win-win programs to develop and deploy energy efficient technologies and spur the development and broader use of renewable energy. These efforts have accelerated since the Kyoto climate change conference in 1997.

Climate Change Technology Initiative. This vigorous program of *tax incentives* and *investments* focuses on energy efficiency and renewable energy technologies. The FY 1999 appropriations for these programs totaled over \$1 billion and represented a 25% increase over the prior year. The President's FY 2000 budget proposes a still more accelerated effort.

The **tax incentive package** contains \$3.6 billion over five years for consumers who purchase energy efficient products and for producers of energy from renewable sources. Highlights include: a tax credit of up to \$2000 for energy efficient new homes; a 10-20% credit for selected energy efficient products for homes and buildings; a credit of up to \$2000 for rooftop solar systems; a credit of up to \$4000 for qualifying electric, fuel cell or hybrid vehicles; extension of the current 1.5 cents/kilowatt hour credit for the production of electricity from wind and biomass; an expansion of the biomass credit to cover additional sources; and a 1.0 cent/kilowatt hour credit for cofiring coal and biomass in power plants.

The **investment package** contains nearly \$1.4 billion in FY 2000 to research, develop, and deploy clean energy technologies. This represents a 34% increase over the amount appropriated in FY 1999. Highlights include: increased funding for the *Partnership for a New Generation of Vehicles*, a government-industry effort to develop cars that get up to three times the fuel efficiency of today's cars; the *Partnership for Advancing Technology in Housing*, which aims to improve the energy efficiency of new homes by more than 50% and to retrofit 15 million existing homes to make them 30% more energy efficient within a decade; a stepped-up *Bioenergy Initiative* to develop advanced bioenergy technologies; expanded research and development efforts in other key renewable energy technologies, such as solar, wind, and geothermal energy; and a ~~new research project~~ ~~and the Carbon Cycle Initiative~~, to deepen our understanding of carbon "sinks," such as forests and farmlands.

Electricity restructuring. Another core element of the President's plan involves restructuring the electricity industry by

introducing competition that will save consumers millions on their energy bills while reducing greenhouse gas emissions. The Administration's restructuring proposal would provide a profit incentive for generators to produce more electricity with less fuel and to improve energy efficiency. It also includes an aggressive 7.5 percent renewable portfolio standard to increase the use of electricity from renewable sources and a \$3 billion Public Benefits Fund to spur greater investment in energy efficiency and renewables.

Industry Partnerships. The ~~President's plan~~ Administration is also ~~involves building partnerships~~ engaged in a wide range of consultations with key industry sectors to ~~cut~~ improve energy use and reduce emissions. ~~The Industries of the Future program, for~~ For example, the Industries of the Future program works cooperatively with the nation's most energy-intensive industries -- such as aluminum, glass, chemicals, forest products, mining, petroleum refining, and steel -- to develop technologies that increase energy and resource efficiency. ~~The Administration has also initiated high-level consultations with many of these same industries focused on removing technical and regulatory barriers and fostering greater development and diffusion of energy efficient technologies and practices.~~

Credit for Early Action. The Administration is committed to working with Congress and industry on legislation to reward companies taking early, voluntary action to reduce their greenhouse gas emissions or increase carbon sequestration.

Clean Air Partnership Fund. The President's FY 2000 budget proposes \$200 million for the creation of a new Clean Air Partnership Fund to support state and local projects to reduce both greenhouse gas emissions and ground-level air pollutants.

Federal energy use and procurement. The President's plan seeks to substantially reduce the Federal government's own greenhouse gas emissions by improving the energy efficiency of Federal facilities and activities and reforming procurement practices. These actions are important in their own right, since the Federal government is the nation's largest single energy user, but they also set an important example for the private sector.

Domestic emissions trading. The President has proposed a domestic emissions trading system to begin by 2008 so that we can achieve our emissions target at the lowest possible cost. The U.S. has used emissions trading successfully to reduce the pollution that causes acid rain -- exceeding environmental objectives at about 50% the expected cost.

Scientific research. The Administration is continuing its strong support for the U.S. Global Change Research Program, with nearly \$1.8 billion in funding requested for FY 2000. This program provides a sound science foundation for policy decisions by furthering our understanding of human- and naturally-induced changes in the Earth's environment and assessing the likely consequences of global warming.

DIPLOMATIC AGENDA

Thanks largely to U.S. leadership, the international climate change agreement reached at Kyoto, Japan in December 1997, combines strong environmental targets with elements of flexibility that will allow nations to meet their targets in a cost-effective manner, including:

Flexible market mechanisms. The Protocol includes critically important market mechanisms that can dramatically cut the cost of reducing emissions. Chief among these are *international emissions trading* and the so-called *Clean Development Mechanism (CDM)*, which will allow U.S. companies to participate in joint clean energy ventures in the developing world and earn credits from verified reductions in greenhouse gas emissions.

Emissions targets are to be reached over a five-year commitment period. The first commitment period will be 2008-2012. Allowing emissions to be averaged over a commitment period helps smooth out short-term fluctuations due to economic performance or weather. Having a decade before the start of the binding period will allow more time for companies to make the transition to greater energy efficiency and/or lower carbon technologies.

Emissions targets include all six major greenhouse gases. This will provide both more comprehensive environmental protection and additional flexibility to nations and companies.

Activities that absorb carbon, such as planting trees, can be used to offset emissions. Including these so-called "carbon sinks" will encourage afforestation, reforestation, and better forestry and agricultural conservation practices.

At the November 1998 UN climate change conference in Buenos Aires, the parties agreed on a two-year timetable for filling in the key details of the Kyoto Protocol in areas such as emissions trading, the CDM, compliance, and the scope and use of carbon sinks. Buenos Aires also saw progress on the issue of developing country participation as Argentina and Kazakhstan announced their intention to take on binding emissions targets for the 2008-2012 time period. The President has made clear that he will not submit the Kyoto Protocol to the Senate until there is meaningful participation on the part of key developing countries in addressing global warming.

ECONOMIC COST OF KYOTO

The Administration's economic analysis of the Kyoto Protocol concludes that, if we do it right, the cost to the United States of meeting our Kyoto target should be modest. Even without counting the impact of domestic policies or the environmental, health, and economic benefits of limiting climate change, estimates derived from economic modeling suggest an emissions price in the range of \$14 to \$23 per ton of greenhouse gases. In 2010, that would translate into an increase of \$70 to \$110 per year for an average family's energy bill. This increase, however, would be substantially offset by the decline in electricity prices resulting from increased competition in a restructured electricity industry, as the Administration and others have proposed. In addition, noted economists have estimated the ancillary benefits of reducing greenhouse gas emissions -- such as reduced air pollution -- could produce savings equal to one quarter of the costs of meeting our Kyoto target.

CONCLUSION

For the past 25 years, efforts to protect the environment, whether by cleaning our air, our water, or eliminating acid rain, have been repeatedly assailed as a threat to our economy. Yet today, we have the cleanest environment in a generation and the strongest economy in a generation. President Clinton's balanced approach to the challenge of climate change will allow us to continue to grow the economy and protect the environment at the same time.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:15-APR-1999 12:35:15.00

SUBJECT: revisions

TO: David B Sandalow (CN=David B Sandalow/OU=CEQ/O=EOP @ EOP [CEQ])

READ:UNKNOWN

TEXT:

===== ATTACHMENT 1 =====

ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:

Unable to convert ARMS_EXT:[ATTACH.D16]ARMS19941402O.136 to ASCII,
The following is a HEX DUMP:

April X, 1999

MEMORANDUM FOR

FROM:

SUBJECT: Climate Change/Developing Countries

Engaging developing countries is the greatest challenge in the international climate negotiations. Our current policy focuses on urging developing countries to take growth emissions targets, under which emissions could increase, but at some level moderately below the country's business-as-usual curve. To date, only Argentina and Kazakhstan have expressed any willingness to adopt such a target. While we are continuing to push on this front, it is not at all clear that many other developing countries will follow Argentina's lead. Thus, we face the real possibility of not making much progress on developing countries during the President's term in office.

This may or may not be viewed as problematic. There are other major issues racked up for consideration at COP-6 (emissions trading, the CDM, sinks, compliance). So lack of progress on developing countries would not necessarily be equated with stasis in the Kyoto process. Still, developing country participation is the largest looming issue, and if we appear to be getting nowhere in the next 18 months, questions may be asked about Kyoto's continued viability.

In light of this reality, the question arises as to whether, and if so to what degree, we want to consider additional developing country options. This memo lays out several. In broad concept, as you move on the spectrum toward positions that are likely to pull more developing countries in, you open yourself up to potential attack from a variety of quarters.

I. BACKGROUND

A. Need for Developing Country Participation

Developing country participation under the climate treaty is needed for three reasons:

- Environmental Benefits. Greenhouse gas emissions from developing countries will soon exceed those from the industrialized world. No effort to address climate change will be successful without addressing developing country emissions growth.
- Economic Costs. The Administration's economic analysis found very modest

costs of Kyoto assuming that large developing countries (China, India, Korea, and Mexico) adopt binding emissions targets and engage in international emissions trading. Several economic analyses conducted outside of government have found substantially higher costs without this kind of developing country participation. These higher costs could lead to higher energy costs and greater job losses and exacerbate competitiveness concerns.

- Congressional Support. The Byrd-Hagel Resolution stated that the United States should not sign a protocol that fails to “mandate new specific scheduled commitments to limit or reduce greenhouse gas emissions for Developing Country Parties within the same compliance period [as Annex I Parties].” Without greater participation from key developing countries, the Protocol will lack sufficient support in the Senate for advice and consent to ratification.

B. Why Developing Countries Resist

No nation attaches a higher priority to developing country participation in the climate treaty than the United States. Even our “Umbrella Group” partners largely consider this issue to be a U.S. priority driven mainly by domestic political concerns.

Developing countries in general resent the effort to engage them more fully in the treaty. In resisting greater commitments, developing countries make the following arguments:

- Industrialized Nations Caused this Problem. Carbon dioxide stays in the atmosphere for more than 100 years. More than 75% of the increase in carbon dioxide concentrations since the beginning of the Industrial Revolution comes from the industrialized world.
- Industrialized Nations Promised to Go First. The deal at Rio was clear: you go first, we’ll follow. But you failed to meet your Rio goals and still aren’t reducing greenhouse gas emissions much if at all off their business-as-usual path.
- Development is the Top Priority. We must devote all available resources to lifting our people from poverty. Emissions limits can’t help.
- Uncertainty in Forecasting Emissions. The challenges we face in predicting emissions 10–15 years out are even greater than those you face. We lack the modeling capability and data to do this meaningfully. So our emissions target

could be too stringent and inadvertently constrain growth. (Related to this, EU countries are concerned that targets could be inadvertently lax and generate “tropical hot air.”)

- “All Men Are Created Equal.” Therefore the only emissions limits we’ll accept are those that confer the same per capita right to use the atmosphere as you enjoy under the Kyoto Protocol.

II. Five Options

Option 1: Status Quo

- *As our top priority, continue to seek growth emissions targets from key developing countries for the period 2008-2012.*
- *For those countries unwilling to talk about targets now, seek greater participation in the Clean Development Mechanism, new policies and measures to reduce emissions and other steps. But don’t give up on the need for a target, and insist that a critical mass of countries taking targets is essential to U.S. ratification of the Protocol.*

PROS

- Consistent with Byrd-Hagel.
- Binding targets could provide substantial environmental benefits. If set slightly below BAU, a target could result in lower emissions than would occur otherwise and forestall leakage.
- Economic gains to both developing and industrialized nations, due to emissions trading.

CONS

- Odds that more than a handful of developing countries take fixed targets in the next few years are very low.
- Pursuing a strategy with this focus may make it more difficult to convince

developing countries to take other steps to reduce emissions.

- Setting fixed developing country targets several years in advance risks an excessively stringent target. This would increase costs both to developing countries and to the United States. (If targets are excessively stringent, developing countries would have fewer tons to sell. Others may need to purchase tons.)
- Setting fixed targets several years in advance risks generating “tropical hot air.” This could undercut the treaty’s environmental objectives and generate criticism from the EU and environmental NGOs.

OPTION 2: Adjustable Targets

- *In addition to seeking fixed targets, seek targets that would be adjustable based on future economic performance. Examples include:*
 - *Indexed Quantitative Targets. Countries would agree now to an emissions target, along with a forecast of economic growth for 1999–2007. In 2007, the target would be raised (or lowered) by X% for every percentage point that GDP turns out to be higher (or lower) than the forecast. (If a developing country preferred indicators other than GDP, such indicators might be used.)*
 - *Greenhouse Gas Intensity Ratio. Countries would agree to achieve a specific ratio of greenhouse gas emissions to GDP for the 2008–2012 commitment period. As each year during the commitment period ends and GDP figures for that year are made final, the ratio would be converted to a fixed emissions target. Countries would be able to participate in international emissions trading based on this target.*
- *Targets would be binding for the period 2008–2012.*

PROS

- Consistent with Byrd–Hagel.
- May attract greater interest from developing countries than Option 1. Addresses most developing country concerns about inadvertent stringency.
- May attract more support from EU than Option 1. Addresses most EU

concerns about “tropical hot air.”

- A binding target could provide substantial environmental benefits. If set slightly below BAU, it could result in lower emissions than would occur otherwise and forestall leakage.
- Economic gains to both developing and industrialized nations, due to emissions trading.

CONS

- Some will argue that this approach gives developing countries more flexibility in achieving their targets than the United States and is therefore unfair.
- May be too complex to be workable.

Option 3: Transitional Targets

- *Countries would agree to a non-binding target for 2008–2012. If emissions were less than the target, countries could sell the excess on the international market. If emissions were more than the target, countries would not be required to make up the shortfall.*
- *Countries would also agree to take on a binding target for the second Kyoto commitment period (2013–2017). This target would be negotiated at the same time second budget period targets are negotiated for industrialized countries (2005, under the Kyoto Protocol).*

PROS

- Would attract greater interest from developing countries than Options 1 or 2.
- Would provide developing countries incentive to experiment with policies and measures to abate emissions. Potential economic gains from trading may be enough to provide the incentive necessary to stimulate action even in a voluntary regime.
- Consistent with experience of industrialized nations, which took non-binding targets under the climate treaty before agreeing to binding targets.

CONS

- Some would criticize this as inconsistent with Byrd-Hagel. Would be more difficult to gain Congressional support than with Options 1 or 2.
- EU and others would be concerned about risk of “tropical hot air.”

OPTION 4: Binding Policies and Measures/CDM

- *While continuing to call on developing countries to take on targets, we would begin to urge these countries to make legally binding commitments to policies and measures that would reduce greenhouse emissions. Developing countries would also be encouraged to participate in the CDM.*

PROS

- May be more acceptable to many developing countries than previous options.

CONS

- Many would consider this to be inconsistent with Byrd-Hagel. (Although binding policies and measures are “new specific scheduled commitments in the same commitment period...”, several floor statements indicate that the resolution sponsors had emissions targets in mind in passing the resolution.) Would be flatly rejected on the Hill.
- U.S. industry would oppose, fearing that this approach could lead to internationally-harmonized policies and measures for all countries.
- Costs of compliance to the United States would likely be higher under this option than under the other options, because developing countries would not be able to participate in international emissions trading.
- Because these developing countries could not participate in international emissions trading, their potential economic gains could be lower than under other options.
- The potential environmental gains could be lower under this approach than under other options if developing country efforts focus on the CDM. The CDM does not lower world emissions; rather it shifts reductions from Annex I Parties to developing country Parties.

OPTION 5: Non-Binding Plans of Action/CDM

- *While continuing to call on developing countries to take targets, we would also urge them to develop non-binding plans of action to reduce greenhouse gas emissions. These plans would be submitted to the Framework Convention for review. We would also urge developing countries to participate in the Clean Development Mechanism.*

PROS

- More developing countries would react favorably to this option than any other.
- Could generate greater emissions reduction in the developing world than other options. (There is a real risk that developing countries will simply resent and reject our efforts to push them toward binding limits, and fail to take any action at all. By calling for non-binding plans of action, we could help lead developing countries toward emissions-reducing activities at a more realistic pace.)

CONS

- Appears to be inconsistent with Byrd-Hagel. Would be flatly rejected on the Hill.
- Costs of compliance to the United States would likely be higher under this option than under the other options, because developing countries would not be able to participate in international emissions trading.
- The potential environmental gains could be lower under this approach than under other options, if developing countries simply report on activities they would have undertaken anyway.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:15-APR-1999 19:17:58.00

SUBJECT: Re: new science paper

TO: John D. Gibson (CN=John D. Gibson/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

CC: Lisa M. Kountoupes (CN=Lisa M. Kountoupes/OU=WHO/O=EOP @ EOP [WHO])
READ:UNKNOWN

CC: Michael L. Rodemeyer (CN=Michael L. Rodemeyer/OU=OSTP/O=EOP @ EOP [OSTP])
READ:UNKNOWN

CC: Julie M. Anderson (CN=Julie M. Anderson/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

CC: Martha L. Wofford (CN=Martha L. Wofford/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

CC: Rosina M. Bierbaum (CN=Rosina M. Bierbaum/OU=OSTP/O=EOP [OSTP])
READ:UNKNOWN

CC: Meagan M. Earley (CN=Meagan M. Earley/OU=WHO/O=EOP @ EOP [WHO])
READ:UNKNOWN

CC: Roger S. Ballentine (CN=Roger S. Ballentine/OU=WHO/O=EOP @ EOP [WHO])
READ:UNKNOWN

CC: Janet Anderson (CN=Janet Anderson/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

CC: Elliot J. Diringer (CN=Elliot J. Diringer/OU=CEQ/O=EOP @ EOP [CEQ])
READ:UNKNOWN

CC: Dirk Forrister (CN=Dirk Forrister/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

CC: David B Sandalow (CN=David B Sandalow/OU=CEQ/O=EOP @ EOP [CEQ])
READ:UNKNOWN

TEXT:

Good except for last paragraph. That's mostly ok (assuming OSTP clears)
except for last sentence which awkwardly uses the word "climate" twice.
Just polish that up and we'll be fine. Thanks. tds

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:15-APR-1999 19:39:24.00

SUBJECT: pls call asap re climate meeting tomorrow. todd 61985

TO: RON (SKY) (Pager) #KLAIN (RON (SKY) (Pager) #KLAIN [UNKNOWN])

READ:UNKNOWN

TEXT:

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:15-APR-1999 19:21:02.00

SUBJECT: Re: Cover letter for mailing

TO: Martha L. Wofford (CN=Martha L. Wofford/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

CC: Meagan M. Earley (CN=Meagan M. Earley/OU=WHO/O=EOP @ EOP [WHO])
READ:UNKNOWN

TEXT:

GUYS, I CAN'T READ THIS AND THERE ISN'T ANYTHING PRINTED OUT FOR ME. tds

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:15-APR-1999 13:48:55.00

SUBJECT: Re: Presidential Memorandum to the Secretary of Energy and EPA Administrator on CO2 Emissions

TO: Elliot J. Diringer (CN=Elliot J. Diringer/OU=CEQ/O=EOP @ EOP [CEQ])

READ:UNKNOWN

TEXT:

This was part of the electricity bill rollout.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:16-APR-1999 14:21:08.00

SUBJECT: sched. request

TO: Lisa A. Berg (CN=Lisa A. Berg/O=OVP @ OVP [UNKNOWN])

READ:UNKNOWN

TEXT:

You should have received a request that may very well not have made it onto your radar screen. It's from a James Wascher, President of the Legal Assistance Foundation in Chicago asking whether the VP could keynote their annual fundraising luncheon in June (I think they didn't specify a date because they're flexible and would seek to accommodate VP if you guys had any interest). I know about this because a friend of mine in Chicago is prominent in this organization.

This will be a big luncheon, doubtless with a lot of Chicago legal muscle in attendance. I have no vested interest in it; just steered them in your direction. I am now getting called by Wascher, doubtless to find out what's going on. Is there anything you can tell me? tds

RECORD TYPE: PRESIDENTIAL (NOTES READ RECEIPT)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:16-APR-1999 17:49:34.00

SUBJECT: RECEIVED: Enviro letter

TO: Phillip Caplan (CN=Phillip Caplan/OU=WHO/O=EOP [WHO])

READ:UNKNOWN

TEXT:

RETURN RECEIPT

Your Document:

Enviro letter

was successfully received by:

CN=Todd Stern/OU=WHO/O=EOP

at:

04/16/99 05:49:53 PM

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:16-APR-1999 17:54:39.00

SUBJECT: hearing on climate change

TO: Roger S. Ballentine (CN=Roger S. Ballentine/OU=WHO/O=EOP @ EOP [WHO])
READ:UNKNOWN

TO: Lisa M. Kountoupes (CN=Lisa M. Kountoupes/OU=WHO/O=EOP @ EOP [WHO])
READ:UNKNOWN

TO: Julie M. Anderson (CN=Julie M. Anderson/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

TEXT:

We've got to manage this process better. We should be proactively identifying Dems to work with and then providing them with paper. It is silly and makes us look bad to have Dems saying "we wanted to help but they never got us the goods or gave us any guidance." Either we have to do this ourselves or we need more effective working relationships with Leg Affairs people at DOE and EPA who can take the pen under our guidance. If such people don't exist, then we should just do it. Our approach to hearings is too passive.

----- Forwarded by Todd Stern/WHO/EOP on 04/16/99 05:50 PM -----

Neal Lane
04/16/99 08:43:03 AM
Record Type: Record

To: Todd Stern/WHO/EOP
cc:
Subject: hearing on climate change

Todd: I forgot to tell you, this morning, that some of the House Democrats on the Energy and Environment Subcommittee were unhappy that DOE and EPA got their testimony over so late - and without any suggestions of questions they might ask - that the members couldn't help as much as they would have liked at the hearing. I have spoken with Bart Gordon (D-TN) and will let you know any more I learn. Neal

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:16-APR-1999 16:12:56.00

SUBJECT: quote for post

TO: John Podesta (CN=John Podesta/OU=WHO/O=EOP @ EOP [WHO])

READ:UNKNOWN

TEXT:

FYI. tds

----- Forwarded by Todd Stern/WHO/EOP on 04/16/99 04:13

PM -----

Elliot J. Diringer

04/16/99 04:04:44 PM

Record Type: Record

To: Ron Klain/OVP @ OVP, George T. Frampton/CEQ/EOP, Todd Stern/WHO/EOP, David B Sandalow/CEQ/EOP

cc:

Subject: quote for post

Joby Warrick's interested in the story. I'd like to give him the following quote attributed to a White House official:

"The President is saying: Get real. We're as committed as anyone to the fight against global warming. But you have to play it smart. Attacking Al Gore and pushing unrealistic proposals gets us nowhere."

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:16-APR-1999 18:40:17.00

SUBJECT: Re: Weekly

TO: Martha L. Wofford (CN=Martha L. Wofford/OU=WHCCTF/O=EOP @ EOP [WHCCTF])

READ:UNKNOWN

CC: John D. Gibson (CN=John D. Gibson/OU=WHCCTF/O=EOP @ EOP [WHCCTF])

READ:UNKNOWN

TEXT:

Thanks. And especially good work to you and John for getting this mailing done. And sorry about the interns! We've all done our share of envelope stuffing, but I'm sorry you got stuck today. They won't make you do this at Kellogg!

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:16-APR-1999 17:54:59.00

SUBJECT: Re: hearing on climate change

TO: Neal Lane (CN=Neal Lane/OU=OSTP/O=EOP @ EOP [OSTP])

READ:UNKNOWN

TEXT:

Thanks. I've passed this on to our Leg. team. This is our fault. tds

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:16-APR-1999 16:13:29.00

SUBJECT: press plan on enviro letter

TO: Sara M. Latham (CN=Sara M. Latham/OU=WHO/O=EOP @ EOP [WHO])

READ:UNKNOWN

TEXT:

Forgot to copy you on this. tds

----- Forwarded by Todd Stern/WHO/EOP on 04/16/99 04:13

PM -----

Todd Stern

04/16/99 04:06:51 PM

Record Type: Record

To: John Podesta/WHO/EOP

cc: Phillip Caplan/WHO/EOP

Subject: press plan on enviro letter

Phil asked me to send you a note on the press plan.

The letter is going to TIME, which is doing a VP story for Monday issue, and Washington Post because we think they'll be most receptive to our take on this. It would be quite possible for reporters, especially political reporters, to think "touchy, touchy," when they see this; we want instead for the message to be the President telling the enviros, in effect, "get real, we're committed to your goals but we're committed to moving in a smart way so we have a chance of getting there rather than just beating our chest -- and Al Gore is the best thing that ever happened to you." Our sense is that we have the best chance of that via the Post. tds

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:16-APR-1999 16:06:25.00

SUBJECT: press plan on enviro letter

TO: John Podesta (CN=John Podesta/OU=WHO/O=EOP @ EOP [WHO])

READ:UNKNOWN

CC: Phillip Caplan (CN=Phillip Caplan/OU=WHO/O=EOP @ EOP [WHO])

READ:UNKNOWN

TEXT:

Phil asked me to send you a note on the press plan.

The letter is going to TIME, which is doing a VP story for Monday issue, and Washington Post because we think they'll be most receptive to our take on this. It would be quite possible for reporters, especially political reporters, to think "touchy, touchy," when they see this; we want instead for the message to be the President telling the enviros, in effect, "get real, we're committed to your goals but we're committed to moving in a smart way so we have a chance of getting there rather than just beating our chest -- and Al Gore is the best thing that ever happened to you." Our sense is that we have the best chance of that via the Post. tds

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=‘Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:16-APR-1999 14:09:00.00

SUBJECT: Weekly Science clip

TO: Julie M. Anderson (CN=Julie M. Anderson/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

TEXT:

If this isn't true, could you work it out with Mike?

----- Forwarded by Todd Stern/WHO/EOP on 04/16/99 02:07

PM -----

Michael L. Rodemeyer 04/16/99 01:45:32 PM

Record Type: Record

To: Meagan M. Earley/WHO/EOP, Todd Stern/WHO/EOP, Martha L. Wofford/WHCCTF/EOP

cc:

Subject: Weekly Science clip

I assume WHCCTF is writing up the House Science hearing from last week and the EIA report?

Climate Linked to Rainforest Extinction

Many frogs, lizards, and birds of the high elevation "cloud forest" of Costa Rica are dependent on the misty environment provided by the cooling of moisture-laden winds to form mountaintop cloud banks. Researchers this week reported that warmer drier conditions from a combination of El Nino weather patterns and a longer-term rise in sea surface temperatures have caused the base of the cloud bank to rise, leaving the habitat of moisture-dependent species warmer, drier, and less suitable to support the wildlife of the cloud forest. The changed conditions coincided with the disappearance of 20 frog species in Costa Rica, including the Golden Toad, as well as several high elevation lizards over the last decade. These results suggest that climate change can produce effects on biological communities much more quickly than expected.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:17-APR-1999 09:56:29.00

SUBJECT: developing country meeting

TO: Meagan M. Earley (CN=Meagan M. Earley/OU=WHO/O=EOP @ EOP [WHO])

READ:UNKNOWN

CC: David B Sandalow (CN=David B Sandalow/OU=CEQ/O=EOP @ EOP [CEQ])

READ:UNKNOWN

TEXT:

Where are we on this?

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:17-APR-1999 10:01:09.00

SUBJECT: New York

TO: Meagan M. Earley (CN=Meagan M. Earley/OU=WHO/O=EOP @ EOP [WHO])
READ:UNKNOWN

CC: David B Sandalow (CN=David B Sandalow/OU=CEQ/O=EOP @ EOP [CEQ])
READ:UNKNOWN

Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])
READ:UNKNOWN

TEXT:

We need a meeting with Frank and Melinda to get to the agenda item we didn't reach at the meeting with Frank on Thursday: our objectives and plans for the Umbrella Group lunch and the Extended Bureau Meeting in New York. This needs to be Monday or Tuesday, because they leave for New York on Wednesday, I believe. David and I will go to State -- no need for Frank to come here.

David -- you and I ought to put our heads together on Monday to think through what we think we want to accomplish in New York. I'm not totally current with State of play re submissions and what not. If Dan Reifsnyder is around, I'd actually like to talk with him Monday -- in person if possible, on phone if not, to get his take on where we and other major players are on the key issues and what he thinks we ought to be doing in New York. tds

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:19-APR-1999 20:22:37.00

SUBJECT: Re: staffing

TO: Meagan M. Earley (CN=Meagan M. Earley/OU=WHO/O=EOP @ EOP [WHO])

READ:UNKNOWN

TEXT:

Let's do these with Martha and Elliot. Roger and David will be too much.

tds

----- Forwarded by Todd Stern/WHO/EOP on 04/19/99 08:23 PM -----

Martha L. Wofford
04/19/99 07:40:00 PM
Record Type: Record

To: Todd Stern/WHO/EOP

cc:

Subject: Re: staffing

yay -- seems like it would be a bit much to do a 5 on 1. Elliot and I talked about it earlier and both felt strongly that the two of us should do it with you, at least for Bledsoe. I'd like to see how he processed the conversations we've had and Elliot obviously will have to work closely with whomever gets the job. Maybe we could set up another round of meetings with your candidate of choice?

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:19-APR-1999 13:57:08.00

SUBJECT: Re: Indianapolis

TO: Martha L. Wofford (CN=Martha L. Wofford/OU=WHCCTF/O=EOP @ EOP [WHCCTF])

READ:UNKNOWN

CC: Elliot J. Diringer (CN=Elliot J. Diringer/OU=CEQ/O=EOP @ EOP [CEQ])

READ:UNKNOWN

TEXT:

Good. I'd talk to David. He could probably do it; or might suggest Reifsnyder. Dan would be good on the technical, factual background. David could supply a little more political context.

I also wouldn't stop at Thompson. I really think the workshop gives a peg to people who are always looking for an angle that would allow them to get their own stuff into their papers or mags. Thanks. tds

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:19-APR-1999 11:43:16.00

SUBJECT: revised memo

TO: David B Sandalow (CN=David B Sandalow/OU=CEQ/O=EOP @ EOP [CEQ])

READ:UNKNOWN

TEXT:

===== ATTACHMENT 1 =====

ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:

Unable to convert ARMS_EXT:[ATTACH.D10]ARMS209618521.136 to ASCII,
The following is a HEX DUMP:

===== END ATTACHMENT 1 =====

Withdrawal/Redaction Marker

Clinton Library

DOCUMENT NO. AND TYPE	SUBJECT/TITLE	DATE	RESTRICTION
002. email	Todd Stern to Joseph P. Lockhart at 13:31:00.00. Subject: Re: Most important business. (1 page)	04/19/1999	b(6)

COLLECTION:

Clinton Presidential Records
Automated Records Management System [Email]
WHO ([From Todd Stern])
OA/Box Number: 500000

FOLDER TITLE:

[04/15/1999 - 04/20/1999]

2013-0914-F
ab1331

RESTRICTION CODES

Presidential Records Act - [44 U.S.C. 2204(a)]

- P1 National Security Classified Information [(a)(1) of the PRA]
- P2 Relating to the appointment to Federal office [(a)(2) of the PRA]
- P3 Release would violate a Federal statute [(a)(3) of the PRA]
- P4 Release would disclose trade secrets or confidential commercial or financial information [(a)(4) of the PRA]
- P5 Release would disclose confidential advice between the President and his advisors, or between such advisors [(a)(5) of the PRA]
- P6 Release would constitute a clearly unwarranted invasion of personal privacy [(a)(6) of the PRA]

C. Closed in accordance with restrictions contained in donor's deed of gift.

PRM. Personal record misfile defined in accordance with 44 U.S.C. 2201(3).

RR. Document will be reviewed upon request.

Freedom of Information Act - [5 U.S.C. 552(b)]

- b(1) National security classified information [(b)(1) of the FOIA]
- b(2) Release would disclose internal personnel rules and practices of an agency [(b)(2) of the FOIA]
- b(3) Release would violate a Federal statute [(b)(3) of the FOIA]
- b(4) Release would disclose trade secrets or confidential or financial information [(b)(4) of the FOIA]
- b(6) Release would constitute a clearly unwarranted invasion of personal privacy [(b)(6) of the FOIA]
- b(7) Release would disclose information compiled for law enforcement purposes [(b)(7) of the FOIA]
- b(8) Release would disclose information concerning the regulation of financial institutions [(b)(8) of the FOIA]
- b(9) Release would disclose geological or geophysical information concerning wells [(b)(9) of the FOIA]

Withdrawal/Redaction Marker

Clinton Library

DOCUMENT NO. AND TYPE	SUBJECT/TITLE	DATE	RESTRICTION
003. email	Todd Stern to Joseph P. Lockhart at 10:32:48.00. Subject: Most important business. (1 page)	04/19/1999	b(6)

COLLECTION:

Clinton Presidential Records
Automated Records Management System [Email]
WHO ([From Todd Stern])
OA/Box Number: 500000

FOLDER TITLE:

[04/15/1999 - 04/20/1999]

2013-0914-F
ab1331

RESTRICTION CODES

Presidential Records Act - [44 U.S.C. 2204(a)]

P1 National Security Classified Information [(a)(1) of the PRA]
P2 Relating to the appointment to Federal office [(a)(2) of the PRA]
P3 Release would violate a Federal statute [(a)(3) of the PRA]
P4 Release would disclose trade secrets or confidential commercial or financial information [(a)(4) of the PRA]
P5 Release would disclose confidential advice between the President and his advisors, or between such advisors [(a)(5) of the PRA]
P6 Release would constitute a clearly unwarranted invasion of personal privacy [(a)(6) of the PRA]

C. Closed in accordance with restrictions contained in donor's deed of gift.

PRM. Personal record misfile defined in accordance with 44 U.S.C. 2201(3).

RR. Document will be reviewed upon request.

Freedom of Information Act - [5 U.S.C. 552(b)]

b(1) National security classified information [(b)(1) of the FOIA]
b(2) Release would disclose internal personnel rules and practices of an agency [(b)(2) of the FOIA]
b(3) Release would violate a Federal statute [(b)(3) of the FOIA]
b(4) Release would disclose trade secrets or confidential or financial information [(b)(4) of the FOIA]
b(6) Release would constitute a clearly unwarranted invasion of personal privacy [(b)(6) of the FOIA]
b(7) Release would disclose information compiled for law enforcement purposes [(b)(7) of the FOIA]
b(8) Release would disclose information concerning the regulation of financial institutions [(b)(8) of the FOIA]
b(9) Release would disclose geological or geophysical information concerning wells [(b)(9) of the FOIA]

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:19-APR-1999 13:54:02.00

SUBJECT: developing country memo

TO: David B Sandalow (CN=David B Sandalow/OU=CEQ/O=EOP @ EOP [CEQ])

READ:UNKNOWN

TEXT:

We ought to circulate it to George, Sally/Gene, Janet, Rosina (for Neal), Steinberg, Klain. NEC should be given option of going on the memo as a drafter, though they probably won't want to. I doubt whether we're going to get it through system and back from POTUS by Wednesday evening, but if there's any chance of that, he'd have to get it in office time tomorrow.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:19-APR-1999 20:22:44.00

SUBJECT: Re: staffing

TO: Martha L. Wofford (CN=Martha L. Wofford/OU=WHCCTF/O=EOP @ EOP [WHCCTF])

READ:UNKNOWN

TEXT:

Deal.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:19-APR-1999 19:16:28.00

SUBJECT: Re: virgil goode letter

TO: John D. Gibson (CN=John D. Gibson/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

CC: Julie M. Anderson (CN=Julie M. Anderson/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

CC: Meagan M. Earley (CN=Meagan M. Earley/OU=WHO/O=EOP @ EOP [WHO])
READ:UNKNOWN

CC: Roger S. Ballentine (CN=Roger S. Ballentine/OU=WHO/O=EOP @ EOP [WHO])
READ:UNKNOWN

TEXT:

Thanks to John for catching some mistakes in earlier draft. Try this.

John -- on the advice and consent point, I know I'm speaking in the vernacular, but that doesn't bother me unless someone thinks I should be

bothered. tds===== ATTACHMENT 1 =====

ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:

Unable to convert ARMS_EXT:[ATTACH.D68]ARMS21226662O.136 to ASCII,
The following is a HEX DUMP:

The Honorable Virgil H. Goode
U.S. House of Representatives
Washington, D.C. 20515

Dear Representative Goode:

Thank you for your January 26, 1999 letter to the President regarding the Kyoto Protocol. The President has asked that I respond directly to your concerns.

I understand that you have real reservations about the Kyoto Protocol and that you are concerned that it could place undue burdens on your constituents and on American business, farmers and consumers generally.

Let me take a moment and try to explain what I think is the fundamental reasonableness and soundness of the President's approach to this difficult issue.

First, the state of the science makes it incumbent upon the President to take prudent action. There is, to be sure, a great deal we don't know yet about the science of climate change. But the great weight of independent scientific authority tells us that climate change is a real problem and that the risks it poses to us, our children and grandchildren are too serious to ignore. The issue, then, is whether the actions the President has proposed are balanced and measured, given the nature of the risks and potential costs involved. I think a dispassionate view of the facts makes it clear that he is.

On the diplomatic front, there are two important things you should keep in mind concerning Kyoto. First, we have recognized from the beginning that it does not include an adequate level of participation by developing countries. The President has made clear that he will not submit the Protocol to the Senate for ratification until there is meaningful participation on the part of key developing countries.

On the other hand, we disagree with the notion that the right course is to abandon the process. On issues other than developing countries, the Protocol largely reflects the flexible, market-based approach advanced by the United States. For example, the Protocol includes provisions for international trading of emission allowances, and a so-called "Clean Development Mechanism," under which U.S. companies can earn low-cost credits through clean energy projects undertaken in developing countries. Economists recognize that such market-based approaches, as well as other elements of flexibility, such as the coverage of all six greenhouse gases (not just CO₂) and the inclusion of carbon-absorbing "sinks" such as forests and farmlands, can substantially lower the cost of complying with Kyoto's emissions targets.

Thus, we think the right approach is to continue pursuing a vigorous diplomatic effort to secure greater participation by developing countries, while also seeking to nail down the details on key provisions like emissions trading.

Domestically, President Clinton is pursuing a series of "win-win" initiatives centered around tax

incentives and investments in R&D to increase energy efficiency and spur the broader use of renewable energy. These efforts are good for the economy, good for our national security, and good for the environment as well, reflecting the kind of balanced approach that makes sense.

Let me add a brief word on the issue of costs. I recognize that there are a great many analyses out there that tell different stories about how much it would cost for the United States to comply with the Kyoto Protocol. It is our belief, reflected in the economic analysis prepared by the Council of Economic Advisors, that if done in a manner consistent with U.S. policy -- that is, with active international emissions trading, a well-functioning Clean Development Mechanism, and meaningful participation by key developing countries -- the cost of complying with Kyoto would be relatively modest. There are, to be sure, a variety of studies that analyze the costs of Kyoto without the benefit of the flexible, market-based provisions we negotiated into the Protocol. Those studies tend to find compliance costs much higher than those found in the CEA's analysis. But these studies analyze a policy we don't subscribe to.

Again, we appreciate your interest in this issue and hope that as this process goes forward, we can maintain an open and useful dialogue.

Sincerely yours,

Todd D. Stern
Assistant to the President for Special Projects

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:19-APR-1999 13:34:57.00

SUBJECT: fuel cells

TO: Martha L. Wofford (CN=Martha L. Wofford/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

TO: Elliot J. Diringer (CN=Elliot J. Diringer/OU=CEQ/O=EOP @ EOP [CEQ])
READ:UNKNOWN

CC: Julie M. Anderson (CN=Julie M. Anderson/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

CC: David B Sandalow (CN=David B Sandalow/OU=CEQ/O=EOP @ EOP [CEQ])
READ:UNKNOWN

CC: Janet Anderson (CN=Janet Anderson/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

CC: John D. Gibson (CN=John D. Gibson/OU=WHCCTF/O=EOP @ EOP [WHCCTF])
READ:UNKNOWN

CC: Roger S. Ballentine (CN=Roger S. Ballentine/OU=WHO/O=EOP @ EOP [WHO])
READ:UNKNOWN

TEXT:

fyi
----- Forwarded by Todd Stern/WHO/EOP on 04/19/99 01:35
PM -----

Ronald Minsk
04/19/99 11:44:33 AM
Record Type: Record

To: Sally Katzen/OPD/EOP, Todd Stern/WHO/EOP
cc:
Subject: fuel cells

Toyota, GM To Make Fuel-Cell Cars

A.P. INDEXES: TOP STORIES | NEWS | SPORTS | BUSINESS |
TECHNOLOGY | ENTERTAINMENT

Filed at 10:37 a.m. EDT

By The Associated Press

DETROIT (AP) -- Toyota Motor Corp. and General Motors Corp. have reached a five-year agreement to jointly develop cars and trucks that can run off fuel cells and other environmentally friendly alternative-fuel technology.

"Pooling our efforts should result in commercially viable advanced technologies faster and at a lower cost to our customers, and as breakthroughs are reached, suppliers will be able to count on the volume of production from two of the world's largest automakers," GM vice chairman Harry Pearce said in remarks prepared for delivery today at a Detroit news conference.

GM, the world's largest automaker, and No. 3 Toyota have worked on several joint ventures, including a California-based venture to produce small cars and to market of GM's Cavalier cars through Toyota's sales network in Japan. They had been in talks on the advanced technology venture since last year.

The new venture will involve research and development of electric, hybrid electric and fuel-cell technology. Hybrid electric vehicles typically combine an electric motor with other power systems.

The deal is to last through 2004, the year that GM, Ford Motor Co. and DaimlerChrysler AG have said they plan to be ready to produce fuel-cell vehicles.

Today's announcement also comes a day before Ford, DaimlerChrysler and Ballard Power Systems Inc., a fuel-cell developer, plan to announce a deal with oil companies to develop a demonstration fleet of fuel-cell powered vehicles in California.

Fuel cells produce electricity using a chemical reaction between hydrogen and oxygen and produce little or no emissions. The technology was developed for use in spacecraft, but problems in supplying and

storing
hydrogen have hampered plans to use it for cars. So far, fuel
cells remain
prohibitively expensive.

DaimlerChrysler has been working on technology to convert
gasoline to
hydrogen on board the car, eliminating the need for a heavy,
expensive
hydrogen storage tank.

GM and Toyota have been working on alternative-fuel vehicles for
years.

GM was the first to mass-market an electric car, the EV1, which
has
failed to catch on in the markets where it is being leased.

Toyota brought
the first hybrid electric car to market, the Prius, in Japan two
years ago.

The Prius uses gasoline and electricity and is scheduled to go
on sale in
the United States and Europe next year.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:19-APR-1999 19:24:04.00

SUBJECT: Re: staffing

TO: Martha L. Wofford (CN=Martha L. Wofford/OU=WHCCTF/O=EOP @ EOP [WHCCTF])

READ:UNKNOWN

CC: Meagan M. Earley (CN=Meagan M. Earley/OU=WHO/O=EOP @ EOP [WHO])

READ:UNKNOWN

TEXT:

Martha -- maybe too much to add Roger and David to you and me and Elliot.

Do you think? tds

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:19-APR-1999 18:28:28.00

SUBJECT: virgil goode letter

TO: John D. Gibson (CN=John D. Gibson/OU=WHCCTF/O=EOP @ EOP [WHCCTF])

READ:UNKNOWN

CC: Julie M. Anderson (CN=Julie M. Anderson/OU=WHCCTF/O=EOP @ EOP [WHCCTF])

READ:UNKNOWN

CC: Roger S. Ballentine (CN=Roger S. Ballentine/OU=WHO/O=EOP @ EOP [WHO])

READ:UNKNOWN

TEXT:

Here's a rewrite. Roger and Julie -- in basic letter to POTUS, Goode expresses his strong opposition to Kyoto and says his constituents all think it'll cost a fortune, etc., etc.

The half hour I spent editing this was undoubtedly more time than it was worth, but I thought it might be worthwhile to have a basic response to the opposition. If you have edits and copy me. Thanks. tds===== ATTACHMENT 1
=====

ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:

Unable to convert ARMS_EXT:[ATTACH.D1]ARMS25253662T.136 to ASCII,
The following is a HEX DUMP:

The Honorable Virgil H. Goode
U.S. House of Representatives
Washington, D.C. 20515

Dear Representative Goode:

Thank you for your January 26, 1999 letter to the President regarding the Kyoto Protocol. The President has asked that I respond directly to your concerns.

I understand that you have real reservations about the Kyoto Protocol and that you are concerned that it could place undue burdens on your constituents and on American business, farmers and consumers generally.

Let me take a moment and try to explain what I think is the fundamental reasonableness and soundness of the President's approach to this difficult issue.

First, the state of the science makes it incumbent upon the President to take prudent action. There is, to be sure, a great deal we don't know yet about the science of climate change. But the great weight of independent scientific authority tells us that climate change is a real problem and that the risks it poses to us, our children and grandchildren are too serious to ignore. The issue, then, is whether the actions the President has proposed are balanced and measured, given the nature of the risks and potential costs involved. I think a dispassionate view of the facts makes it clear that he is.

On the diplomatic front, there are two important things you should keep in mind concerning Kyoto. First, we have recognized from the beginning that it does not include an adequate level of participation by developing countries. The President has made clear that he will not submit the Protocol to the Senate for ratification until there is meaningful participation on the part of key developing countries. And we are pursuing in this regard.

On the other hand, we disagree with the notion that the right course is to abandon the process. On issues other than developing countries, the Protocol largely reflects the flexible, market-based approach advanced by the United States. For example, the Protocol includes provisions for international trading of emission allowances, and a so-called "Clean Development Mechanism," under which U.S. companies can earn low-cost credits through clean energy projects undertaken in developing countries. Economists recognize that such market-based approaches, as well as other elements of flexibility, such as the coverage of all six greenhouse gases (not just CO₂) and the inclusion of carbon-absorbing "sinks" such as forests and farmlands, can substantially lower the cost of complying with Kyoto's emissions targets. Thus, we think the right approach is to continue pursuing a vigorous diplomatic effort to secure greater participation by developing countries, while also seeking to nail down the details on key provisions like emissions trading.

Domestically, President Clinton is pursuing a series of "win-win" initiatives centered around tax incentives and investments in R&D to increase energy efficiency and spur the broader use renewable energy. These efforts are good for the economy, good for our national security, and

good for the environment as well, reflecting the kind of balanced approach that makes sense.

Let me add a brief word on the issue of costs. I recognize that there are a great many analyses out there that tell different stories about how much it would cost for the United States to comply with the Kyoto Protocol. It is our belief, reflected in the economic analysis prepared by the Council of Economic Advisors, that if done in a manner consistent with U.S. policy -- that is, with active international emissions trading, a well-functioning Clean Development Mechanism, and meaningful participation by key developing countries -- the cost of complying with Kyoto would be relatively modest. Many studies document how high the costs would be if we had to meet our Kyoto targets without the benefit of the flexible, market-based provisions we negotiated into the Protocol. But these studies are largely irrelevant; they analyze a policy we don't subscribe to.

Again, we appreciate your interest in this issue and hope that as this process goes forward, we can maintain an open and useful dialogue.

Sincerely yours,

Todd D. Stern
Assistant to the President for Special Projects

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:19-APR-1999 13:36:33.00

SUBJECT: Indianapolis

TO: Martha L. Wofford (CN=Martha L. Wofford/OU=WHCCTF/O=EOP @ EOP [WHCCTF])

READ:UNKNOWN

TO: Elliot J. Diringer (CN=Elliot J. Diringer/OU=CEQ/O=EOP @ EOP [CEQ])

READ:UNKNOWN

TEXT:

Could you guys let me know at the end of the day how we're doing on putting together a pitchable package? Thanks. tds

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Todd Stern (CN=Todd Stern/OU=WHO/O=EOP [WHO])

CREATION DATE/TIME:20-APR-1999 14:50:41.00

SUBJECT: Re: Steinberg at 6

TO: David B Sandalow (CN=David B Sandalow/OU=CEQ/O=EOP @ EOP [CEQ])

READ:UNKNOWN

CC: Meagan M. Earley (CN=Meagan M. Earley/OU=WHO/O=EOP @ EOP [WHO])

READ:UNKNOWN

CC: Nancy Marlow (CN=Nancy Marlow/OU=CEQ/O=EOP @ EOP [CEQ])

READ:UNKNOWN

CC: George T. Frampton (CN=George T. Frampton/OU=CEQ/O=EOP @ EOP [CEQ])

READ:UNKNOWN

TEXT:

I'll try to see him on my own. I already said I can't make 6.