

**PERSPECTIVES ON THE ROLE OF  
BIOFUELS AND THE CONSERVATION RESERVE PROGRAM  
IN THE 2008 FARM BILL**

by

Bryan Jason Haney

A thesis submitted to the Faculty of the University of Delaware in partial fulfillment of the degree of Master of Energy and Environmental Policy

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*Conservation means development as much as it does protection. I recognize the right and duty of this generation to develop and use the natural resources of our land; but I do not recognize the right to waste them, or to rob, by wasteful use, the generations that come after us ... the farmer is a good farmer who, having enabled the land to support himself and to provide for the education of his children, leaves it to them a little better than he found it himself*

-Theodore Roosevelt  
Ossawatimie, Kansas  
August 31, 1910

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## **ABSTRACT**

The expiration of the *Farm Security and Rural Investment Act* of 2002 provided an opportunity to specifically address the role of agriculture as a bioenergy producer in the newly enacted 2008 Farm Bill. The reauthorization process sought to address the growing need for energy resources, the potential of agriculture to supply bioenergy and biofuels, and whether idle and retired land can and should be reallocated to bioenergy production. Proposals suggested targeting part of the large amount of land enrolled in the Conservation Reserve Program (CRP) – a land-retirement program that contains over 36 million acres of land – and transforming it into a biomass reserve program that meets the multiple objectives of conservation, energy security, and agricultural growth.

This research utilized the E3 Framework (Energy-Environment-Economy) to evaluate various proposals for modifying the CRP to allow contracted acres to be used for bioenergy feedstock production. A land utilization model based on profit maximization was developed to analyze if CRP participants would convert contracted acres to alternate uses and model how farmer income, program cost, biofuel feedstock potential, and cropland usage were affected by four possible CRP program structures between 2007 and 2016. A multi-perspective analysis was employed to judge the results based on environmental and energy implications as well as economic efficiency and recommend an optimum policy solution that balances the conservation mandate of the CRP with the growing demands for land to grow biofuel feedstocks.

The optimum policy proposal recommends incorporating sustainable bioenergy production on contracted acres as a primary goal of the Conservation Reserve Program. Landowners would be permitted to submit applications to the Farm Service Agency (FSA) to convert *up to 25%* of contracted acres to sustainably grow and harvest bioenergy feedstocks. Model results indicate that the optimum policy proposal increases net farm income over a 10-year period, reduces program administration costs, preserves the environmental integrity of the CRP, and expands the availability of biofuel feedstocks. In comparison, actual legislation implemented as part of the 2008 Farm Bill provides substantial support for the development of sustainable 2<sup>nd</sup> generation domestic biofuel production systems on existing cropland, but fails to capitalize on the available land resources contained within the Conservation Reserve Program.

## **Chapter 1**

### **1 INTRODUCTION**

#### **1.1 Overview**

The subject of this thesis is the growing reliance on biofuels in the United States. The theoretical framework is based on the tradeoff between the long-term need for low-cost, secure energy sources and the growing environmental burden attributed to the quest for abundant energy supplies. The primary research evaluates the function of the Conservation Reserve Program (CRP) and policy solutions for balancing the growing land requirements to produce bioenergy with the continued need to conserve land to preserve environmental integrity. It directly examines the resource limitations, economic constraints, and policy options surrounding the CRP within the context of the 2008 Farm Bill policy process and the variety of land-use proposals suggested for the CRP.

A Geographic Information System (GIS) is employed to quantitatively assess different policy proposals for the Conservation Reserve Program, estimate land-use change at the county level, and gauge the effect on program enrollment, bioenergy production, farm income, government program payments, and crop selection. Quantitative results are judged based on their economic merit, potential environmental impact, and total bioenergy produced to provide perspective on the variety of proposals for the CRP. Finally, an optimum policy that balances the capacity of

acreage enrolled in the CRP to produce bioenergy with the continued need for conservation is suggested.

## **1.2 Introduction**

In the United States, a growing policy emphasis to improve energy security, reduce oil price volatility and mitigate global climate change has led to a renewed search for alternative sources of energy. Bioenergy produced from agriculture sources, either in the form of liquid fuel for transportation or combustible fuel for electricity generation, has emerged as a viable renewable energy source that can expand energy supplies, offset imports of petroleum, and reduce emissions of carbon dioxide (Collins, “Emerging Bioeconomy”; Cook and Beyea 442; Sims 95-97). Additionally, bioenergy derived from agriculture presents new market opportunities to domestic farmers who have faced low prices and limited market growth for traditional bulk agricultural commodities in recent years (Collins and Duffield, 6-9).

Bioenergy production has historically been confined to the forestry sector where waste products from timber mills and paper and pulp facilities are used to generate industrial heat, steam and electricity. Even in this limited application, over 3 percent of total energy consumption in the United States is supplied by bioenergy, making it the largest source of renewable energy today (US-USDA/DOE “Billion Ton Annual Supply” 1). However, considerable potential exists for expanded bioenergy production in the agriculture sector. A study commissioned by the United States Department of Agriculture (USDA) and the Department of Energy (USDOE) concluded that the agriculture sector could potentially produce almost one billion dry tons of biomass per year, a five-fold increase over current bioenergy production levels (US-USDA/DOE “Billion Ton Annual Supply” Table B.6). In a world where the real

price of crude oil is expected to continue rising (US-EIA, “AEO 2008” 83), the agriculture sector may be poised to become a major alternative energy source for the United States in the 21st century.

The rapid increase in the production of biofuels – ethanol and biodiesel – over the last 10 years (See Figure 2-2) has underscored both the incredible potential of the agriculture sector to produce bioenergy and the possible consequences of large-scale bioenergy production. Bioenergy production strengthens the linkage between agriculture and energy markets and further increases competition for limited land resources. The extent that the U.S. agriculture industry will produce bioenergy depends on a number of issues, including but not limited to:

- World energy prices for petroleum and natural gas,
- Availability and productivity of cropland,
- Agriculture, energy and environmental policy at the national and international level,
- Environmental effects and sustainability of bioenergy production,
- Development of technologies for converting agricultural commodities into energy,
- Demand for agricultural food products versus agricultural bioenergy products, and
- Changes in farm management practices, energy usage, crop varieties and land use characteristics.

Of particular concern is the development of agricultural, energy, and environmental policies that have uniform bioenergy goals and promulgate complementary regulations and bioenergy development programs (Nipp, 25). A

number of policies currently encourage the use of ethanol in the United States, but few have similar goals and most are designed to serve specific energy, environmental or agricultural interests. Ethanol production in the United States was initially spurred by a production tax credit established in the Energy Tax Act of 1978, a piece of energy policy legislation aimed at diversifying energy supply. The Clean Air Act Amendments of 1990 (CAA), a piece of environmental policy legislation aimed at reducing air pollution, permitted the use of ethanol as an oxygenate in reformulated gasoline. In 2000, the USDA initiated the Commodity Credit Corporation (CCC) Bioenergy Program, an agricultural program, which incentivized biofuels production to provide price support for agricultural commodities. The net effect of these programs has been a rapid, unexpected increase in the production of ethanol, a short-term surge in corn prices, and the highest recorded planting of corn ever during the Spring of 2007 (Martin).

The expiration of the *Farm Security and Rural Investment Act* of 2002 (2002 Farm Bill) provided an opportunity to specifically address the role of agriculture as a bioenergy producer in the newly enacted 2008 Farm Bill. Despite the comprehensive nature of the 2008 Farm Bill, Senate Agriculture Committee Chairman Tom Harkin-D from Iowa was quoted in an AP news release stating, “Energy actually may be the engine that pulls this farm bill, or pushes it.” In particular, there was considerable interest to craft policies that encourage increased production of ethanol derived from cellulosic feedstocks like switchgrass and poplar trees instead of corn. Proposals suggested targeting part of the large amount of land enrolled in the Conservation Reserve Program (CRP) – a land-retirement program that contains over 36 million acres of land – and transforming it into a biomass reserve program that

meets the multiple objectives of conservation, energy security, and agricultural growth (Collins, “New World of Biofuels”). The integrated, comprehensive nature of a Farm Bill provides a framework to thoroughly evaluate the energy, environment, and economic issues surrounding such a proposal.

The Conservation Reserve Program contains nearly 9% (36.8 million acres) of the total land in the United States classified as cropland (US-USDA, “2002 Agriculture Census” Table 8). Established in 1985, the land retirement program provides financial incentives for farmers to voluntarily remove acreage from traditional crop production and implement long-term conservation practices for periods of 10-15 years. However, land is not permanently retired and can again be used for crop production at the end of the contract period if the farmer chooses. Given the increasing demand for agricultural commodities, rising crop prices, and heightened competition for existing cropland, there is considerable pressure to convert CRP acreage to alternate uses upon contract expiration. A major focus of the 2008 Farm Bill proceedings, and the primary concentration of this thesis, is to evaluate the Conservation Reserve Program and propose a program that balances necessity for land conservation with the increased pressure to utilize agricultural land to produce bioenergy and biofuels.

### **1.3 Redirecting the CRP – The 2008 Farm Bill**

At the beginning of 2007, 36.8 million acres of land, or approximately 9% of total cropland in the United States, was enrolled in the Conservation Reserve Program (USDA 2002 Agriculture Census, Table 8). Annual rental payments provided to landowners exceeded \$1.8 billion dollars in 2006, making it the largest conservation program funded by the United States Department of Agriculture. The

CRP is aimed primarily at retiring the most environmentally sensitive cropland in the United States for periods of 10-15 years and a competitive bidding process is used to identify the most suitable acres for enrollment. Cost-sharing is provided to landowners to install soil, wildlife, or wetland conservation practices on the land and a variety of sub-programs are contained within the CRP to manage the various types of cropland.

Authorization for the CRP was slated to expire at the end of the 2007 fiscal year unless reauthorized as part of the 2008 Farm Bill. The reauthorization process sought to address the growing need for energy resources, the potential of agriculture to supply bioenergy and biofuels, and whether idle and retired land can and should be reallocated to bioenergy production. Biofuel industry growth, coupled with increasing demand for traditional agricultural commodities has led to elevated prices for bulk agricultural commodities and highlighted the inherent land-resource limitations of the agricultural sector in the United States.

A number of researchers, environmental groups, wildlife associations, and farm organizations have expressed concern about the uncertain future of the CRP and suggested proposals (See Sections 4.5 and 4.6) for satisfying the multiple demands placed on CRP lands by ecosystems, wildlife, hunters, birdwatchers, farmers, environmentalists, and bioenergy producers (Ringelman, 54-55).

To what extent elements of these proposals influenced the 2008 Farm Bill remains uncertain and depends on any number of unpredictable factors inherent to the policy process. Achieving balance between the sometimes-conflicting goals of energy production, land and wildlife conservation, government program requirements, and farm security remains extremely difficult.

## **1.4 Statement of the Problem**

The varying nature and number of proposals for the CRP, coupled with the large impact program changes will have on stakeholders compels a thorough examination of the costs and benefits associated with changing the CRP. The growing demand for corn, soybean and cellulose feedstocks from the biofuel sector has focused attention on the potential for acreage enrolled in the CRP to produce bioenergy. As such, this thesis specifically investigates different program proposals aimed at utilizing CRP land to produce bioenergy crops and how acreage enrollment, farm income, bioenergy production, and land-usage will be affected.

Examining the costs and benefits of the various CRP program proposals is aimed at answering a number of research questions:

- 1) How might the CRP best be utilized to produce bioenergy and biofuel feedstocks?
- 2) How much biofuel can be produced from CRP land? How will this change with different biomass feedstocks (cellulose, corn, soybeans) and varying economic assumptions? Can the CRP produce enough biofuel to reduce petroleum imports?
- 3) How much land may be removed from the CRP and applied to other uses?
- 4) What are the environmental costs/benefits associated with CRP land-use changes?
- 5) Is bioenergy production compatible with the conservation mandate of the CRP?
- 6) How will farm income and CRP program costs change?
- 7) Should CRP lands be utilized to produce bioenergy?

8) How should the CRP be altered to balance bioenergy production with conservation?

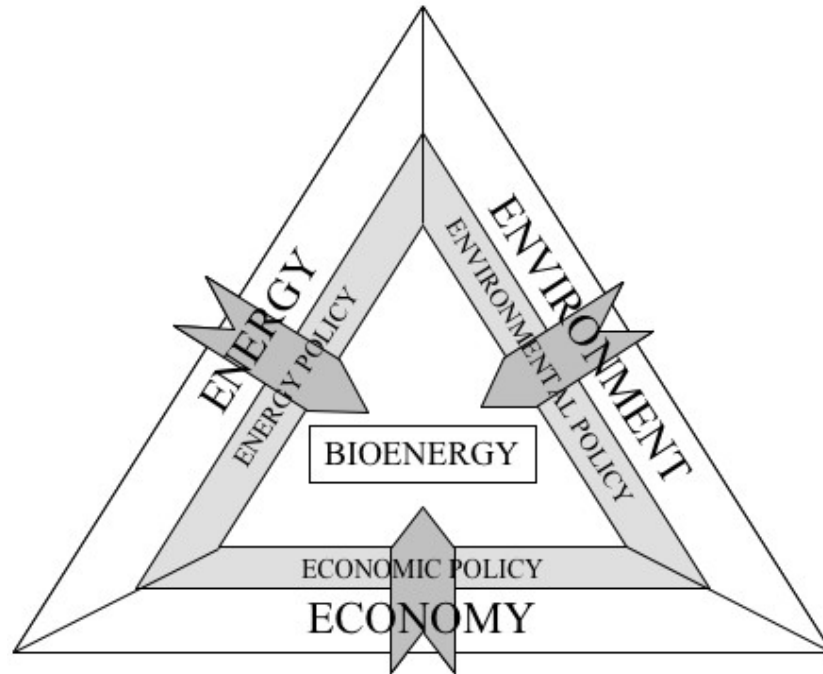
This research is used to provide perspective on the uncertain future of the CRP and make a recommendation for the most suitable policy to balance and satisfy the multiple objectives of energy production, environmental conservation, and economic efficiency.

### **1.5 Conceptual Framework**

The size and scope of the 2008 Farm Bill necessitates a broad framework to analyze the costs and benefits of various CRP program proposals. The Energy-Economy-Environment framework (E3), implicitly employed by the United Nations in the *Report of the World Commission on Environment and Development* (“Our Common Future”) (171-176), provides a suitable method to investigate the effects of land-use changes on society and the environment and to weigh the relative merits of each proposal against the potential costs. The E3 framework acknowledges the complicated interaction between energy, environment and economy and forces a multi-perspective analysis aimed at achieving a socio-economic pareto-optimal solution, an established policy goal.

The energy, economic and environmental effects of the Conservation Reserve Program have been well-documented within independent disciplines, but most lack the comprehensive, multi-disciplinary analysis necessary for policy development. The E3 framework, depicted in Figure 1-1 provides a way to unify the research performed on wildlife habitat, rural economies, soil and water conservation, farm management, agricultural policy and energy and link it to policies designed to encourage bioenergy production. Importantly, land utilization models based on profit

maximization and the theory of consumer behavior are judged on environmental and energy implications and not just economic efficiency. Cost, benefits and tradeoffs associated with different policies become readily apparent when analyzed in this fashion.



**Figure 1-1 Energy – Economy – Environment (E3) Framework**

## **1.6 Research Methodology**

The objective of this thesis is to explore the variety of proposals aimed at utilizing the CRP for bioenergy production, quantify the effects of each proposal on farm income, bioenergy production, program enrollment and government program payments, and determine an optimal proposal for the CRP. The major research is categorized into three sections, divided among chapters 4-7 of the thesis:

- 1) Proposals for the future of the CRP (Chapter 4) – The surging demand for biofuels is applying upward pressure on land rental rates, even as CRP annual program payments remain fixed, and encouraging landowners to reallocate their CRP land to more profitable uses. Program proposals suggested by the current Administration, farm industry, wildlife, dairy, conservation and food groups are reviewed and proposals affecting the CRP are critiqued. Previous research analyzing the effect of program changes on the CRP is also reviewed.
- 2) Quantitative Analysis of Major CRP Program Proposals (Chapters 5,6) – An analytical GIS model was constructed to quantify the effects of four proposals that integrate bioenergy production into CRP program guidelines. The model predicts, at the county level, if acres will remain enrolled in the CRP or converted to other uses based on the present-value of farm income over the 2007-2016 period. It is assumed that landowners will act in their own best interest and seek profit maximization. Discount rates, yield growth rates, commodity price forecasts, land productivity and production costs can be altered to test the sensitivity of the projections. For each scenario, the effect of program changes on net farm income, bioenergy production, program enrollment, and government program payments are quantified.
- 3) Optimum Policy Proposal (Chapter 7) – Results from the GIS model are merged with suggestions from numerous CRP proposals

to generate an optimal program within the E3 framework. The optimal scenario seeks to maximize environmental benefits, minimize program costs, expand bioenergy production and increase net farm income. This proposal will be evaluated relative to the any changes made to the CRP as a result of the 2008 Farm Bill.

## **1.7 Thesis Organization**

This thesis is organized into seven chapters. The first chapter, *Introduction*, identified the potential for bioenergy production in the U.S. agriculture sector and the opportunity to redirect the Conservation Reserve Program to produce bioenergy in the 2008 Farm Bill. Chapter 2, *Bioenergy Challenges and Potential*, examines the role of bioenergy, specifically the biofuels ethanol and biodiesel, in the U.S. energy supply and outlines the major economic, technical, and political challenges facing continued industry growth. Chapter 3, *Conservation Reserve Program Origins and Opportunities*, investigates specific attributes of the program including goals, mandates, enrollment statistics, costs, major criticisms and opportunities. Chapter 4, *Redirecting the Conservation Reserve Program* describes the major proposals for changing the program and each proposal's advantages and disadvantages. A summary of current research analyzing the effects of CRP program changes supplements the discussion. Chapter 5, *Research Goals and Methodology*, describes four program proposals for the CRP, a general framework for analyzing each program using Geographic Information Systems (GIS) Software and the general assumptions and parameters used in the analytical model. Chapter 6, *Conservation Reserve Program Proposal Results and Analysis*, summarizes the major findings for

each of the four CRP program proposals and presents a comparative analysis of the costs and benefits. Chapter 7, *The Future of the CRP: Research Conclusions and Policy Perspectives*, presents an informed policy proposal for the CRP that balances bioenergy production with conservation.

## **Chapter 2**

### **2 BIOENERGY CHALLENGES AND POTENTIAL**

#### **2.1 Bioenergy in the United States**

Bioenergy – energy derived from trees, plant matter and other forms of biomass – composed a significant portion of total energy consumed in the United States in the early parts of the 20th century. Wood was widely used as a heating fuel and hay and oats fed to horses met most transportation needs. Liquid transportation fuels that powered the first automobiles were also derived from agricultural sources; Rudolph Diesel’s diesel engine was designed to run on peanut oil and Henry Ford’s petrol engine used ethanol (Duffield, “Overview” 5). However, the amount of bioenergy derived from agriculture stagnated following the introduction of petroleum in the 1920’s (US-EIA, “AER 2008 – Energy Perspectives: Figure 5). The low cost, convenience, high energy density, and nearly limitless supply of petroleum throughout the 20th century discouraged further development or use of bioenergy.

Bioenergy continues to be used today, albeit in a fairly limited fashion. Of the nearly 102 quadrillion Btu (quads) of energy consumed by the United States in 2007, 85% was supplied by fossil fuel sources, but only 3.54% was supplied from domestic biomass sources (US-EIA, “AER-2008” Table 1.3). 60% (2.166 quads) of the biomass produced in the United States was in the form of wood, the remainder was composed of municipal solid waste, sludge waste, agricultural byproducts and alcohol fuels. 21.2% (0.460 quads) of the wood was consumed by the residential sector for

heating and 67.2% (1.457 quads) was used by the timber and paper and pulp industries to produce industrial heat and steam (US-EIA, “AER-2008” Table 10.2a/b). 0.427 quads of biomass were used to generate electricity, primarily from landfill gas and wood waste used in combined heat and power applications (US-EIA, “AER-2008” Table 10.2c). Table 2-1 provides a breakdown of biomass energy consumption in the United States in 2007.

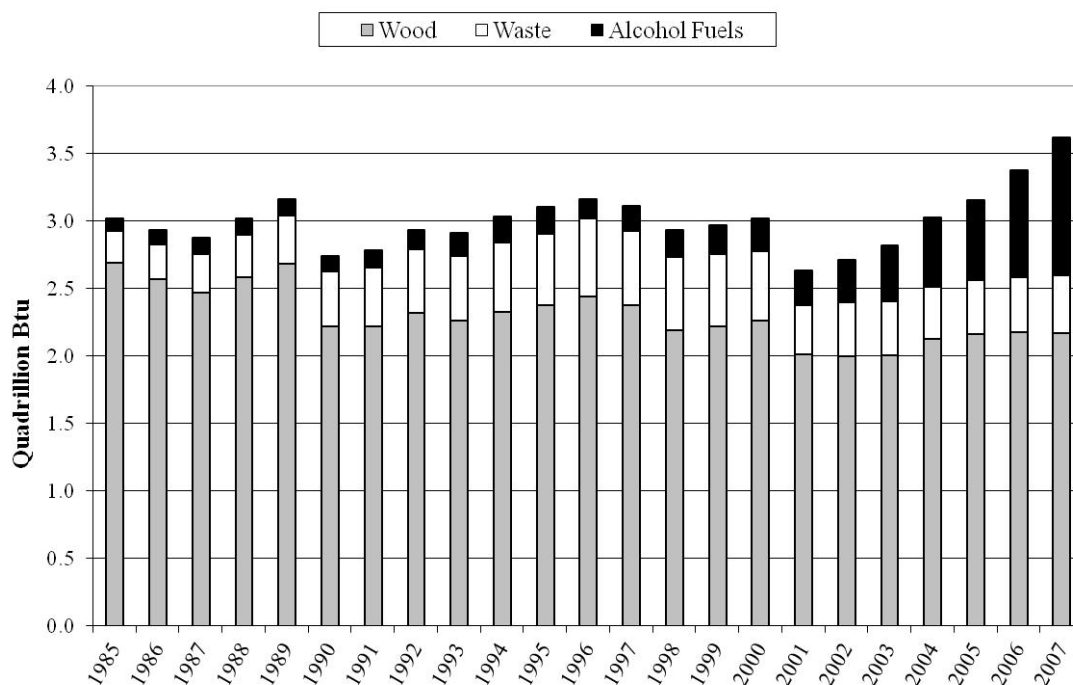
**Table 2-1 Biomass Energy Consumption in 2007**

(quadrillion Btu)	<i><b>Biomass Sources</b></i>		
<i><b>End-Use Consumption</b></i>	<i><b>Wood</b></i>	<i><b>Waste</b></i>	<i><b>Biofuels</b></i>
Residential	0.460	0.000	0.000
Commercial	0.065	0.037	0.002
Industrial	1.457	0.151	0.012
Electric Generation	0.184	0.243	0.000
Transportation	0.000	0.000	0.626
<i><b>Total</b></i>	<i><b>2.166</b></i>	<i><b>0.431</b></i>	<i><b>0.640</b></i>

**Source:** (US-EIA, “AER 2008” Tables 10.1, 10.2a, b, c)

The absolute amount of bioenergy used in the United States has remained relatively constant since 1985, even though total energy consumption has increased from 76.6 quads in 1985 to nearly 102 quads in 2007 (US-EIA, “AER-2008” Table 1.3). This may be due to the slow, even negative growth of the U.S. timber and paper and pulp industries. As a result, the supply and consumption of inexpensive sources of wood – the dominant form of biomass – has remained relatively constant and growing energy consumption has been met with less expensive fossil fuel sources. However, the amount of bioenergy produced from agriculture and consumed in the form of ethanol and biodiesel has risen dramatically over the last 20 years. Figure 2-1 shows that biofuels constitute an increasingly larger share, in both absolute and

relative terms, of the total bioenergy supply in the United States. Long-term projections from the Energy Information Administration indicate that this trend will continue and that biofuels will comprise 34% of total bioenergy consumption by 2030 (US-EIA, “AEO 2008” Table A17).



Source: (US-EIA, “AER-2008” Table 10.1)

**Figure 2-1 1985-2007 Biomass Energy Consumption (by Source) in the U.S.**

The rapid growth of biofuels underscores the increasing importance of agriculture as a producer of bioenergy. Agriculture currently produces roughly 25% of the bioenergy and bioproducts consumed in the United States (US-USDA/DOE “Billion Ton Annual Supply” 19). Considerable untapped agriculture biomass resources currently exist in the form of crop residues and animal manure. In addition,

the agriculture sector has significant bioenergy potential and could adopt new varieties of grain and oilseed crops, implement improved farm management practices, plant dedicated bioenergy crops like switchgrass and poplar trees, and return retired or marginal cropland to production. Based on varying assumptions, estimates for the potential annual biomass production capacity of the U.S. agriculture sector range between 400 -1,000 million dry tons per year within 35-40 years (US-USDA/DOE “Billion Ton Annual Supply” 32). In the near-term, agriculture bioenergy production will be primarily dedicated to ethanol and biodiesel produced from corn and soybeans respectively.

## **2.2 Biofuels for the Transportation Sector**

Ethanol and biodiesel are the major biofuels currently produced in the United States. Both are derived from bulk agricultural commodities and are considered non-depletable, renewable fuels. Ethanol and biodiesel serve as direct substitutes for gasoline and diesel, respectively, and can be used in nearly all modern automobiles, trucks and buses with little to no modification. The properties of each fuel and a brief discussion of associated benefits and disadvantages are presented here.

### **2.2.1 Ethanol**

Ethyl alcohol, normally referred to as ethanol, is a compound most commonly found in spirits, wine and beer at medium to low concentrations (3 – 40% by volume). However, the high octane and oxygen content of 100% anhydrous ethanol also make it an extremely good motor fuel with desirable combustion characteristics. Fuel ethanol has found practical application as a motor fuel additive in the United States and as a dedicated motor fuel in Brazil. Presently, ethanol is the

most widely used liquid biofuel in the world (Salameh, 8). According to the Energy Information Administration, 6.521 billion gallons of ethanol (4.7% of total gasoline consumption) were produced in the United States in 2007 (“AER 2008” Table 10.3).

In the United States, 10% ethanol is generally blended with 90% gasoline to produce a fuel called E10. A smaller amount of fuel is blended at 85% ethanol/15% gasoline to produce a fuel called E85. The vast majority of automobiles produced since the late 1970’s are warranted to run on blends of E10, but specialized vehicles called Flex-Fuel Vehicles (FFV’s) are necessary to use high percentage ethanol blends like E85. Automobile manufacturers have produced a limited number of FFV’s for the United States market. Based on automobile production figures, nearly 6 million FFV’s have been produced, but only 364,000 FFV’s are assumed to be operating using alternative fuels (US-EIA, “AER 2008” Table 10.5)

Just like alcoholic malt beverages, fuel ethanol is produced using a fermentation process. Common feedstocks include corn (United States), sugar cane (Brazil) sugar beets (Europe) and any other agricultural commodity that contains convertible sugars or starches. The majority of commercial ethanol production facilities in the United States employ dry-mill operations that process the entire corn kernel, ferment the entrained sugars, and distill ethanol from the fermented mixture. Dried Distiller’s Grains and Solubles (DDGS) are a major byproduct of the dry-mill process that is sold as animal feed. A smaller number of facilities employ wet-mill operations that first separate the corn kernel into starch, fibre, gluten and germ components before converting the starch into sugars and fermenting the sugars into ethanol. The residual fibre, gluten and germ can be converted into corn oil, gluten feed, and gluten meal co-products (RFA “How Ethanol is Made”). A typical ethanol

yield for a commercial ethanol facility ranges between 2.6 – 2.8 gallons of ethanol per bushel of corn (Eidman, 35).

A number of positive environmental attributes are typically associated with fuel ethanol. The high oxygen content of ethanol contributes to improved combustion and lower amounts of incomplete combustion products like carbon monoxide (CO) when it is blended with conventional gasoline. Various studies report CO reductions of 2-43% for low percentage ethanol blends (< 10%) relative to conventional gasoline (Williams et al., 1095). Reductions of volatile organic components and other precursors of ozone formation were also reported for low percentage ethanol blends. Ethanol air quality benefits are roughly comparable to another oxygenate fuel additive, methyl-tertiary-butyl-ether (MTBE), that was added to reformulated gasoline beginning in the early 1990's. However, since research indicated that MTBE was permeating into the environment and contaminating groundwater (Pankow et al., 2821-2822), ethanol has become a more favored oxygenate additive.

Ethanol is characterized as a renewable fuel that has the potential to reduce greenhouse gas emissions (GHG) relative to conventional gasoline. Theoretically, carbon dioxide (CO<sub>2</sub>) emissions released during combustion of the fuel are recaptured by plant growth the following year, thereby resulting in zero net CO<sub>2</sub> emissions. However, net CO<sub>2</sub> emissions are highly dependent on the feedstock, associated farming practices, and the amount and type of energy required to process primary feedstocks into ethanol. A number of researchers have performed life-cycle studies to calculate the reduction in greenhouse gas emissions resulting from replacing conventional gasoline with ethanol (Wang et al. 22-32; Hill 11207 ; Hammerschlag

1744; Farrell et al. 506-508). General consensus indicates that ethanol and ethanol blends reduce GHG emissions relative to conventional gasoline but the estimated magnitude of the reduction varies considerably with the life-cycle methodology and assumptions employed.

Less desirable attributes of fuel ethanol include the lower energy density of the fuel and higher evaporative emissions than conventional gasoline. A gallon of ethanol contains only 67% of the energy contained in an equivalent volume of gasoline (US-EIA, “AEO 2008” 215) and will result in proportionally lower mileage when blended and used in automobiles designed for conventional gasoline. Ethanol has a higher Reid Vapor Pressure than gasoline which increases the volatility of ethanol/gasoline blends and increases evaporative emissions (Williams et al., 1097). Lastly ethanol absorbs water and requires special handling and distribution to prevent water contamination during shipment and storage (Whims). Water can cause phase separation in ethanol/gasoline blends and degrade engine performance. As a result, ethanol cannot be shipped through existing pipelines without maintenance to remove water or retrofits to prevent water from accumulating.

### **2.2.2 Ethanol from Biomass**

Ethanol is primarily produced from corn, sugar beets and sugarcane containing easily fermentable starches and sugars. Alternatively, starches and sugars found within cellulose, the primary structural component of green plants and biomass residues (wood waste, paper, agricultural waste), can be separated and converted to ethanol using additional processing techniques. Ethanol derived from cellulosic biomass is called “cellulosic ethanol” and is chemically identical to ethanol derived from corn or sugar cane. Any substance containing significant quantities of cellulose

can be converted to ethanol, but switchgrass (*Panicum virgatum*), poplar and willow trees (*Salix spp.*) agriculture residues (corn stover, wheat straw), and wood waste are some of the most available sources of cellulosic material (US-USDA/DOE “Billion Ton Annual Supply” 23; Eidman 39; Spitzer 3-4).

Cellulosic ethanol is produced using a two-step process. In the first step, acid or enzymatic hydrolysis is used to extract fermentable sugars from the cellulose and hemi-cellulose contained in the feedstock, producing lignin as a byproduct. The extracted sugars are then fermented using a yeast strain to produce ethanol (RFA “How Ethanol is Made”; Aden et al. 5-6). Another production process uses gasification to breakdown the feedstock into carbon monoxide, carbon dioxide and hydrogen (synthesis gas) which are then reconstituted into ethanol using a thermochemical reaction (US-EIA, “AEO 2007” 58). Initial capital cost and per gallon production cost for a cellulosic ethanol plant remains significantly higher than a corn-ethanol plant of equivalent size (US-EIA, “AEO 2007” 58). The additional process complexity, high feedstock transportation costs, low ethanol yields, low corn-ethanol production costs and limited industry experience continue to hinder the development of cellulosic ethanol plants in the United States (Eidman 40,42).

Despite its higher production cost, cellulosic ethanol is generally characterized as a more sustainable biofuel than ethanol derived from corn or sugar cane (Duffield; Graham et al., “Environmental Benefits”; Cook and Beyea). Unlike corn, soybeans and sugarcane, switchgrass and hybrid poplars are perennials that do not have to be harvested and replanted each year, thus reducing soil erosion and providing habitat refuge for birds and other wildlife. Studies have also indicated that the large root structures of perennial native grasses like switchgrass retain soil carbon

and reduce the loss of soil organic matter (SOM) compared to traditional row crops (Downing et al.). Additionally, most biomass crops are hearty, native species that do not require the intensive farm management practices of traditional row crops in most regions in the United States. The result is less application of fertilizer and pesticides, reduced agricultural runoff and improved water quality (Graham et al., “Environmental Benefits”).

Energy produced from biomass, whether to combust for heat or electricity or to produce biofuels from cellulosic energy crops has considerable potential that has only been partially realized in the United States (Section 2.1). Cellulosic ethanol can be produced from a wider array of feedstocks that can be grown with native, versatile plant species on less fertile land in a more sustainable fashion than traditional row crops. However, the infancy of the cellulosic energy industry, coupled with the high transportation cost of biomass continues to limit biomass market opportunities for farmers and biomass is only grown in small areas to serve niche markets.

### **2.2.3 Biodiesel**

Biodiesel, sometimes referred to as fatty-acid methyl ester (FAME), is a renewable substitute for diesel that is produced from vegetable oils, animal fats, or waste greases. Biodiesel can be used in standard compression-ignition engines as a dedicated motor fuel or as a blend component in ordinary diesel fuel. Unlike ethanol, high percentage blends of biodiesel do not require modified vehicles and, in fact, any percentage blend of biodiesel can be used in most diesel engines without problems. Presently, biodiesel is widely used in Europe where 1.7 billion gallons were produced in 2007 (European Biodiesel Board). According to the EIA, 490 million gallons of

biodiesel (1.04% of total diesel consumption) were produced in 2007 in the United States.

In addition to pure biodiesel (B100), three blends of biodiesel are sold in the United States – 2%, 5%, and 20% – which are referred to as B2, B5, and B20 to indicate the percentage of biodiesel in the blend. Most engine manufacturers only warranty their engines for use with low-percentage biodiesel blends B2 and B5. As the ASTM standard for biodiesel continues to develop and the automobile and fuel industries gain more experience with the fuel, it is expected that engine manufacturers will warranty their engines for higher-percentage biodiesel blends. Currently, Jeep Cherokee SUV's and Dodge Ram diesel pickup trucks ship from the factory with B5 in the fuel tank (National Biodiesel Board, "Jeep").

Biodiesel is a product of a chemical reaction called transesterification. Common agricultural feedstocks include soybean and canola oil (United States), rapeseed oil (Europe), and palm oil (Malaysia). Residual animal fats, yellow grease, and waste trap grease are also viable feedstocks, but they require more preprocessing than virgin vegetable oils. Feedstocks are reacted with methanol and a catalyst (sodium hydroxide or potassium hydroxide) to form long-chain methyl esters similar to diesel hydrocarbons. Crude glycerin is a major byproduct of the process sold to the food and pharmaceutical industries for use in a wide variety of products (Eidman 43).

Biodiesel can be directly substituted for diesel in most applications but has physical properties different from ordinary diesel fuel (Kinast). Additionally, the type of feedstock used subtly affects the final fuel properties. In general, biodiesel gels at higher temperatures than ordinary diesel and must be heated during storage and transport to prevent clogging in colder climates. Biodiesel has a lower vapor pressure

and higher flash point than diesel, making it less likely to autoignite and safer to store. Biodiesel has greater lubricating qualities than diesel which can reduce engine wear and extend engine life. Depending on the type of feedstock, biodiesel can also have a higher cetane number than ordinary diesel, resulting in a shorter ignition delay and improved engine operation. The physical properties of biodiesel blends can vary non-linearly with percentage of the blend (Kinast 33-46), but generally greater percentage blends exhibit properties similar to biodiesel and lower percentage blends have properties similar to diesel.

The combustion characteristics of biodiesel and biodiesel blends vary considerably from ordinary diesel. Biodiesel contains 11-12% oxygen and virtually no sulfur or aromatic compounds (Kinast 21-36). As a result, emissions of carbon monoxide, sulphur dioxide, total hydrocarbons and particulate matter will decrease in proportion to higher percentages of biodiesel in the blend. For a blend of B20, particulate matter emissions will decrease by 10.1%, carbon monoxide emissions will decrease by 11.0% and net hydrocarbon emissions will decrease by 21.1%. The use of B20 does result in a net increase of nitrogen oxide emissions, a contributor to smog, of 2.0% relative to ordinary diesel (US-EPA ii).

Like ethanol, biodiesel is characterized as a renewable fuel that has the potential to reduce greenhouse gas emissions (GHG) relative to conventional gasoline. The annual growth of soybeans, canola, and rapeseed recaptures carbon dioxide emitted into the atmosphere upon combustion of the biodiesel. A number of researchers have performed life-cycle studies to calculate the reduction in greenhouse gas emissions of replacing ordinary diesel with biodiesel (Wang et al. 22-32; Hill 11207; US-NREL, "Life Cycle" v). General consensus indicates that biodiesel and

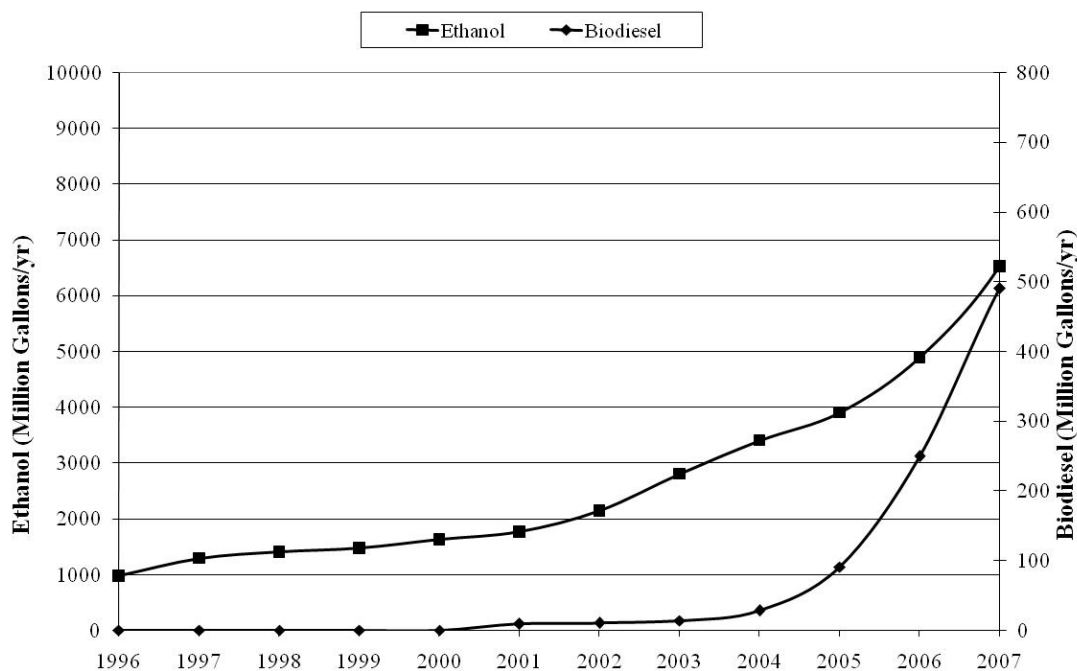
biodiesel blends reduce GHG emissions relative to ordinary diesel but the estimated magnitude of the reduction varies considerably depending on the assumptions used in the life cycle analysis. A comprehensive study performed jointly by the USDA and DOE found that the use of biodiesel as a dedicated fuel reduces net emissions of carbon dioxide by 78.45% compared to ordinary diesel. Replacing a gallon of diesel with biodiesel produced from soybeans results in a much larger reduction of carbon dioxide emissions than replacing a gallon of gasoline with a gallon of ethanol derived from corn. One study found that biodiesel reduces greenhouse gas emissions 2.75 times as much as corn ethanol (Hill 11207).

### **2.3 Drivers of Biofuel Industry Growth**

Biofuels are one of the fastest growing sources of energy in the United States. As of 2007, the latest year with comparable data available from the EIA, energy produced from biofuels grew at a faster rate than any other form of renewable energy. Additionally, more energy was produced from agriculturally derived biofuels (1.025 quads) than wind and solar facilities combined (0.422 quads) (US-EIA, “AER 2008” Table 10.1). Biofuel can also be directly substituted for gasoline and diesel in existing automobiles, making it the only form of renewable energy that can address the needs of the transportation sector. The two primary biofuels, ethanol and biodiesel, remain at the center of a rapidly growing industry. Figure 2-2 shows the rapid growth in biofuel consumption in the United States in the last 10 years. The primary factors contributing to rapid growth in the United States are:

- 1) High world oil prices,
- 2) Energy security concerns,
- 3) Climate change,

- 4) Energy/environmental/agriculture policies, and
- 5) Transportation infrastructure requirements.



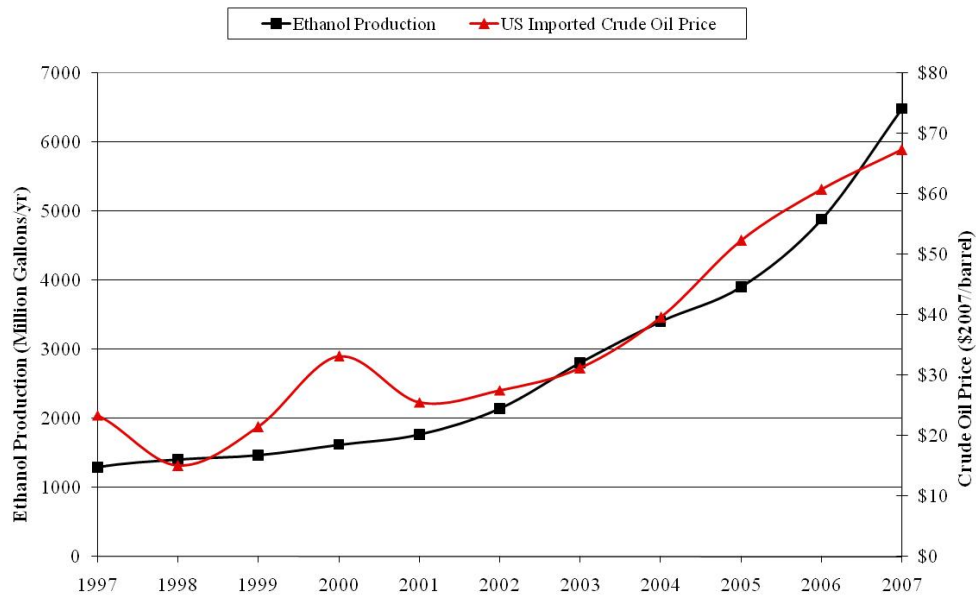
Source: (US-EIA, “AER 2008” Table 10.3/10.4)

**Figure 2-2 U.S. Biofuel Consumption (1996 - 2008)**

### 2.3.4 High World Oil Prices

The cost to produce ethanol and biodiesel has historically been much greater than the cost to produce gasoline and diesel from crude oil (Shapouri and Gallagher 4; US-EIA, “AEO 2007” 60). Since ethanol and biodiesel are substitutes for gasoline and biodiesel, biofuel producers have been unable to provide biofuels at prices competitive with liquid petroleum fuels except in niche markets. However, the dramatic rise of crude oil prices in the last 10 years has resulted in gasoline and diesel

prices that are high enough to justify the production and use of ethanol and biodiesel in the transportation sector. Figure 2-3 shows the dramatic increase in ethanol production capacity in the United States, partly attributed to the rise of world oil prices during the past 10 years. As the EIA predicts in their reference case scenario, world oil prices will remain at elevated levels between \$70-80 per barrel well into the future (US-EIA, “AEO 2008” 56). Continued high world oil prices will encourage further production and use of biofuels as substitutes and extenders of traditional petroleum liquid fuels.



**Source:** (US-EIA, “AER 2007” Tables 5.19, 10.3)

**Figure 2-3 Ethanol Production vs. Crude Oil Prices in the U.S.**

### **2.3.5 Energy Security**

Increasing volatility in the crude oil and natural gas markets (Lindemer 131), coupled with an ever-increasing reliance on imports to meet energy demand (US-EIA, “AER 2008” Table 5.1) have led many to conclude that the economic and security interests of United States are extremely vulnerable to a disruption of the energy supply. As far back as 2001, the National Energy Policy Development Group concluded that it was critical to “lessen the impact on Americans of energy price volatility and supply uncertainty” (pg. xv). Biofuels have been identified as one method to reduce reliance on imported petroleum by displacing gasoline and diesel in the transportation sector. In fact, biofuels have already helped retard the growth of oil imports. Marginal analysis shows that ethanol production met 20% of the increased gasoline demand over the last decade and limited growth in petroleum imports (Collins, “Emerging Bioeconomy”).

Energy security is expected to remain a significant growth driver for biofuel production in the United States. Spurred to diversify energy supplies and reduce the reliance on imported crude oil, President Bush proposed reducing gasoline consumption by 20% in 10 years and reducing imports of foreign oil by 75% in the 2007 State of the Union. The signature piece of the proposal is a fuels standard stipulating that 35 billion gallons of renewable and alternative fuels be produced annually by 2017, the bulk of which may be provided by corn ethanol, cellulosic ethanol and biodiesel. Additionally, the 110<sup>th</sup> Congress is actively trying to pass legislation to promote energy security that incorporates domestic biofuel use and development. Speaking for Senator Larry Craig from Idaho at the EIA Energy Conference 2007, Dr. Corey McDaniel discussed the “Goldilocks” approach to energy security; the three-pronged approach seeks to simultaneously encourage more

domestic oil drilling, reduce gasoline consumption with higher CAFE standards, and increase biofuel production and consumption.

Congressional action culminated in the passage of the *Energy Independence and Security Act of 2007* (EISA 2007), signed into law on December 19, 2007. While the act included many provisions focused on boosting vehicle fuel efficiency and energy efficiency in buildings and appliances, the signature piece of the legislation was a dramatic increase in the renewable fuels standard, requiring 36 billion gallons of fuel per year to be derived from biological feedstocks by 2022. The Renewable Fuel Standard for biofuels will dramatically increase the volume of liquid fuels produced from domestic sources and is expected to reduce reliance on foreign oil imports, even as demand for transportation fuels continues to grow. Analysis completed by the Energy Information Administration predicts that EISA 2007 will cut petroleum imports by nearly 12%, in addition to reducing total primary energy consumption by 3% by 2030 (Conti, “Annual Energy Outlook 2008”).

### **2.3.6 Climate Change**

Growing awareness of the linkage between the burning of fossil fuels, carbon dioxide emissions, and global climate change has encouraged policymakers to search for energy sources less carbon-intensive than fossil fuels. The transportation sector, which contributes roughly 33% of annual carbon dioxide emissions in the United States (US-EIA, “AER 2008” Table 12.2), is largely powered by gasoline and diesel that cannot be easily replaced by renewable energy without significant technological changes to the light-duty vehicle fleet. However, biofuels can be used with the existing automobile fleet and can help reduce carbon dioxide emissions when used in place of gasoline and diesel (Fulton 108; Hill 11207). In the short-term,

biofuels are one of the only methods to reduce the carbon-intensity of the existing transportation fleet. In a carbon-constrained world, the transportation sector is expected to increasingly rely on biofuels to achieve carbon dioxide emission reductions. The European Union and many U.S. States have already passed renewable fuel standards mandating that a certain percentage of transportation fuels must be biofuel.

#### **2.3.7 Energy/Environmental/Agriculture Policies**

Numerous energy, environmental and agricultural policies implemented in the last 20 years have encouraged growth and development of the biofuel industry.

Table 2-2 summarizes the major Federal policies in chronological order and the major effect they have had on the biofuel industry.

**Table 2-2 Summary of Biofuel-related Federal Legislation**

Federal Policy	Policy Details	Effect on Biofuel Industry
<i>Energy Policy and Conservation Act of 1975</i>	Established Corporate Average Fuel Economy (CAFE) standards to control fuel mileage of vehicles	None.
<i>National Energy Act of 1978</i>	Established ethanol motor fuel excise tax exemption (\$0.40/gal)	Promoted production of ethanol as alternative fuel, encouraged production of ethanol-blend compatible vehicles
<i>Caribbean Basin Initiative (1984)</i>	Allowed unlimited duty-free imports of ethanol from Caribbean countries (later amended to 7% of U.S. annual ethanol consumption in 1989)	Encouraged ethanol imports from lower-cost producing countries in limited quantities
<i>Alternative Motor Fuels Act (1988)</i>	Provided CAFÉ credits to manufacturer's of alternative fueled vehicles	Incentivized production of methanol and ethanol flex-fuel light-duty vehicles, over 5 million produced
<i>Clean Air Act Amendments (1990)</i>	Ethanol listed as oxygenate additive for reformulated gasoline	Increased demand for ethanol as a fuel additive
<i>Energy Policy Act of 1992 (EPACT 1992)</i>	Mandated alternative-fuel vehicle purchasing requirements for government/state motor fleets, extended ethanol excise fuel tax exemption	Guaranteed consumers for FFV's produced by auto manufacturers but did not mandate alternative fuel usage, further incentivized production of ethanol
<i>Energy Conservation Act of 1998</i>	Amended EPACT 1992 to include biodiesel fuel use credits for fleets	Encouraged biodiesel blending in fleet vehicles, stimulated biodiesel demand
<i>CCC Charter Act (2000)</i>	Establish Commodity Credit Corporation to stimulate demand, reduce crop surplus for certain commodities; encourage biofuel production	Reduced feedstock costs for corn/soybeans used to produce ethanol/biodiesel, encouraged biofuel production
<i>Biomass Research and Development Act of 2000</i>	Promote research into biobased products, funding provided in 2002 Farm Bill	Provided grants for biofuel research aimed at enhancing productivity, lowering cost of biomass production

**Table 2-2 Continued**

<i>Farm Security and Rural Investment Act of 2002 (2002 Farm Bill)</i>	<i>Title IX: Energy</i> incorporated energy into farm policy; Federal Biobased Product Procurement Program; Biodiesel Fuel Education Program; broadened CCC Bioenergy program to include animal fats, waste grease as biodiesel feedstocks	Acknowledged and supported energy production as a goal of agriculture, stimulated research on biofuels, continued support for CCC bioenergy program to reduce feedstock costs for corn/soybeans
<i>American Jobs Creation Act of 2004</i>	Streamlined ethanol tax credit process, extended ethanol tax credit at \$0.51/gal, established fuel tax credit for biodiesel of \$1.00/gal for virgin feedstock, \$0.50/gal for waste feedstocks	Further incentivized ethanol/biodiesel production, jumpstarted biodiesel industry
<i>Energy Policy Act of 2005 (EPACT 2005)</i>	Renewable Fuel Standard (7.5 Bgal by 2012); Cellulosic Biomass Program, loan guarantees for cellulosic ethanol facilities; Extended biodiesel excise tax credit to 2008; Small producer tax credit for ethanol/biodiesel	Mandated alternative fuel consumption, provides incentives for biofuel production, specifically new cellulosic ethanol production facilities
<i>Energy Independence and Security Act of 2007 (EISA 2007)</i>	Renewable Fuel Standard increased to 36 Bgal by 2022, with 16Bgal derived from cellulosic biomass; Raises minimum average CAFE fuel economy to 35 mpg by 2020	Significant increase in mandated demand for both conventional and cellulosic biofuels; requires car manufacturers to meet higher fuel economy requirements and utilize alternative fuel vehicles

**Source: (Duffield and Collins 16-23)**

### **2.3.8 Transportation Infrastructure Requirements**

Biofuels are readily substitutable for liquid petroleum fuels and can fit into the current transportation infrastructure with only minor modifications. The blendability of biofuels is an extremely convenient attribute that allows biofuels to be distributed, stored and dispensed using the same rack terminals, trucks, railroad cars,

fuel storage tanks, and dispensing equipment. Additionally, biofuels are liquid fuels that can be utilized by the vast majority of the light-duty vehicle (LDV) fleet currently in operation. Consumers are also comfortable and familiar with liquid automobile fuels. “Ethanol and biodiesel are viable because they have been able to fit into the form, time and place requirements already in place” (Doering 117). Other energy sources that have been applied to the automobile transportation sector – electricity, hydrogen, compressed natural gas – have not been able to meet either the form, time or place requirements without wholesale conversion of large parts of the energy infrastructure used to power the transportation sector. Biofuels are, and will remain, the predominant alternative energy source for the transportation sector for the conceivable future.

## **Chapter 3**

### **3 CONSERVATION RESERVE PROGRAM ORIGINS AND OPPORTUNITIES**

This chapter outlines the structure of the Conservation Reserve Program (CRP), reviews program enrollment statistics and examines research into the environmental and economic effects of the program over the last 20 years. Research exploring the potential of the CRP to produce biomass and a review of the major criticisms and deficiencies of the program are also considered.

#### **3.1 Program Overview**

The Conservation Reserve Program (CRP) was established by the Food Security Act of 1985 (1985 Farm Bill) to reduce soil erosion, control land prices, and limit agricultural production. The program has expanded to adopt environmental goals and today, the primary purpose of the program is to “assist owners and operators in conserving and improving soil, water, and wildlife resources on their farms and ranches by converting highly erodible lands and other environmentally sensitive cropland and marginal pastureland to long-term resource conserving covers” (US- USDA, “2007 Farm Bill Theme Paper” 13). The program is administered by the Farm Service Agency (FSA), an agency within the USDA, with technical assistance provided by the National Resource and Conservation Service (NRCS) and funding supplied by the USDA Commodity Credit Corporation (CCC).

The CRP is a voluntary program for private landowners who set-aside productive farm or pasture lands<sup>1</sup> for a period of 10-15 years and implement approved conservation practices on the land. In return, participating landowners receive fixed annual rental payments equivalent to the average dry-land cash rent of similar acres in the county for the term of enrollment. Additionally, landowners may receive up to 50% cost-share assistance to implement approved conservation practices and up to \$10 per acre each year for annual maintenance obligations. Up to 25% of a county's cropland may be enrolled in the CRP. The 2002 Farm Bill capped national program enrollment in the CRP at 39 million acres (~9% of total cropland). As of the end of the 2006 fiscal year, total enrollment in the program was estimated at 36 million acres (US-USDA, "CRP Summary" 1). The CRP must be reauthorized as part the 2008 Farm Bill process to allocate funding, define program guidelines and alter acreage caps beyond the 2007 Fiscal Year (FY).

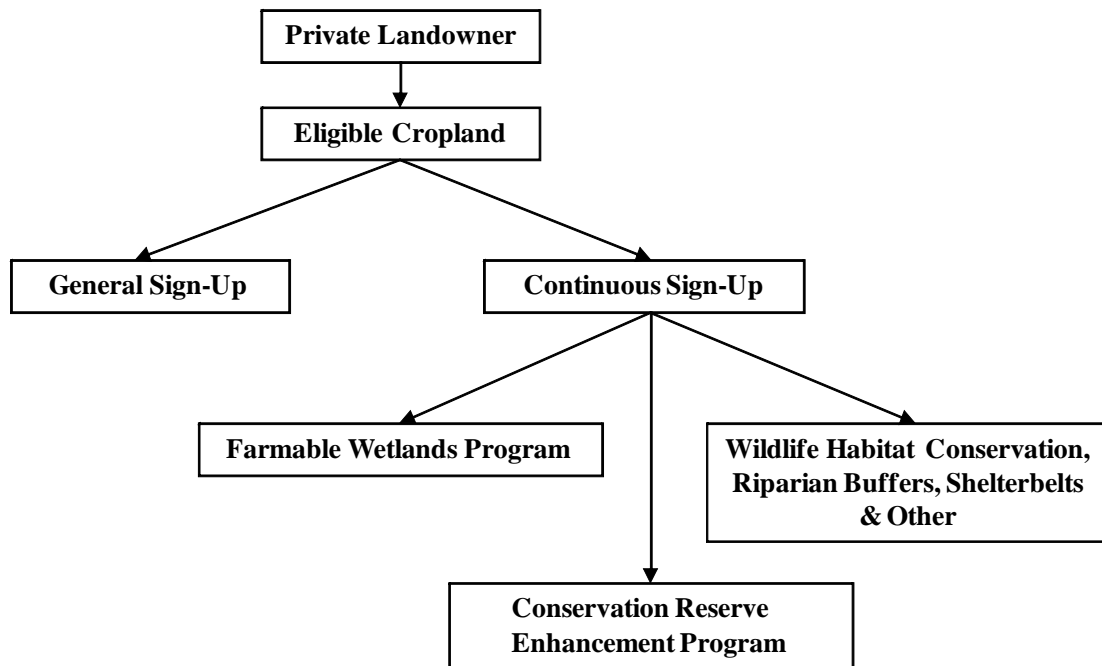
### **3.2 Program Descriptions and Sign-Up Practices**

Landowners can enroll eligible land in the CRP via two separate methods: General Sign-Up and Continuous Sign-Up. General Sign-Up is a nationally competitive enrollment process occurring only for limited periods as determined by the FSA. Sign-Up #33 was the most recent General Sign-up and occurred from March 22 – April 28, 2006 and enrolled 926,699 acres (US-USDA, "CRP Summary" A-18). Continuous Sign-Up is a non-competitive enrollment process devoted to high-priority conservation practices with heightened environmental benefits. Qualifying applications are automatically accepted into the CRP. The Continuous Sign-Up

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<sup>1</sup> To be eligible for the CRP, land must be legally permitted and able to grow an agricultural commodity and must have planted a commodity in the last 4 of 6 years.

program may solicit land for specific conservation practices such as wildlife habitat or forest restoration and wetland preservation (Cowan 5) or can participate in the Conservation Reserve Enhancement Program (CREP) and the Farmable Wetland Program (FWP) as shown in Figure 3-1. A brief description of each of these programs is provided below.



**Figure 3-1 Conservation Reserve Program Enrollment Methods**

### **3.2.1 General Sign-Up**

As of FY 2006, over 90% of the acres in the CRP have been enrolled in this fashion (US-USDA, “CRP Summary” 8). During each sign-up period, landowners may submit bids to enroll eligible land in the program. Each bid is evaluated based on the Environmental Benefits Index<sup>2</sup> score (EBI) and ranked nationally against all other applications. FSA selects a cutoff and awards contracts only to those bidders with EBI scores above the cutoff. The process is extremely competitive; only 66% of the 1.4 million acres submitted during the 33<sup>rd</sup> General Sign-Up in 2006 were accepted into the program (Cowan 4).

### **3.2.2 Continuous Sign-Up**

Environmentally sensitive land that will be devoted to specific conservation practices may apply at any time in a non-competitive process to be admitted to the CRP. Qualifying applications are automatically accepted. Owners enrolling land in the CRP via continuous sign-up agree to install specific long-term, resource conserving covers<sup>3</sup> on their land in return for higher rental payments and up to 50% cost-share assistance (FSA, “Program Fact Sheets”). Additionally, annual and

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2 The EBI score is an index used to evaluate and weight six environmental and cost criteria for each parcel of land enrolling in the CRP. The index is based on six factors: 1) wildlife benefits resulting from conservation practices, 2) water quality benefits from reduce erosion and runoff, 3) soil erosion benefits, 4) post-contract, long-term environmental benefits, 5) air-quality benefits and 6) cost. Land owners can improve their EBI score by agreeing to accept lower annual rental payments or planting wildlife enhancing cover crops (US-USDA, “CRP Summary” A-22)

3 Eligible conservation practices include riparian buffers, wetland restoration, grass waterways, shelterbelts, salt-tolerant vegetation, living windbreaks and snow fences and others.

up-front incentives are available to landowners who implement certain conservation practices. The 2002 Farm Bill reserved four million acres of the CRP exclusively for acreage enrolled via continuous sign-up.

### **3.2.3 Conservation Reserve Enhancement Program (CREP)**

This program has the same goals as other CRP programs, but the program is a partnership between landowners, state/federal government, local communities and non-governmental organizations. Areas with high-priority agriculture-related environmental concerns (i.e. Chesapeake Bay, Everglades, Snake Plain Aquifer) are the targets of the program. CREP projects are identified and initiated by stakeholders, then submitted for approval and funding to state and federal agencies (FSA, “Conservation Reserve Enhancement Program”). Up to 100,000 acres can be enrolled in a single project and there are currently 39 projects in 30 states (US-USDA, “CRP Summary” 2).

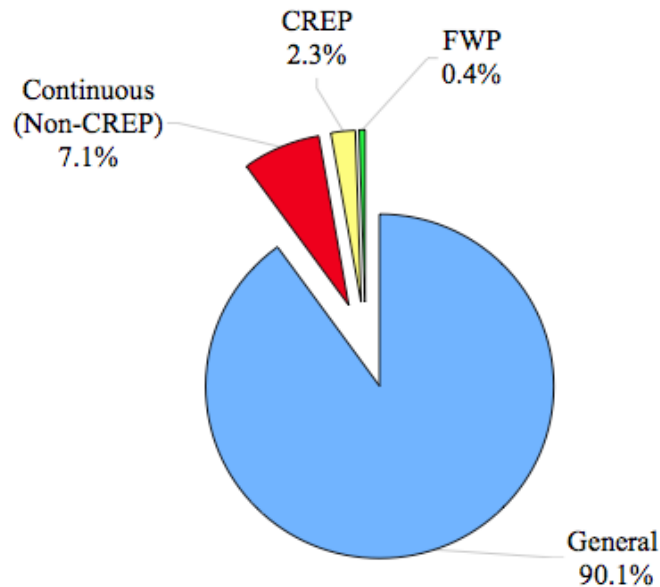
### **3.2.4 Farmable Wetlands Program (FWP)**

The 2002 Farm Bill reserved 1 million acres of the 39 million acre cap to enroll farmable wetlands – areas with productive capacity but technically classified as wetland – in the CRP. Eligible wetlands must be less than 10 acres and cropped 3 of the 10 preceding years. Owners receive higher annual rental payments by enrolling in the FWP and agreeing to restore the hydrology and install a vegetative cover (Zinn 7).

## **3.3 CRP Enrollment and Conservation Practices**

At the conclusion of the 2006 fiscal year (September 30, 2006), 36,003,300 acres were enrolled in the Conservation Reserve Program. 32.5 million acres were enrolled via general sign-up and 3.5 million acres via continuous sign-up.

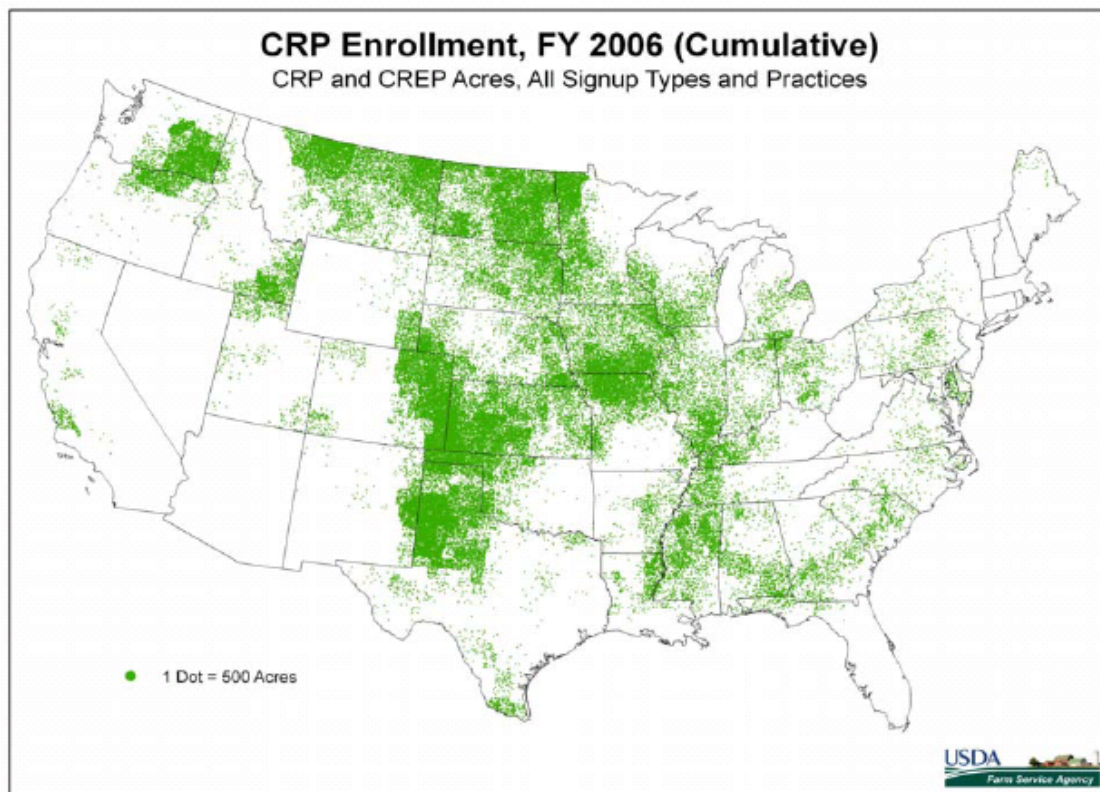
Of the acres enrolled via continuous sign-up, 832,577 were enrolled in CREP and 153,788 were enrolled in the Farmable Wetland Program. Figure 3-2 shows a detailed breakdown of acreage enrolled in the CRP according to program type.



**Source: (US-USDA, FY2006 CRP Summary Report)**

**Figure 3-2 Breakdown of Enrolled CRP Acreage by Program Type**

The vast majority of enrolled acres are located in farming regions in the central United States in Texas (4,044,892 acres), Colorado (2,372,906 acres), Kansas (3,085,226 acres), Iowa (1,958,883 acres), North Dakota (3,371,582 acres) and Montana (3,481,533 acres). CRP acres are also clustered in other farming regions in the United States including the Pacific Northwest, Southeastern Idaho, the Mississippi Delta region and the Southeast. Figure 3-3 shows the location of acres enrolled in the Conservation Reserve Program as of September 2006.

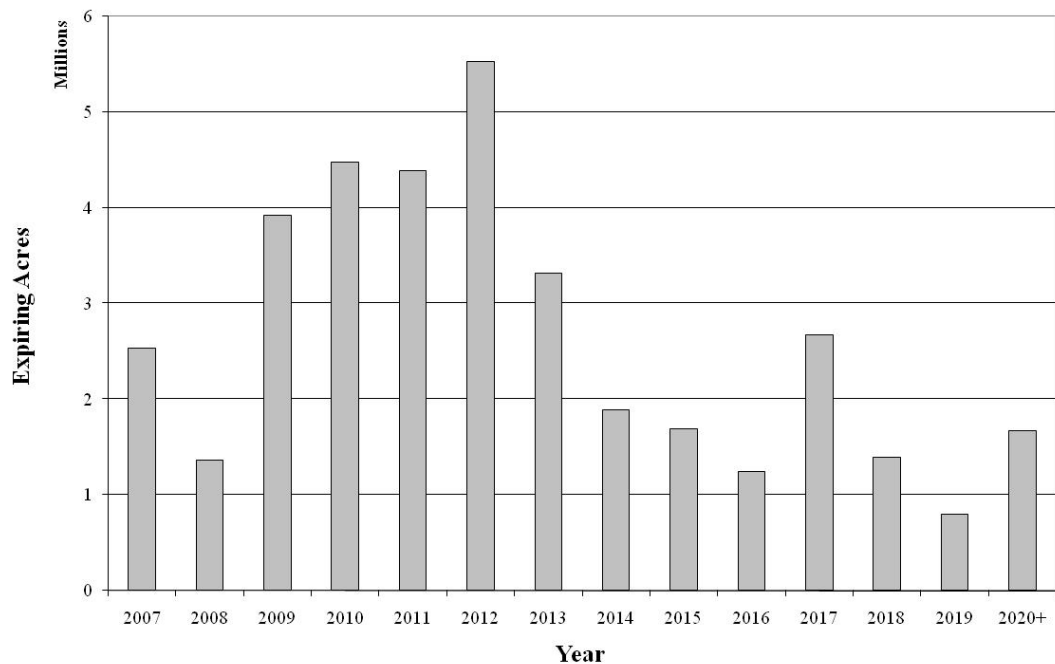


**Source: (US-USDA, FY2006 CRP Summary Report)**

**Figure 3-3 Location of Acres Enrolled in the CRP in Lower 48 States**

Contracts for 27.8 million acres currently enrolled in the Conservation Reserve Program are set to expire between 2007 and 2010, just as the CRP is set to be reauthorized as part of the 2008 Farm Bill. To sustain program enrollment through the Farm Bill process and any prospective program changes and funding levels, the FSA offered contract re-enrollment and extension (REX) to CRP participants with expiring contracts. The FSA segregated expiring contracts into quintiles based on the EBI score, offering the highest quintile new 10 or 15 year contracts, the second highest quintile 5-year contracts, the third highest quintile 4-year contracts and lowest two quintiles 3 and 2-year contracts. Annual rental rates are updated with contract

renewal. Of the 27.8 million acres set to expire, 23.2 million acres (83%) were re-enrolled as of March 9, 2007 (FSA, “Re-Enroll and Extend CRP Contracts”). The contract renewal rate (86.6%) is similar to previous CRP re-enrollment and extension efforts (Cowan 2). Figure 3-4 shows the contract expiration by year for all acres in the CRP, factoring in the most recent contract re-enrollment and extensions.



**Source: (US-USDA, FY2006 CRP Summary Report)**

**Figure 3-4 CRP Expirations with Recent Re-Enrollment and Extensions (REX)**

Acres enrolled in the Conservation Reserve Program must implement an approved conservation practice. Landowners receive annual maintenance payments ranging from \$4 – 10 per acre depending on the conservation practice implemented.

Landowners select one of 37 approved conservation practices to implement on enrolled acres. Some conservation practices include:

- Planting new or maintaining existing new grass/legume cover crops
- Creating wildlife habitat
- Planting new hardwood/longleaf trees
- Restoring wetlands
- Implementing riparian buffers, shelterbelts, erosion control, etc.

The vast majority (~70%) of acres enrolled in the CRP have been planted with native and existing grasses. Table 3-1 shows the five most common and least common conservation practices implemented on CRP land.

**Table 3-1 Conservation Practices Summary (2006)**

Code	Rank	Description	Acres	Fraction Total Acres
CP10	1	Existing Grasses and Legumes	15,270,331	0.4222
CP2	2	New Grasses - New Seedings	6,881,372	0.1902
CP1	3	Introduced New Grasses and Legumes - New Seedings	3,445,010	0.0952
CP4	4	Permanent Wildlife Habitat	2,473,677	0.0684
CP23	5	Wetland Restoration	1,651,427	0.0457
CP32	33	Hardwood Trees	7,196	0.0002
CP17	34	Living Snow Fences	5,032	0.0001
CP6	35	Diversions	825	0.0000
CP24	36	Cross Wind Trap Strips	736	0.0000
CP7	37	Erosion Control Structures	536	0.0000
All Practices			36,171,050	

**Source: US-USDA, FY2006 CRP Summary Report**

CRP land is also used for approved research programs investigating soil/water conservation methods, alternate conservation cover crops, wildlife habitats, and alternate land uses (i.e. carbon sequestration, reforestation). The Biomass Pilot Program, established in 2000, investigates using CRP land to produce biomass in a

fashion consistent with the environmental objectives of the program. Projects have been initiated in four (4) states to investigate biomass production using switchgrass (Iowa and Pennsylvania), hybrid poplar (Minnesota), and willow trees (New York) (US-USDA, “2007 Farm Bill Theme Paper” 13). Installing wind turbines on CRP land is also permitted, but the acres used for the turbines and access roads may be removed from the CRP contract acreage (US-USDA, “2007 Farm Bill Theme Paper” 23).

### **3.4 Program Cost and Annual Outlays**

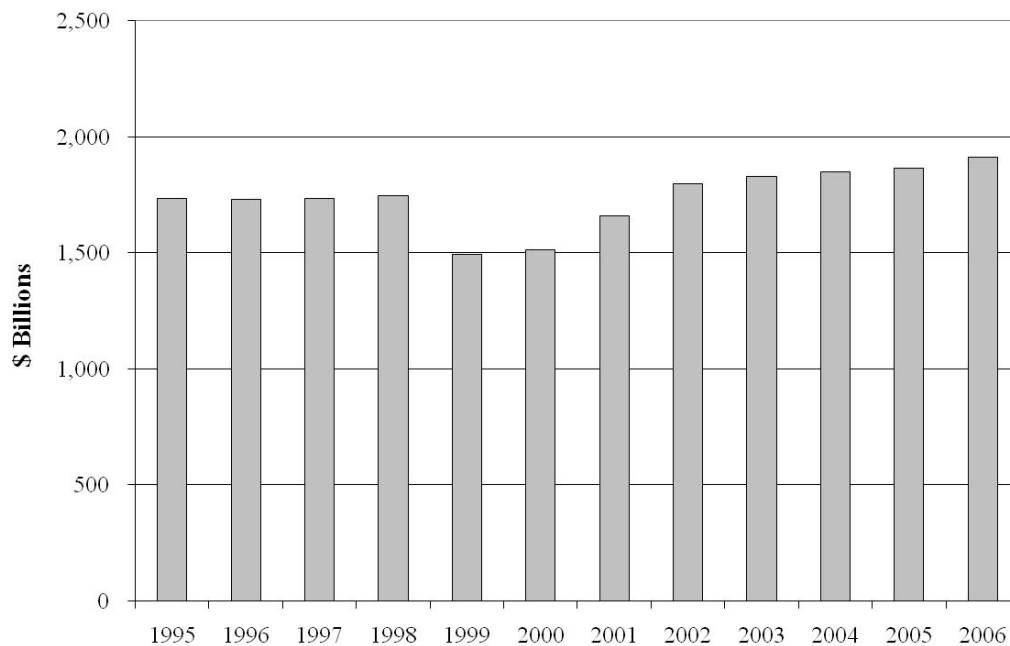
The CRP program remains the most expensive conservation program administered by the USDA, constituting nearly 40% of total conservation program spending in FY 2006 (Zinn 5). However, during the period from 2001 to 2005, the USDA nearly doubled spending on conservation programs and outlays for the CRP fell from nearly 80% of total USDA conservation spending to 40% in 2006.

Conservation programs that received considerable funding increases included the Environmental Quality Incentive Program (EQIP) and the Conservation Security Program (CSP). Authorization of funding for the CRP was set to expire on December 31, 2007 unless the current Farm Bill is extended or a new one is enacted. Table 3-2 shows a breakdown of USDA spending on conservation programs for FY 2006 while Figure 3-5 shows annual CRP outlays for the past 10 years.

**Table 3-2 Conservation Program Outlays (2006)**

<b>Conservation Program</b>	<b>Acronym</b>	<b>FY 06 Outlay (\$ millions)</b>	<b>% of Total</b>
Conservation Reserve Program	CRP	\$1,993	39.16%
Environmental Quality Incentives Program	EQIP	\$1,096	21.54%
Conservation Operations - Technical Assistance	CO-TA	\$696	13.68%
Emergency Watershed Program	EWP	\$300	5.90%
Conservation Security Program	CSP	\$259	5.09%
Wetland Reserve Program	WRP	\$250	4.91%
Emergency Conservation Program	ECP	\$200	3.93%
Grasslands Reserve Program	GRP	\$54	1.06%
All Other Conservation Programs		\$241	4.74%
<b>Total</b>		<b>\$5,089</b>	

**Sources: (Zinn, US-USDA, FY2006 CRP Summary Report)**



**Source: (US-USDA, FY2006 CRP Summary Report)**

**Figure 3-5 Annual CRP Outlays**

### **3.5 Evaluating the CRP Through the E3 Framework: Status, Trends and Research**

Since its inception in 1985, the CRP has been credited as an extremely successful conservation program with significant environmental and wildlife benefits (US-USDA, “FY2006 CRP Summary Report; TRCP-AWWG). However, the program is expensive and rural farming economies have changed as acres have moved out of cultivation and into the CRP. With an increased emphasis on biomass and biofuels, the CRP shows considerable potential to become a large renewable energy resource and boost farm income. However, cultivating CRP land, even if only to harvest perennial grasses for biomass, may erode the environmental gains of the CRP over the last 20 years. Major works of research on the environmental, economic and energy implications of the CRP are evaluated in this section of the report.

#### **3.5.1 Environmental Effects of the CRP**

The environmental benefits of the CRP have been researched extensively in the past 15 years with efforts focused on monitoring and quantifying the impacts of the land-retirement program on wildlife, soil erosion, and air and water quality. The FY 2006 annual program summary published by the FSA quantified the annual effects of the CRP as follows:

- Reduces soil erosion by an estimated 450 million tons per year, compared with pre-CRP rates,
- Provides improved nesting areas for ducks in the Prairie Pothole Region (PPR), boosting duck populations by 2 million per year, and
- Sequesters 50 million metric tons of carbon annually in soils and vegetation.

Additionally, the CRP has been credited as the largest tree-planting program in the United States and with restoring more than 2 million acres of wetlands over the life of the program. Additional effects of the CRP on wildlife, soil erosion, and air and water quality and carbon storage are reviewed in detail in the following sections.

#### **3.5.1.1 Wildlife**

In a survey of CRP participants conducted in 2001, 73.2% of respondents credited the CRP with contributing to positive changes in wildlife populations (Allen 102). Researchers have documented increased nest success of upland duck species, pheasants and grassland songbirds on land enrolled in the CRP relative to cropped or public lands (Adair and James 56-57; Reynolds 144; Rodgers and Hoffman 125; Cunningham 56). Reynolds developed a model to determine duck production in the Prairie Pothole Region (PPR) based on 5 years of observational data and predicted that an additional 2.2 million ducks per year were produced as a result of the CRP in the PPR (145).

Minimal disturbances (i.e. tilling, mowing, harvesting), large field area, perennial field grasses and a higher prevalence of wetlands are all attributes of acres enrolled in the CRP that contribute to improved wildlife habitat for grassland birds. Wildlife habitat, as indicated by nesting success, was significantly improved when large contiguous areas were enrolled in the CRP or adjacent to other grassland areas (Cunningham 392). Large undisturbed areas of CRP grassland have higher prevalence of wetlands and allow nesting birds better protection from predators (Reynolds 145). Smaller areas of CRP land enrolled in alternate conservation practices (i.e. riparian buffers, shelterbelts, and grass strips) also provide improved wildlife habitat but have

increased levels of disturbance and predation and do not provide adequate nesting cover (Adair and James 57).

Landowners are not permitted to disturb fields enrolled in the CRP, except to mow noxious weeds during certain times of year and for emergency grazing practices. While a survey of CRP fields found that more than half of fields were disturbed improperly (Swanson et al. 392), CRP fields continue to provide fewer disturbances and better wildlife habitat than non-CRP fields and long-term consequences of common disturbances (i.e. burning, mowing for weed control) on wildlife are deemed minimal (Rodgers and Hoffman 126).

The height and type of grasses planted as a conservation cover on CRP land directly contribute to the quality of habitat for various types of grassland birds. Bird density and diversity on CRP lands were found to positively correlate with the height of vegetation (Swanson et al. 392). Grass mixtures (including native grasses) planted as CRP conservation cover crops were partly responsible for boosting prairie grouse populations in North Dakota, South Dakota, Minnesota, and Kansas. CRP seeding mixtures contain a minimum of four species to provide adequate concealment from predators, protection from weather, and food resources for wildlife (Rodgers and Hoffman 125).

There is little disagreement among researchers about the documented wildlife benefits of the CRP, but most caution that changes to the program design, enrollment practices, or lack of funding could erode or even reverse the wildlife benefits achieved by the program. Many researchers have noted that changes to the scoring of the Environmental Benefits Index (EBI) used to evaluate land for enrollment in the program have selectively shifted large acreages out of the Prairie

Pothole Region and grassland and wetland conservation practices into areas with lower land rental rates and conservation practices less beneficial to wildlife (riparian buffers, grass waterways, shelterbelts, etc.) (Adair and James 60; Swanson et al. 393; Reynolds 146). Ensuring that enrolled acres remain part of the CRP as contracts expire and the program is renewed in future farm bills is critical to preserving the wildlife benefits of the program.

#### **3.5.1.2 Soil Erosion and Nutrient Runoff**

In a survey of CRP participants conducted in 2001, nearly 85% of respondents credited the CRP with diminishing soil erosion (Allen 102). Some respondents implicated the CRP for enhancing soil organic matter and boosting fertility on enrolled acres as well. Numerous researchers have documented that enrollment of cropland in the CRP dramatically reduces soil and nutrient loss and increases the amount of organic matter (Rao et al. 177-179; Burke et al. 795-796; Davie and Lant 409-411; Robles and Burke 349; Lindstrom et al. 421-422; FAPRI, “Estimating Water Quality ...” 22).

The Food and Agricultural Policy Research Institute (FAPRI) developed a comprehensive, nationwide model to gauge the effects of CRP enrollment on soil loss and nitrogen/phosphorus loss from wind and water erosion (12-20). The model estimated that the annual effect of the CRP was to reduce nationwide soil loss due to water erosion by 71 million tons/yr and soil loss due to wind erosion by 335 million tons/yr. Additionally, conservation practices implemented on CRP lands are responsible for reducing nutrient runoff of 859 million pounds of nitrogen and 213 million pounds of phosphorus annually. Acres enrolled in the CRP have 99% less soil runoff, 95% less nitrogen runoff, and 86% less phosphorus runoff than similar acres

used for agricultural cropland. FAPRI surmises that year-round vegetative cover planted on CRP acres improves soil structure and reduces water runoff and wind velocity at ground level, resulting in less sediment and nutrients discharged into streams and rivers (10).

Mao et al. and Davie and Lant both conducted analyses at the watershed level to estimate the effect of CRP enrollment on annual sediment loss (i.e. tons of soil erosion per acre). Mao et al. found that the more CRP land enrolled in a watershed, the greater the sediment loss reduction. For the Beaver River Watershed in Texas County, Oklahoma, with 21.4% of cropland acres enrolled in the CRP, sediment loss was reduced on average by 32.6% (176-177) compared to a scenario with no CRP acres. Davie and Lant generated similar results for the Big Creek and Cypress Creek watersheds in southern Illinois, where sediment loss was reduced by 24% and 37% respectively as compared to a scenario with no CRP acres (407). Approximately 20% of cropland in the Big Creek and Cypress Creek watersheds was enrolled in the CRP. Both authors identified the presence of CRP land in a watershed as a significant factor contributing to reduced sediment loss, but indicated that other factors (e.g. field slope, weather patterns, pre-CRP cultivation) may also influence sediment loss.

Continuous cultivation generally leads to a degradation of soil quality and losses in soil organic matter. Burke et al. documented that continuously cultivated grasslands have 44% less carbon, 46% less nitrogen and significantly less microbial biomass and activity than native fields never cultivated (796). Researchers have studied CRP fields, noting that cessation of cultivation and planting a vegetative cover crop improves soil quality and regenerates organic matter pools. Lindstrom notes that structural improvement of soil can be seen in as little as 4-5 years once cultivation

ceases and grass is seeded. Burke et al. determined that fields abandoned for 50+ years had microbial biomass carbon and nitrogen, and carbon and nitrogen mineralization levels no different from native, non-cultivated fields (798). Specific to the CRP, Marcos and Burke found that fields enrolled in the CRP and planted with legumes and grass showed measurable increases in soil organic matter after 6 years (352).

#### **3.5.1.3 Air/Water Quality**

The CRP is credited with improving both air and water quality in major farming regions in the United States. In a survey of CRP participants conducted in 2001, nearly 39% of respondents believed the CRP was responsible for improved water quality, while 29% of respondents credited the program for improving air quality and 24% attributed an increased permanence of surface waters to the program (Allen 102). Researchers have documented reduced wind and water soil erosion on CRP fields (Section 3.5.1.2), implying improved water and air quality in the environment surrounding CRP fields (Rao et al. 177-179; Davie and Lant 409-411; FAPRI, “Estimating Water Quality ...” 22).

FAPRI estimated the annual reduction in soil, nitrogen and phosphorus loss attributed to the CRP, but could not determine the direct effect of the reduction on air and water quality, noting that further research and long-term monitoring would be required. The authors did note that reduced water erosion from fields enrolled in the CRP should contribute to reduced sediment loading in waterways (34) and reduced wind erosion should virtually eliminate airborne particulate matter originated from CRP contracted acres (27).

Davie and Lant investigated to what extent enrollment in the CRP affects the sediment load in two watersheds in the Cache River basin in Southern Illinois. High sediment loads in waterways contribute to ecosystem damage, silt build-up and decrease water storage capacities (407). While sediment loss in the watershed was reduced by approximately 30% as compared to a scenario with no CRP acres (407), the authors did not discover a significant relationship between soil loss and stream sediment load. However, the authors surmise that measurable reductions in sediment load caused by reduced soil loss from CRP-contracted acres is measurable only after a delayed period of time determined by the sediment dynamics of the watershed (410). Long-term monitoring would be required to detect the effect.

#### **3.5.1.4 Carbon Sequestration**

The process of photosynthesis removes carbon from the air and temporarily incorporates the carbon into the plant and soil structure until the plant is harvested or the soil structure is dispersed by water or wind erosion. Continuous cultivation results in significant reductions of soil organic matter and carbon content. After 50 years of cultivation, continuous cultivation results in surface soils with 30-40% less carbon than non-cultivated soils (Burke et al. 797). Other researchers determined that soil organic carbon (SOC) losses due to cultivation averaged 61% in the first 0-5cm of soil and as much as 15% at depths of 100-150cm (Gebhardt et al. 51). Cessation of cultivation and seeding of conservation covers will increase SOC content over time as erosion is reduced and the amount of standing plant material increased.

Numerous researchers have documented that cessation of cultivation and seeding a vegetative cover increases the SOC content of the soil. Burke et al. determined that fields abandoned for 53 years and planted with the perennial grass *B.*

*gracilis* recovered 200 g/m<sup>2</sup> of carbon in the first 5 cm of surface soil. The increased SOC immediately beneath the grass as compared to the interstitial spaces between the plants suggest that the plant plays an important role in SOC recovery (797-798).

Other researchers have noted that SOC content in the first 0-25cm of fields abandoned for 50+ years was similar to the content in native non-cultivated grasslands (Gebhert et al. 488). A study comparing the SOC content of fields enrolled in the CRP for five years to cultivated fields demonstrated that 21% of the SOC lost during cultivation had been recovered (Gebhert et al. 492), corresponding to 3.5 tons of carbon per acre.

FAPRI estimated the amount of SOC contained in the soil for acres enrolled in the CRP and compared it to a scenario where the land remained in cultivation. FAPRI determined that soil organic carbon fell 6% over a 10-year period for cultivated fields, but rose 7% for fields enrolled in the CRP. CRP contracted acres accumulated, on average, 0.7 tons/acre of SOC, equating to nearly 23 million tons of SOC per year nationwide (31). Gebhert et al. estimated that the CRP was directly responsible for sequestering nearly 45% of the annual carbon emissions of the agricultural sector in 1994 (488).

#### **3.5.1.5 Rural Amenities**

Improved wildlife habitat, air and water quality, and reduced disturbances contribute to an improved environment and greater recreational and hunting opportunities. The CRP is credited with significantly boosting rural amenities in areas dominated by farm operations. In a survey of CRP participants conducted in 2001, nearly 38% of respondents credited the CRP with improving the prevalence of wildlife and boosting hunting and wildlife viewing opportunities (Allen 102). Other respondents indicated that the CRP was responsible for a number of other welcome

social benefits. Respondents welcomed the return of wildflowers, improved outdoor areas for camping and social gatherings, and the visibly improved state of waterways (Allen 103).

Feather et al. employed non-market valuation models to indirectly assess the wildlife-viewing, pheasant-hunting, and freshwater-based recreation benefits of the CRP. The annual contribution of the CRP to all freshwater-based recreation was estimated at \$35.4 million dollars, while the annual contribution of the CRP to pheasant-hunting was estimated at \$80.3 million dollars and the annual contribution to wildlife-viewing was estimated at \$348 million (15-19). Significant non-market benefits and improvements in rural amenities are linked to the CRP. The Agriculture and Wildlife Working Group (AWWG) of the Theodore Roosevelt Conservation Partnership compiled similar estimates from other researchers, valuing the annual contribution of the CRP to hunting migratory waterfowl at \$122 million and wildlife viewing at \$629 million (11).

#### **3.5.1.6 Quantification of CRP Benefits**

Gauging the success of the Conservation Reserve Program is highly dependent upon measuring environmental benefits associated with conservation practices implemented on CRP contracted acres, quantifying those benefits, and comparing the benefits to the program costs. Numerous researchers, as documented in Sections 3.5.1.1 through 3.5.1.5, have attempted to measure changes in the environment and link any benefits to land-use change resulting from the CRP. However, measuring and quantifying environmental effects and linking those effects to CRP program goals is complicated by many factors.

Changes to environmental quality cannot be measured directly, but must be inferred from quantifiable indicators (Smith, 17-18). Water quality cannot be measured with a scientific instrument, but researchers have collected data on stream sediment load (Davie and Lant), nitrates, herbicides and pesticides in drinking water wells (Feather et al. 3), and freshwater recreation activities (i.e. fishing, boating, swimming) (16) in areas with and without CRP-contracted acres. Comparison of the two scenarios allows researchers to infer how water quality, as indicated by the measured variable, is affected by the CRP.

Collecting the necessary field data for each environmental indicator for each acre enrolled in the CRP would not be cost-effective approach to determine the net, program-wide benefits of the CRP. Instead, researchers use existing site-specific research, field data (i.e. acreage, slope, soil type, etc.) and knowledge about agriculture systems to develop models to simulate how the CRP affects the environment. The model can be used to extrapolate environmental benefits on a program-wide basis given limited information about acreage enrolled in the CRP. Additionally, linkages between environmental systems can allow modelers to predict how changes to enrollment, eligibility criteria, or funding may affect the environment and provide focused insight on proposed policy changes.

Most environmental benefits claimed by the CRP are a result of calculations performed by models (Feather et al., US-USD, “CRP Summary”, FAPRI) on a national scale. The accuracy of these models is necessarily limited by the amount of site-specific data that is available and are fundamentally based on historical data, supplemented with assumptions about economic conditions, weather patterns, watershed behavior, nutrient transport, and cropping practices (Smith 19).

Additionally, these models cannot anticipate how “shock” events (i.e. floods, droughts, tornados, etc.) will affect the environment without resorting to long-term stochastic modeling techniques. Despite these drawbacks, national agri-environmental models remain the best tool available for determining the environmental benefits of the CRP on a nationwide scale and a comprehensive effort to develop a national modeling framework to assess the environmental effects of conservation programs is underway (Kellogg).

### **3.5.2 Economic Effects of the CRP**

As a land-retirement program, the CRP annually removes nearly 9% of the total cropland in the United States from production. Compared to a scenario where all cropland in the United States is cultivated, enrolling acres in the CRP results in reduced total demand for agricultural inputs (i.e. fertilizer, seed, herbicides, equipment), agricultural services (i.e. product transport, storage), and farm labor. Additionally, cultivating less land should result in lower production of farm commodities, which may have an effect on the commodity price and annual farm income. The economic effects of the CRP are diverse and comprehensive and may affect farm income, agricultural jobs and businesses, rural economies, commodity prices.

In a survey of CRP participants conducted in 2001, responses were mixed regarding the economic effects of the CRP (Allen 102). Nearly 17% of respondents saw participation in the CRP as contributing to future income through timber sales and improved soil fertility and crop yields while 11% saw increased opportunities to lease land for hunting or other recreational opportunities. 8% of respondents believed that the CRP had a negative effect on local economies by reducing demand for local

agricultural-based business and shrinking the number of agricultural jobs. Other negative and positive economic effects noted by respondents and other researchers are shown in Table 3-3.

**Table 3-3 Economic Effects of the CRP**

<b>Positive Effects</b>	<b>Negative Effects</b>
<ul style="list-style-type: none"> <li>▪ Reduce commodity supply and increase prices</li> </ul>	<ul style="list-style-type: none"> <li>▪ Fewer cultivated acres increases rental rates and cost of production</li> </ul>
<ul style="list-style-type: none"> <li>▪ Assured income for long-periods of time</li> </ul>	<ul style="list-style-type: none"> <li>▪ Retired/absentee landowners do not spend income received for CRP rental payments in local economy</li> </ul>
<ul style="list-style-type: none"> <li>▪ Stabilization/diversification of farm income</li> </ul>	<ul style="list-style-type: none"> <li>▪ Reduced dependence on commodity farm income encourages farmers to retire and move elsewhere</li> </ul>
<ul style="list-style-type: none"> <li>▪ Increase in farm property values</li> </ul>	<ul style="list-style-type: none"> <li>▪ Increased property values make it difficult for existing and beginning farmers to acquire cropland</li> </ul>
<ul style="list-style-type: none"> <li>▪ Savings in farm operation by farming only the most productive acres</li> </ul>	<ul style="list-style-type: none"> <li>▪ Fewer cultivated acres reduces farm-related jobs and business activity</li> </ul>
<ul style="list-style-type: none"> <li>▪ Increased recreational spending (hunting, fishing, water sports)</li> </ul>	<ul style="list-style-type: none"> <li>▪ High numbers of CRP acres contributes to depopulation of rural farming communities</li> </ul>

**Source: (Allen, Cowan, Sullivan et al., Sullivan and Hellerstein)**

The Economic Research Service (ERS) of the USDA conducted a detailed econometric analysis to determine how the CRP affected rural agrarian economies since the program began in 1986. The ERS examined how the CRP affected employment, population, farm-related businesses, beginning farmers and recreational spending at the county level across the United States (Sullivan et al.). ERS selected

counties with greater than 20% of cropland acres enrolled in the CRP as the sample group. ERS inferred that areas with higher ratios of CRP land compared to total cropland are likely to be more susceptible to any economic effects associated with the CRP.

### **3.5.2.1 Employment and Population**

ERS conducted matched-pair and multiple regression analysis to examine employment and population trends in counties with more than 20% of the cropland enrolled in the CRP, compared to counties with low levels of CRP enrollment. The primary explanatory variables included: (1) prior trends in population and employment, (2) economic conditions, (3) quality of life/amenity measures, and (4) demographic measures. After controlling for other factors, no significant systematic negative effects on population trends immediately following enrollment or over the long-term (1985-2000) were associated with the CRP (Sullivan et al. 32). It was noted that most counties with more than 20% of cropland enrolled in the CRP were suffering negative population trends prior to the start of the CRP, which continued, but were not augmented by enrollment in the CRP (29).

ERS documented that the CRP contributed to negative employment effects in the short-term, but found that the CRP was correlated with positive employment growth over the long-term (32). Farm-related jobs were certainly lost in counties with high levels of CRP enrollment, but local economies generally compensated with increased non-farm employment opportunities in the long-term (Sullivan and Hellerstein 33).

### **3.5.2.2 Farm-Related Business**

The large transfer of land out of cultivation and into the CRP has been implicated as a primary contributor to the decline of farm-related businesses and employment in rural economies (i.e. farm suppliers, grain elevators, and food processors). After examining County Business Patterns (CBP) data, ERS concluded that “CRP’s net impact was small given the consolidation trends buffeting farm-related industries over the past 25 years,” (38) but noted that farm-related businesses in high-CRP counties composed a larger share of economic activity, making even small losses produce an acute negative economic effect. Over the period of 1985-2000, counties with high enrollment in the CRP have replaced most, if not all, farm-related businesses and employment opportunities.

### **3.5.2.3 Beginning Farmers**

Counties with high enrollment of acres in the CRP have reduced availability of land and can contribute to upward competitive price pressure which may make it difficult for beginning farmers to acquire land necessary to expand farming operations. However, ERS did not find a statistically significant relationship between the amount of land enrolled in the CRP in a county and changes in the number of beginning farmers (40). ERS did discover that beginning farmer trends are negatively associated in counties with whole-farm enrollments and positively associated in counties with partial-farm enrollments. ERS surmised that enrollment of large tracts of farmable land (whole-farm enrollments) in the CRP does remove more attractive land from the market, possibly hindering beginning farmers more than if small tracts of marginal, difficult-to-farm land (partial-farm enrollments) are enrolled in the CRP (42). In the presence of other socio-economic trends in rural farming

communities, ERS concluded that the CRP likely has small to negligible effects on beginning farmer trends (44).

#### **3.5.2.4 Recreational Spending**

While enrolling acres in the CRP removes them from cultivation and may have adverse effects on farm-related businesses and employment, the environmental and scenic benefits gained by CRP enrollment may contribute to the local economy by boosting recreational opportunities (hunting, fishing, wildlife viewing) and tourism (Sullivan and Hellerstein 33). ERS determined that the environmental benefits (wildlife viewing, hunting, reduced soil erosion, improved water quality and water-based recreation) associated with enrolling an acre of land in the CRP amount to nearly \$38/acre (Sullivan et al. 24). However, only about 10% of these benefits accrue to the CRP participant directly (i.e. hunting or land access fees), with the remaining 90% accruing over a larger region, possibly contributing to new employment opportunities and non-farm related businesses.

#### **3.5.2.5 Summary of Economic Effects**

The analysis performed by ERS concluded that high levels of enrollment in the CRP generally do not cause statistically significant long-term changes in population, employment, community well-being, or economic viability of beginning farmers (44). High levels of enrollment in the CRP, especially in farm-dependent areas, may cause significant short-term changes resulting in loss of farming employment opportunities and farm-related businesses in certain regions, but these effects are short-lived and not apparent in the long-term (1985-2000).

### **3.5.3 Biomass Potential of the CRP**

The CRP is characterized as a land-retirement program despite the fact that enrolled acres are only under contract for 10-15 years. Political and economic circumstances can shift drastically in a 10-15 year period and contract renewal for enrolled acres is not guaranteed. At the conclusion of a CRP contract period, the owner can elect to re-apply to the CRP or return the land to productive use as cropland or pastureland. Despite the 86.6% contract renewal rate (FSA, “Re-Enroll and Extend CRP Contracts”), preserving the environmental benefits of acres once enrolled in the CRP after contract expiration remains a serious long-term challenge (Lindstrom et al. 420).

Preserving the environmental benefits on CRP acres is highly dependent on the owner’s willingness to re-apply to the CRP, the rental rate of the land relative to offered CRP payments, and the likelihood that the land can be used profitably for crop or livestock production. As part of the REX initiative, the FSA renewed contracts on nearly 23.2 million acres of 27.8 million acres expiring between 2007 and 2010 by offering CRP rental payments competitive with the average land rental rate in the respective county. The remaining acres are expected to become actively farmed or grazed land at the expiration of the CRP contract, negating many of the benefits achieved while the land was enrolled in the CRP.

Researchers have suggested alternative conservation program structures, classified as Working-land Conservation Programs, which seek to balance the desire of the landowner to utilize land for a productive use with the environmental benefits of a land-retirement program. The Environmental Quality Incentives Program (EQIP) and the Conservation Security Program (CSP) provide technical assistance and funding for farmers to implement approved conservation practices on actively

cultivated land (Lambert and Sullivan 24). Active conservation programs are advocated for expiring CRP acres to limit environmental degradation associated with standard farming practices and maintain environmental benefits accrued while under CRP contract.

Many researchers have also suggested that acres under CRP contract and acres on expiring CRP contracts could be used to produce biomass for annual harvest, thereby allowing a productive use of retired land while maintaining most, if not all, of the environmental benefits of the CRP (Downing et al.; Walsh et al.; US-USDA, “2007 Farm Bill Theme Paper”; Graham et al., “Environmental Benefits”). Planting native, perennial plants that do not require irrigation, pest and weed management, or tillage of the soil and are compatible with conventional farming and harvesting equipment can limit water and wind erosion, provide wildlife habitat, and reduce nutrient runoff while still permitting owners to produce biomass for energy production (McLaughlin et al.).

Numerous researchers have documented the positive effects of utilizing acres enrolled in the CRP to produce biomass from native plant species like switchgrass, hybrid poplar and hybrid willow trees. Besides the environmental benefits listed previously, managing CRP fields to grow and harvest biomass can provide an additional source of income for farmers (Downing et al. 4), helps maintain demand for agricultural supplies and products at local farm-related businesses (Sullivan et al.), and may reduce the cost of the CRP over the long-term as CRP rental payments are reduced for acres harvesting biomass (US-USDA, “2007 Farm Bill Theme Paper”, 24). Harvested biomass is a potentially large energy source and can be converted into liquid fuels (i.e. ethanol) or combusted directly to produce heat, steam

or electricity (Spitzer). Usage of biomass-derived energy in place of fossil fuel energy can help reduce emissions of greenhouse gases and common pollutants (i.e. sulfur and nitrogen oxides, mercury, and volatile organic compounds). Considerable potential exists to utilize the CRP to produce biomass while preserving the environmental mandate of the program. Major proposals for the CRP, along with the economic, environmental, and energetic effects are examined in further depth in the remainder of this thesis.

## **Chapter 4**

### **4 REDIRECTING THE CONSERVATION RESERVE PROGRAM: THE 2008 FARM BILL**

#### **4.1 Introduction – Overview of a Farm Bill**

The Farm Bill is an omnibus piece of legislation, “a collection of new laws and amendments to longstanding laws that sets the overall direction of federal food and farm policy for a specified number of years” (Jones 2). Farm Bills have been debated and passed in Congress every five to seven years; the most recent passed prior to this analysis was the *Farm Security and Investment Act of 2002*. The size and scope of a typical Farm Bill is vast – the 2002 Farm Bill contained more than 420 pages and 10 separate titles – and contained regulations that focus not only on the agricultural industry (commodity support programs, marketing assistance loans) but also on agricultural trade (export promotion, food aid, WTO compliance), nutrition (food stamps), rural development (small business grants), environment (land retirement programs, environmental stewardship incentives) and energy (biofuel production incentives, research grants). A number of provisions of the 2002 Farm Bill were slated to expire at the end of 2007 fiscal year and revert to permanent statute unless reauthorized by the new Farm Bill.

The structure of a Farm Bill varies and reflects both short and long-term considerations of the agricultural sector at the time the bill is drafted. In an effort to comply with WTO regulations and expand export markets, the 1996 Farm Bill

emphasized agricultural market deregulation and subsidy reductions. The 2002 Farm Bill focused on farm income support to combat historically low commodity prices. The 2008 Farm Bill was drafted under the purview of a Democratic majority in a climate of high commodity prices, budget constraints and an increasing emphasis on domestic markets and bioenergy production (IATP, “Farm Bill for America”; Johnson 2; Becker 6). While commodity support programs remain the centerpiece of Farm Bill legislation, issues related to renewable energy, specialty crops, competition, nutrition and conservation were key elements of the 2008 Farm Bill debate. Table 4-1 provides short descriptions of titles included in the 2008 Farm Bill.

**Table 4-1 Farm Bill Title Descriptions**

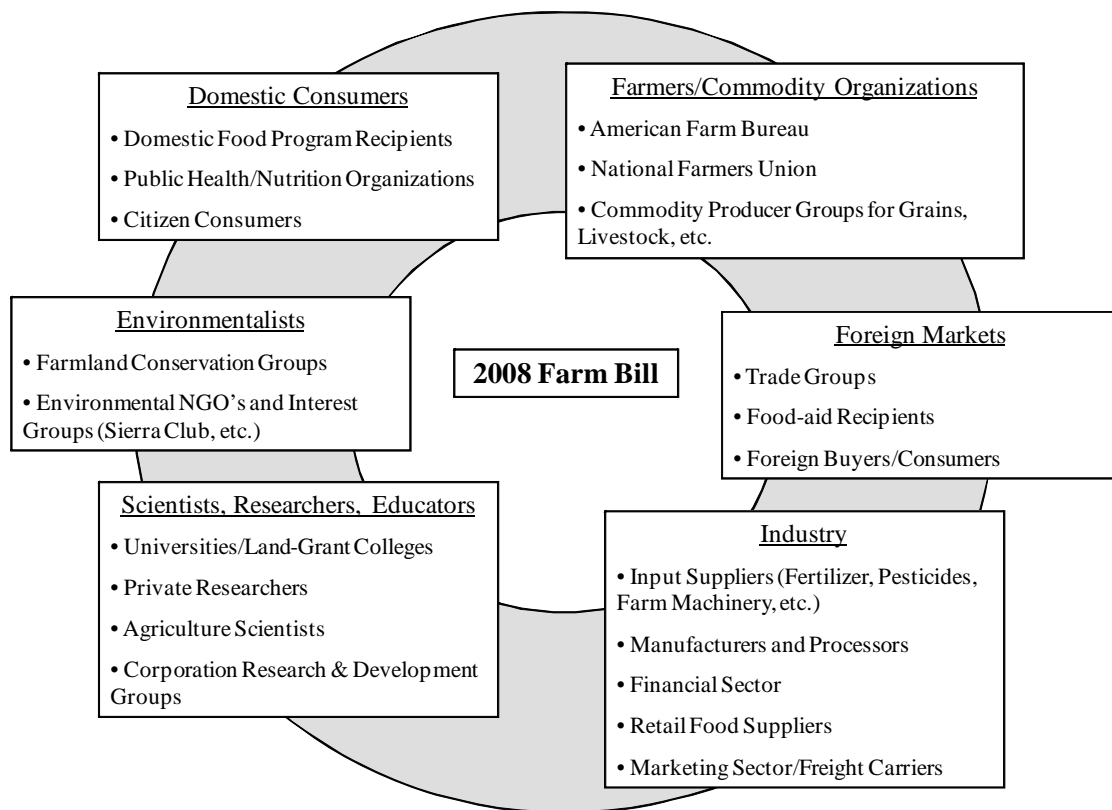
<b><u>Title Name</u></b>	<b><u>Description</u></b>
Commodity Programs	Commodity support - direct payment/production marketing loan levels, counter-cyclical payments, sugar program
Conservation	Authorizes and funds conservation programs – Conservation Reserve Program (CRP), Grassland Reserve Program (GRP), Wetland Reserve Program (WRP), Environmental Quality and Incentive Program (EQIP), Conservation Security Program (CSP)
Trade	Food aid programs, WTO compliance and obligations
Nutrition	Food stamps, emergency food assistance, nutrition assistance
Credit	USDA farm lending programs, farm ownership loans and emergency credit
Rural Development	Rural business, small community grants, rural broadcast/broadband services, regional planning and infrastructure
Research	University research, state agriculture extension services, biotechnology research, food production, organic food production
Forestry	Sustainable forest management practices, wildfire protection, U.S. Forest Service projects
Energy	Bioenergy programs, Federal bio-based procurement, renewable energy, energy efficiency loans and grants

**Table 4-1 Continued**

Horticulture and Organic Agriculture	Local and organic foods marketing, specialty crop assistance, food safety, disease and pest management programs
Livestock	Country of origin labeling, USDA inspections and certification
Crop Insurance	Crop insurance company oversight, standard reinsurance agreement
Commodity Futures	Commodity Futures Trading Commission (CFTC)
Miscellaneous	Disaster assistance, animal welfare, agriculture security, socially disadvantaged producers

**Source: (H.R. 2419, Food, Conservation and Energy Act of 2008)**

The Farm Bill addresses the concerns of much more than just the agricultural sector, as Figure 4-1 below shows. Provisions of the Farm Bill allocate research dollars to universities, determine funding and eligibility for conservation programs, authorize funds for food stamps and school lunch assistance programs, distribute food aid to foreign countries, set support levels for commodity assistance and determine trade practices. As a result, there are significant numbers of stakeholders at the local, national and international levels directly affected by the 2008 Farm Bill. As compared to previous Farm Bills, interest groups and the public were much more engaged in the policy making process for the 2008 Farm Bill. Some coalitions of interest groups formed to pursue specific objectives in conservation and wildlife protection (i.e. Theodore Roosevelt Conservation Partnership), to advocate for broad reform of the agriculture sector (i.e American Farmland Trust), or to lobby for policies geared towards agriculture based energy production (i.e. 25x'25 Renewable Energy Alliance).



**Source: (Jones 3)**

**Figure 4-1 Stakeholders in the 2008 Farm Bill**

Although Farm Bill legislation makes up only 1% of the national budget (IATP, “Farm Bill for America”), there is considerable pressure to reduce spending over the life of the next Farm Bill (FY2008-FY2013), especially in light of the running federal deficit. Since most farm bill programs are classified as mandatory spending, expenditures enacted by the legislation are fulfilled regardless of actual cost, even though they vary from year to year based on program enrollment, prevailing economic conditions, or unexpected weather events. Elimination of mandatory spending programs can boost budget flexibility, making existing and potential Farm

Bill programs a prime target for budget hawks. Table 4-2 shows the breakdown of actual spending for the 2002 Farm Bill as estimated by the Congressional Budget Office for FY2002-FY2007 and the expected Farm Bill spending for the FY2008-FY2013 period. Total spending is expected to rise, even as farm commodity support decreases by nearly 40% in response to higher commodity prices and less government commodity support payments.

**Table 4-2 Estimated 2008 Farm Bill Spending**

(\$ millions)	Farm Commodity Support	Conservation	Exports	Food Stamps	Total
<i>Total Baseline (FY08-FY13)</i>	42,446 (14.3%)	26,496 (8.9%)	2,005 (0.7%)	225,845 (76.1%)	296,792
<i>Actual (FY02-FY07)</i>	72,934 (26.9%)	18,323 (6.8%)	1,648 (0.6%)	178,158 (65.8%)	271,063
<i>Total Difference</i>	(30,488)	+8,173	+357	+47,687	+25,729

**Source: (Johnson 2)**

Discussions surrounding the 2008 Farm Bill began as far back as 2005. As part of the 109<sup>th</sup> Congress, the House Committee on Agriculture and the Senate Committee on Agriculture, Nutrition and Forestry conducted over 30 hearings throughout the country (Johnson 4). Additionally, the USDA held 52 public forums in 48 states to collect input on current farm programs and suggestions for the 2008 Farm Bill (US-USDA, “News Release 0103.09”). On January 31, 2007, Department of Agriculture Secretary Mike Johanns released a detailed proposal for the 2008 Farm Bill to be used as a foundation for Farm Bill discussion in Congress (US-USDA, “News Release 0020.07”). A number of other organizations, including farm groups,

commodity associations, wildlife protection and environmental groups, energy and fuel associations, and trade institutes also made detailed recommendations for the 2008 Farm Bill (See Section 4.5). Congressional hearings on the 2008 Farm Bill continued with the 110<sup>th</sup> Congress and two pieces of farm legislation, the *Healthy Farms, Food and Fuels Act of 2007* and the *Equitable Agriculture Today for a Healthy America Act* (“*EAT Healthy Act*”), were introduced in the House on March 15<sup>th</sup> and March 20<sup>th</sup>, 2007 respectively. While a comprehensive Farm Bill was planned for completion before September 2007 to prevent a lapse of authorization for farm programs that expire at the end of the 2007 fiscal year, a number of extensions were issued for the existing Farm Bill before the *Food, Conservation and Energy Act of 2008* was enacted by Congress on June 18, 2008.

#### **4.2 The Potential of the 2008 Farm Bill**

A number of institutions characterized the 2008 Farm Bill has a unique opportunity to reform and enhance farm programs to increase farm income, reduce environmental burdens, improve nutrition and benefit society as a whole. The Institute for Agriculture and Trade Policy (IATP) characterized it as “an historic opportunity to build a food system that supports family farmers, healthier food, a better environment, fair trade, and energy security,” while the American Farmland Trust stated, “U.S. farm policy needs a new framework and direction to meet the challenges of the 21<sup>st</sup> century. Our national commitment to farmers and ranchers needs to promote competition and prosperity for all farm sectors, protect the land on which we all rely and foster innovation and entrepreneurship” (7).

The increasing relevance of the agricultural sector as a source of energy was a primary factor affecting the development of the 2008 Farm Bill (IATP, “Farm

Bill for Renewable Energy”). Dramatic increases of ethanol and biodiesel production have already been linked to increased demand for corn and soybean commodities and underscores how bioenergy production may affect U.S. agriculture. Sustained higher commodity prices for corn and soybeans could result in some or all of the following: conservation and crop rotation may be deemphasized in a rush to shift acreage towards more profitable crops, other crops may become less desirable to grow, native prairie and forests may be converted to cropland, food and feed producers could face lower profit margins, government budgets for commodity support may shrink and rural communities could change dramatically in response to shifts in farm income (Womach 61-63; US-USDA, “2007 Farm Bill Theme Paper” 17-18). The rapid changes taking place in the agriculture industry as a result of biofuels have concerned environmentalists, agri-business, farmers, rural communities, and consumers and stimulated calls for a comprehensive approach to bioenergy in the 2008 Farm Bill.

The effects of promoting bioenergy production as a primary goal of U.S. agriculture policy may be even more dramatic than those linked to the increased production of biofuels derived only from corn and soybeans. However, the opportunities for bioenergy to meet multiple environmental, economic and agricultural objectives are also significant (See Section 3.5.3). In an open letter, a number of environmental, wildlife and agriculture organizations cautioned Senator Tom Harkin, Chairman of the Senate Agriculture Committee, about the two-sided nature of bioenergy development: “Done right, bioenergy holds great potential to advance essential environmental and energy security goals. Pursued without adequate guidelines, however, bioenergy production carries grave risk to our lands, forests, water, wildlife, public health and climate,” (Aurilio and Patlis). The stakes for U.S.

agriculture, energy, and environmental interests are high and the 2008 Farm Bill provided the best opportunity to craft a bioenergy program that meets multiple environmental and economic objectives.

#### **4.3 The Role of Conservation and Energy in the 2008 Farm Bill**

The Conservation Reserve Program represents the largest bloc of potentially productive cropland in the United States. Upon contract expiration, the land may revert to productive use and be farmed if desired. Increasing land rental rates, coupled with a desire to profit from high commodity prices, currently provide a strong incentive for farmers to convert their CRP land to cropland after contract expiration. During the most recent period of contract expirations in 2007, 4.6 million contracts were not renewed, representing 16.5% of total expiring acres (US-USDA, “News Release 0058.07”). Land enrolled in the CRP has significant nonuse value<sup>4</sup> and provides improved water quality, wildlife habitat, recreational opportunities, and erosion control compared to cropped farmland (Feather et al.). As a result, the clash between conservation and production on land enrolled in the CRP is fierce.

Redirecting the agriculture sector to produce energy from corn, soybeans and biomass in addition to food and fiber could further exacerbate the problem.

The 2008 Farm Bill contained an Energy Title and a Conservation Title, thereby providing for discussion of both issues in a comprehensive framework as part of the same piece of legislation. A number of organizations and researchers have noted that conservation and energy goals are not mutually exclusive and do not necessarily have to conflict (Ugarte and Walsh; Jordan). Bioenergy production using

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4 Nonuse Value – The value given to the existence of an environmental resource even though it is not currently used (Feather et al., 8)

perennial crops like switchgrass or poplar trees can achieve many of the same environmental and wildlife objectives as a conservation cover crop but still allow for productive use of the land by harvesting biomass intermittently (Downing et al.). Pilot programs to explore the use of CRP lands to grow bioenergy are already underway in Minnesota, New York, Iowa and Pennsylvania (US-USDA, “2007 Farm Bill Theme Paper” 13). Additionally, targeted conservation programs and environmental stewardship incentives can result in “working-lands” programs, like the Conservation Security Program, that encourage farmers to practice conservation on productive farmland.

#### **4.4 Guiding Principles for the 2008 Farm Bill Policy Process**

To balance the sometimes-divergent goals of energy policy and conservation policy in agriculture, some organizations suggested goals or “guiding principles” (American Farmland Trust) for the 2008 Farm Bill process to prevent contradictory policy recommendations. Guiding principles establish a framework within which complimentary policies on conservation and energy can be made. In the case of bioenergy production, guiding principles expressed by agricultural and environmental interest groups, policy analysts and agricultural researchers are strikingly similar. These principles focus on sustainable bioenergy production that preserves or enhances the environmental integrity of existing cropland while still allowing for productive use, expanding existing conservation programs and objectives, and preserving native lands by limiting conversion of grassland or forestland to cropland.

#### **4.4.1 Principle 1: Sustainable Bioenergy Production**

“The conservation of natural resources, including soil quality, water and air quality, wildlife habitat and native biodiversity, must be a major focus of agriculturally-based energy production systems.”

~Sustainable Agriculture Coalition, pg. 52

The use of environmentally sensitive land (highly erodible land, wetlands), land not classified as cropland (native prairie and forestland), and land with significant wildlife benefits (important wildlife habitat, untouched ecosystems) is generally deemed unsuitable for sustainable bioenergy production. Some cropland enrolled in existing conservation programs and currently in production can be used with perennial biomass crops and may provide both environmental and economic benefits. The lands targeted for biomass production should be carefully selected and biomass production and sustainable production practices should be incentivized on those acres to minimize biomass production in less advantageous areas.

#### **4.4.2 Principle 2: Expand Conservation and Environmental Stewardship**

“Well-managed agricultural land can supply environmental benefits including cleaner water, increased wildlife habitat, flood-control, wetlands protection and air quality improvements.”

~American Farmland Trust, pg. 18

Conservation programs provide significant soil and water quality protection and measurable wildlife and hunting benefits (TRCG-AWWG). The Farm Bill is the single largest source of funding for conservation on private lands in the United States. Conservation funding complies more readily with international trade agreements and should be expanded and targeted towards programs or lands that will provide the largest environmental benefits. Programs should be administered in the most efficient way; conservation gains must be appropriately audited and under-

funded initiatives should receive adequate appropriations. Environmental stewardship of producing lands is critical to preserving land integrity for future farmers and appropriate incentives should be implemented. Conservation programs must manage lands for conservation benefits and not alternative uses.

#### **4.4.3 Principle 3: Preserve Native Lands**

Native grasslands and forests provide significant wildlife and environmental benefits that are lost when converted to cropland. Additionally, ranchers, hunters and associated industries derive significant economic gain from native lands. The conversion of 24 million acres of grassland to cropland (US-USDA, “Release No. 0092.07”) in the 1982-2002 period represents significant loss of wildlife habitat, ranchlands, and waterfowl hunting regions. Conservation policy should actively prevent conversion of native lands to cropland; bioenergy production incentives should be limited to existing cropland and designed to prevent conversion of native grassland and forests.

#### **4.5 Major Proposals for the Conservation Reserve Program**

Support for bioenergy production on existing cropland, and to a limited extent on forestland or land enrolled in conservation programs, has received overwhelming support from most interest groups as a way to strengthen domestic markets for agricultural commodities, boost farmer income, reduce carbon dioxide emissions and encourage land conservation. Nonetheless, there was considerable disagreement regarding how the Conservation and Energy titles should be formulated and specifically how bioenergy production should be linked to the Conservation Reserve Program. In this section, major proposals for the Conservation and Energy

Titles of the 2008 Farm Bill, and specifically the Conservation Reserve Program, are reviewed, followed by a discussion of more limited possible program changes and actual legislation enacted in the 2008 Farm Bill.

#### **4.5.1 USDA Administration Proposal**

The USDA began developing a 2008 Farm Bill proposal in 2005 by conducting public forums throughout the United States to obtain input and suggestions on all programs affected by the Farm Bill. Public input was condensed into five separate issue analysis papers and utilized to develop a comprehensive title-by-title 2008 Farm Bill Proposal. The USDA proposal is far more detailed than previous proposals in 1996 and 2002 and may be indicative of the heightened interest, increased number of stakeholders, and broadened focus of the 2008 Farm Bill proceedings. Secretary Mike Johanns released the proposal on January 31, 2007 to the public (US-USDA, “News Release 0019.07”).

As iterated by Secretary Mike Johanns on numerous occasions (US-USDA, “Transcript No. 0032.07”), the goal of the 2008 Farm Bill proposal was to take “a reform-minded and fiscally responsible approach to making farm policy more equitable, predictable and protected from challenge.” The USDA Farm Bill proposal seeks to improve WTO compliance of commodity support programs, distribute support among producers and commodities more equitably, enhance and streamline conservation programs, improve planting flexibility, and provide research and development assistance for bioenergy. The USDA 2008 Farm Bill proposal requires \$5 billion more than the 10-year Office of Management and Budget baseline for the FY2008-2017 period (US-USDA, “2007 Farm Bill Proposal” 183).

Specific program provisions of the USDA Farm Bill proposal are grouped by title. The second and ninth titles, called Conservation and Energy respectively, contain most of the provisions pertaining to bioenergy production and conservation programs. A sampling of the general provisions of the energy title include:

- Creation of a temporary Cellulosic Bioenergy Program to provide \$100 million in direct support over four years to cellulosic ethanol producers who increase production above the previous year's level and use eligible biomass feedstocks like agriculture residues.
- Reauthorization of existing Renewable Energy Systems and Energy Improvements loan guarantee and grant programs for cellulosic ethanol projects and small alternative energy and energy efficiency projects.
- Authorization of \$800 million over 10 years for cellulosic ethanol, bioenergy, bioproducts, and biomass feedstock research.

Provisions proposed in the Conservation title were aimed at consolidating and refining existing programs to more effectively target environmentally sensitive lands, integrating market-based or merit-based funding mechanisms to improve cost-effectiveness, and boosting participation in stewardship programs for farmers implementing conservation practices on cropped land. Specifically, reauthorization of the Conservation Reserve Program at current funding levels was proposed with the following refinements:

- Refocus enrollment criteria on the most environmentally sensitive areas, including partial land enrollments as well as watershed or whole landscape enrollments.

- As part of the General Sign-Up process, lands planted with perennial crops and used for biomass production would receive priority consideration for inclusion in the Conservation Reserve Program.

#### **4.5.2 25x'25 Renewable Energy Alliance Proposal**

The 25x'25 Renewable Energy Alliance, a grassroots coalition composed of agricultural, forestry, business, labor, environmental and government interests, has stated the goal that, “By the year 2025, America’s farms, ranches and forests will provide 25 percent of the total energy consumed in the United States, while continuing to produce safe, abundant and affordable food, feed and fiber.” The coalition has developed a comprehensive proposal for achieving this goal by enacting energy, agricultural, and tax policies to increase production of renewable energy, improve delivery of renewable energy to markets, expand renewable energy markets, improve energy efficiency, and encourage conservation of the environment (25x'25 Alliance, “Action Plan”). Key points of their proposal include expanding federal renewable energy research programs, maintaining biofuel and wind electricity production incentives, expanding tax credits for E85 pump installations, implementing mandates for E85 fuel availability and FFV automobile production, establishing a grant program to replace fossil-fuel based heating systems with ones based on renewable energy, and increasing funding for existing conservation programs. The total cost of the proposal is expected to be almost \$65 billion over five years.

Conservation programs, and specifically the Conservation Reserve Program are included in the 25x'25 Action Plan. The 25x'25 Alliance proposes the following for conservation programs and agricultural bioenergy production:

**Table 4-3 25x'25 Policy Proposals and Expected Costs**

<b>Policy Proposal</b>	<b>Add'l 5-year Cost (Millions \$)</b>
Expand Section 9010 of 2002 Farm Bill – Create transition assistance program for farmers, ranchers, forest landowners to establish and produce biomass feedstocks	750
50% new investment tax credit for specific conservation improvements	Unknown
Increase funding for EQIP conservation program	5,000
Feedstock Residue Management Program – transition assistance for proper collection, storage, transportation of residual agriculture and forestry feedstocks (i.e. corn stover, forestry residue)	175
Expand Conservation Security Program to incentivize conservation practices on existing cropland	10,000
Reauthorize Conservation Reserve Program, maintain existing provisions for production of biomass energy feedstocks consistent with conservation and habitat values	0
Increase funding for Farm and Ranchland Protection and other land improvement and easement programs	3,680
Expanded research, development, demonstration and deployment (RDD&D) for bioenergy and renewable energy initiatives	4,000

**Source: (25x'25 Action Plan)**

The 25x'25 Action Plan has been widely endorsed by a number of organizations (25x'25 Alliance, “Endorsements”) and many of their policy proposals are authorized by Farm Bill legislation. Certain Farm Bill stakeholders, including The American Farm Bureau Federation (“Issue Brief: Energy”), the National Association of State Departments of Agriculture (“2007 Farm Bill Highlights”) and both Houses of Congress during the 110<sup>th</sup> Congress, 1<sup>st</sup> Session (H. Con. Res 25; Sen. Con. Res. 3), have explicitly voiced support for the 25x'25 proposal. Other Farm Bill stake holders – the National Association of Wheat Growers, the Institute for Agriculture and Trade Policy, the American Farmland Trust, the National Farmer’s Union, the National Corn

Grower's Alliance, and the Theodore Roosevelt Conservation Partnership among others – have voiced support for certain provisions of the 25x'25 proposal.

#### **4.5.3 Theodore Roosevelt Conservation Partnership (TRCP)**

The Theodore Roosevelt Conservation Partnership “is a coalition of leading hunting, fishing and conservation organizations, labor unions and individual grassroots partners working together to preserve the traditions of hunting and fishing by a) expanding access to places to hunt and fish, b) conserving fish and wildlife and the habitats necessary to sustain them, and c) increasing funding for conservation and management.” (TRCP, “Vision and Mission”). A number of sportsmen and conservation organizations formed the TRCP Agriculture and Wildlife Working Group (AWWG) to formulate a 2008 Farm Bill proposal aimed at expanding and optimizing conservation programs and maximizing opportunities for hunters, wildlife and farmers<sup>5</sup>. The AWWG primarily advocates for improved conservation programs in the 2008 Farm Bill, stating that “Conservation must become the new priority commodity” (TRCG-AWWG 6). The AWWG urges caution and further research when considering lands enrolled in conservation programs for bioenergy production.

The AWWG deems the conservation programs funded as part of Farm Bill legislation highly successful and advocates for expansion and increased funding. Without conservation programs, the AWWG argues that 450 million tons of topsoil would be eroded each year, 170,000 miles of streams would be unprotected, and 40

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<sup>5</sup> The TRCP-AWWG proposal was crafted by number of sportsman, wildlife, and environmental organizations including The Nature Conservancy, the Association of Fish & Wildlife Agencies, The Wildlife Society, the National Wildlife Federation, and the American Sportfishing Association.

million acres of wildlife habitat would be lost (TRCG-AWWG 6). To continue supporting conservation, AWWG made the following general recommendations for the 2008 Farm Bill:

- Provide greater support for existing under-funded conservation programs,
- Link conservation program objectives to national fish and wildlife initiatives,
- Ensure that annual rental rates/cost-share agreements are fair, equitable and competitive,
- Reauthorize and expand successful conservation programs,
- Accurately measure and quantify economic and environmental gains resulting from conservation programs
- Reduce the loss of native grassland to urban/agricultural development (i.e. “Sodsaver”)
- Ensure that biomass production does not displace existing conservation programs

A number of specific recommendations were made for individual conservation programs, including the CRP. The AWWG proposes that the 2008 Farm Bill should modify the CRP in the following ways:

- Reauthorize the CRP with a higher acreage cap of 45 million acres,
- Establish a periodic schedule to conduct general and continuous CRP sign-ups,

- Target conservation practices on specific acres to support national wildlife initiatives,
- Require annual review of CRP rental rates and adjustment to ensure competitiveness,
- Tailor individual CRP contracts to meet specific conservation objectives

While not outright opposed to bioenergy production on agricultural lands, the AWWG only supports bioenergy production “based on sustainable polycultures that are consistent with fish, wildlife, soil, nutrient management and water conservation goals.” (TRCG-AWWG 33). Conservation, wildlife habitat protection, and native grassland and forest protection remain the most important priorities for the AWWG. As a result, the AWWG recommends the 2008 Farm Bill Energy title should incorporate the following provisions to limit the impact of bioenergy production on conservation goals and objectives:

- Provide funding for research and development of sustainable bioenergy production practices based on polycultures,
- Limit bioenergy production to lands where conservation priorities are not compromised,
- Develop appropriate harvesting practices for biomass that minimizes impact on wildlife habitat,
- Conservation incentives should not be replaced with bioenergy production incentives; where bioenergy is allowed, incentive payments should be reduced commensurate with realized economic gain.

## **4.6 Other Proposals for the Conservation Reserve Program**

Multiple organizations made proposals to modify the CRP to allow biomass production on enrolled lands as part of the 2008 Farm Bill process. Few are as comprehensive as the proposals outlined in Sections 4.5.1, 4.5.2, and 4.5.3, but many contain innovative provisions aimed at addressing particular concerns regarding the expansion of biomass production on CRP lands and were included in the scenario development process for this thesis.

### **4.6.1 “Sod Saver” Provision to Preserve Native Lands**

Both the Theodore Roosevelt Conservation Partnership and the Defender’s of Wildlife have expressed concern that policies emphasizing biomass production on agricultural lands may encourage the conversion of CRP program acres, native grasslands, forests, or wetlands into active cropland. As such, both organizations support a “Sod Saver” provision that makes cropland converted from native lands ineligible for any federal agriculture benefits, including enrollment in conservation programs, crop insurance, and disaster payments (TRCG-AAWG 30).

### **4.6.2 Biofuel/Biomass Reserve Program**

The 2002 Farm Bill instituted provisions allowing harvest of biomass on CRP lands for biomass production, so long as the harvesting was consistent with the conservation objectives of the CRP and the rental payment was reduced by an amount equivalent to the value of biomass produced (US-USDA, “2007 Farm Bill Theme Paper” 13). The Great Plains Institute (Jordan), Sustainable Agriculture Coalition (Kemp), and National Wildlife Federation (Sibbing) have all made proposals to develop this existing authority into an established Biomass Reserve Program (BRP), either as part of the Conservation Reserve Program or the Conservation Security

Program. The program would enroll up to 5 million acres of land dedicated to sustainable production of native perennial crops destined for facilities that produce biofuels, electricity or heat from biomass. Producers would receive cost-share assistance and incentives to enroll existing cropland in the program and would be contracted to produce biomass for a period up to ten years. Contract stipulations would require producers to grow and harvest biomass in a fashion consistent with maintaining the environmental mandate of USDA conservation programs. Priority enrollment would be granted to lands located close to existing or planned biomass conversion facilities, or acres already enrolled in the CRP.

#### **4.6.3 Strategic Biofuels Feedstock Reserve**

Acknowledging the current limited market demand and transportation constraints for biomass (agricultural residue, corn stover, cellulosic biomass), the Institute for Agriculture and Trade Policy (IATP, “Renewable Energy”) and the National Farmer’s Union (NFU) proposed a strategic biofuel feedstock reserve. The reserve would purchase biomass from farmers and store it, providing both a year-round market for biomass feedstocks and a stable supply of biomass for biofuel producers. The creation of a feedstock reserve could be linked to the Conservation Reserve Program and provide additional stability for landowners who choose to sustainably harvest biomass from acres enrolled in the program.

#### **4.7 2008 Farm Bill Enacted Legislation**

Typical of most types of omnibus legislation, the *Food, Conservation and Energy Act of 2008* contains provisions influenced by many factors inherent to the policy process. Proposals made for the 2008 Farm Bill (Sections 4.5 and 4.6) were

modified or excluded based on budget constraints, agency recommendations, or general lack of support. Two titles in the final piece of legislations – Conservation and Energy – contain many provisions either directly modifying the Conservation Reserve Program or providing support for the production of bioenergy in the agricultural sector.

#### **4.7.1 Conservation Title**

Title II of the 2008 Farm Bill includes provisions affecting conservation programs. Major provisions pertaining to the Conservation Reserve Program are listed in Table 4-4 below.

**Table 4-4 Provisions of the Conservation Title of the 2008 Farm Bill**

Section	Description
2101	Extends authorization for the Conservation Reserve Program through FY 2012.
2103	Caps the total enrolled acreage permitted in the CRP at 32 million acres as of Oct. 1, 2009.
2105	Classifies alfalfa, multi-year grasses and legumes grown on contracted acres as agricultural commodities.
2108	Clarifies the contract requirements with respect to managed haying, grazing or other commercial use of enrolled land (i.e. installation of wind turbines) and authority to reduce rental rates commensurate with the economic value of the activity.
2110	Requires the Department to conduct an annual survey of average market dryland and irrigated cash rental rates for cropland and pastureland.
2111	Establishes transition assistance program and funding sale of CRP land to beginning or socially disadvantaged farmers or ranchers.
2301	Replaces the Conservation Security Program with the Conservation Stewardship Program for FY 2009 – 2012, providing owners of privately held productive farmland with incentives to implement and maintain conservation practices. Provides funding for enrollment of 12.77 million acres per year through FY 2017.

**Table 4-4 Continued**

2709	Requires the Department to develop technical guidelines to measure, verify and report environmental services benefits from conservation and land management activities, particularly with regards to participation in carbon markets.
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**Source: (H.R. 2419, Food, Conservation and Energy Act of 2008, US-USDA, “2008 Farm Bill Side-by-Side”)**

Despite the relative success of the CRP program, the 2008 Farm Bill reduces the enrollment cap from 39.2 million acres to 32 million acres. The 2008 Farm Bill continues the trend of shifting funding and acreage away from the CRP and into targeted conservation needs or “working-lands” conservation programs like the Conservation Stewardship Program (CSP). Established by the 2008 Farm Bill, the CSP replaces the Conservation Security Program and provides incentives to farmers who implement conservation practices on productive cropland or pastureland. “Working-lands” programs (i.e. EQIP, WHIP, and CSP) target the majority of large farms unlikely to participate in land retirement programs and can achieve many of the same environmental benefits as a land retirement program without removing the acreage from production. (Claassen 5-6)

The 2008 Farm Bill also establishes a program to monitor the rental rates of contracted CRP acres relative to the average dry land and irrigated cash rental rates in the same region. This information can be used in the future to keep CRP rental payments competitive with cash rental rates and limit the demand for returning lands to production when contracts expire. Additionally, the legislation classifies alfalfa, multi-year grasses and legumes as agricultural commodities. Such a provision

expands the number of acres eligible to participate in the CRP, but also provides a framework for measuring and valuing any biomass crops grown on contracted acres.

Finally, the 2008 Farm Bill directs the Department of Agriculture to establish technical guidelines for measuring, verifying and reporting the environmental benefits of conservation programs. Such information is important for valuing the benefits and assessing the cost-effectiveness of conservation programs or initiatives (See Section 3.5.1.6). Quantifying the environmental benefits in a systematic manner is also important for participating in markets that trade and sell environmental commodities (i.e. carbon credits).

#### **4.7.2 Energy Title**

Title IX of the 2008 Farm Bill includes provisions affecting programs aimed at supporting energy production from domestic agriculture and forests. Major provisions pertaining to the Energy Title are listed in Table 4-5 below.

**Table 4-5 Provisions of the Energy Title of the 2008 Farm Bill**

Section	Description
9001	Clarifies definitions for <i>Advanced Biofuel</i> , <i>Biobased Product</i> , <i>Biofuel</i> , <i>Biomass Conversion Facility</i> , <i>Biorefinery</i> , and <i>Renewable Biomass</i> .
9002	Directs the Secretaries of Energy, Agriculture, Transportation and Environmental Protection Agency to assess the infrastructure needs and provide recommendations for expanding the domestic production, transport and distribution of biofuels.
9003	Authorizes funding for competitive grants and loan guarantees to fund development of biorefineries the convert renewable biomass to advanced biofuels. Mandates \$75 million in loan guarantees for FY 2009 and \$245 million in FY 2010.
9004	Authorizes payments to encourage existing biorefineries to replace fossil fuels with new systems that utilize biomass for heat, power, or other energy from renewable biomass.

**Table 4-5 Continued**

9005	Establishes Bioenergy Program for Advanced Fuels to encourage production of advanced biofuels by providing payments to eligible producers. Mandates \$300 million in funding for FY 2009 – 2012.
9011	Establishes the Biomass Crop Assistance Program to support establishment and production of eligible crops for conversion to bioenergy. Eligible project areas must be located near a biomass conversion facility and can apply for 5 year (annual and perennial crops) and 15 year (woody biomass) contracts to receive up to 75% assistance for establishing an eligible crop and annual payments thereafter. Separate funding available for the collection, harvest, storage and transport of biomass to conversion facility. Also includes a “Sod Saver” provision to prevent conversion of native lands to cropland.

**Source: (H.R. 2419, Food, Conservation and Energy Act of 2008, US-USDA, “2008 Farm Bill Side-by-Side”)**

The Energy Title of the 2008 Farm Bill incorporates a number of provisions to fund and support domestic production of advanced biofuels. Most importantly, all funding is made available exclusively for the production of advanced biofuels, defined as, “fuel derived from renewable biomass other than corn-kernel starch.” Acknowledging that ethanol produced from corn starch is now a mainstream commodity, this provision refocuses programs and funding on development of sustainable 2<sup>nd</sup> generation biofuels that offer significant environmental benefits but are not currently cost-effective to produce.

To that end, the Energy Title establishes two programs: one designed to encourage the construction of biorefineries that produce advanced biofuels from renewable biomass and another (Biomass Crop Assistance Program) to encourage production of renewable biomass on cropland surrounding the biorefinery. Simultaneously providing funding to establish biomass crops and development of a

biorefinery may make production of advanced biofuels at a commercial scale cost-effective in some locations.

The rapid development of the corn ethanol industry revealed some of the difficulties integrating distribution of ethanol into the existing fossil fuel infrastructure (See Section 2.2.1). Section 9002 directs the Secretaries of Agriculture, Energy, Transportation and the Environmental Protection Agency to assess the infrastructure requirements and make appropriate recommendations to support continued domestic production of biofuels. As domestic production of 2<sup>nd</sup> generation biofuels expands, building efficient distribution infrastructure will be critical for keeping advanced biofuels cost-competitive with other liquid fuels.

#### **4.7.3 Other Titles**

Changes to tax provisions affecting the production of biofuels were also incorporated into the 2008 Farm Bill and are outlined in Table 4-6. A new tax credit is available for production of cellulosic ethanol through Dec. 31, 2012 and the existing Blender's Tax Credit was reduced from 51 cents to 45 cents in years where total ethanol production and imports exceeds 7.5 million gallons. Additionally, the tariff on ethanol imports was also extended by 2 years through the end of 2010. In response to mounting criticism regarding the environmental and economic impacts of domestic biofuel production, the 2008 Farm Bill directs the National Academy of Sciences to conduct a comprehensive study on the effects of increased domestic production of biofuels.

**Table 4-6 Provisions of Other Titles of the 2008 Farm Bill**

Section	Description
15321	Establishes a Production Tax Credit of \$1.01/gal for cellulosic ethanol through Dec. 31, 2012.
15322	Mandates a comprehensive study be completed by the National Academy of Sciences that explores the effects of increased domestic production of biofuels.
15331	Reduces alcohol blender's tax credit from 51 cents to 45 cents in any calendar year where the annual production and imports exceeds 7.5 million gallons.
15334	Extends tariff on imported ethanol through the end of 2010.

**Source: (H.R. 2419, Food, Conservation and Energy Act of 2008, US-USDA, "2008 Farm Bill Side-by-Side")**

#### **4.8 Existing Policy Research on Proposed CRP Program Changes**

Established in 1985, the Conservation Reserve Program has been reauthorized in four separate Farm Bills and continues to be the most successful conservation program offered by the USDA. Administration of the CRP has changed in response to feedback from program participants, budget constraints, and an increased emphasis to include lands with the greatest potential to reduce soil erosion and improve water quality and wildlife habitat. The rapid development of the biofuel industry in the United States and the availability of large tracts arable land in the CRP have prompted both the USDA and independent teams of researchers to evaluate policy options for producing biomass on CRP land without jeopardizing the environmental gains of the program. Researchers at Oak Ridge National Laboratory, the University of Tennessee Agricultural Policy Analysis Center (APAC), and the USDA Economic Research Service have evaluated the economic effects of policy

options for both incorporating biomass/biofuel production and other administrative changes to the Conservation Reserve Program.

#### **4.8.1 USDA – Office of Energy Policy and New Uses (OEPNU) and Economic Research Service (ERS)**

Commissioned jointly by the USDA and the DOE Office of Energy Policy and New Uses, scientists at Oak Ridge National Laboratory and the University of Tennessee Agricultural Policy Analysis Center published *The Economic Impacts of Bioenergy Crop Production on U.S. Agriculture* in February 2003. The research utilized an agricultural policy simulation model (POLYSYS) to assess the economic impact of growing biomass crops on idle cropland, active cropland, cropland used for pasture, and cropland enrolled in the CRP assuming two different crop management and bioenergy price scenarios. The model incorporates regional estimates of crop yield, production costs, farmgate prices and CRP rental rates to forecast crop supply and demand. Additionally, certain land types can be excluded from the analysis. In these scenarios, environmentally sensitive acres enrolled in the CRP are excluded from consideration for biomass production.

**Table 4-7 Crop Management and Bioenergy Price Scenarios**

Scenario	Wildlife Management Practices on CRP Land	Production Management Practices on CRP Land
Farmgate Biomass Price	Switchgrass: \$30.00/dt Willow: \$31.74/dt Hybrid Poplar: \$32.90/dt	Switchgrass: \$40.00/dt Willow: \$42.32/dt Hybrid Poplar: \$43.87/dt
Scenario Description	- Fewer fertilizer and chemical inputs - Annual switchgrass harvest is limited to alternating halves of the field each year	- Standard fertilizer and chemical inputs - Annual switchgrass harvest of whole field
Rental Rate	75% of standard CRP rental rate	75% of standard CRP rental rate

**Source: (Ugarte et al. 10)**

For each scenario, the model predicts the following for each Agricultural Supply District (ASD): the number of acres allocated to bioenergy crops, field crops, pastureland, idle lands, and the CRP; farmgate prices for field crops; annual net farm income; and the amount of biofuels or bioenergy produced from the acres growing bioenergy crops. Results from the model are displayed in Table 4-8. The model predicts deviations from a reference case scenario that is based on the 1999 USDA Agriculture Baseline Forecast (US-USDA, “Agricultural Baseline Projections”).

**Table 4-8 POLYSYS Bioenergy Modeling Results**

	Model Results	Reference Case	Wildlife Management	Production Management
Land Use Impacts (Million acres)	Cropland	325.4	316.5	304.9
	CRP	29.8	21.6	16.9
	Bioenergy	0.0	19.4	41.9
	Idle/Pasture	79.3	77.0	70.8
Crop Prices (\$)	Corn (/bu)	2.55	2.65	2.79
	Sorghum (/bu)	2.44	2.57	2.77
	Oats (/bu)	1.50	1.58	1.67
	Barley (/bu)	2.35	2.43	2.55
	Wheat (/bu)	4.25	4.40	4.74
	Soybeans (/bu)	6.10	6.42	6.71
	Cotton (/cwt)	0.68	0.74	0.77
	Rice (/cwt)	10.37	11.23	11.37
	Biomass (/dt)	N/A	30	40
Net Farm Income (Billion \$/yr)	Crops/Livestock	50.5	52.6	54.2
	Bioenergy	0.0	0.7	2.3
	Total	50.5	53.3	56.5
Bioenergy Supply	Biomass (Million dt/yr)	0.0	96.0	188.1
	Energy ( $1 \times 10^{15}$ btu/yr)	0.0	1.54	2.92
	Ethanol (Billion gal/yr)	0.0	8.5	16.7
	Electricity (MWh/yr)	0.0	163 million	308 million

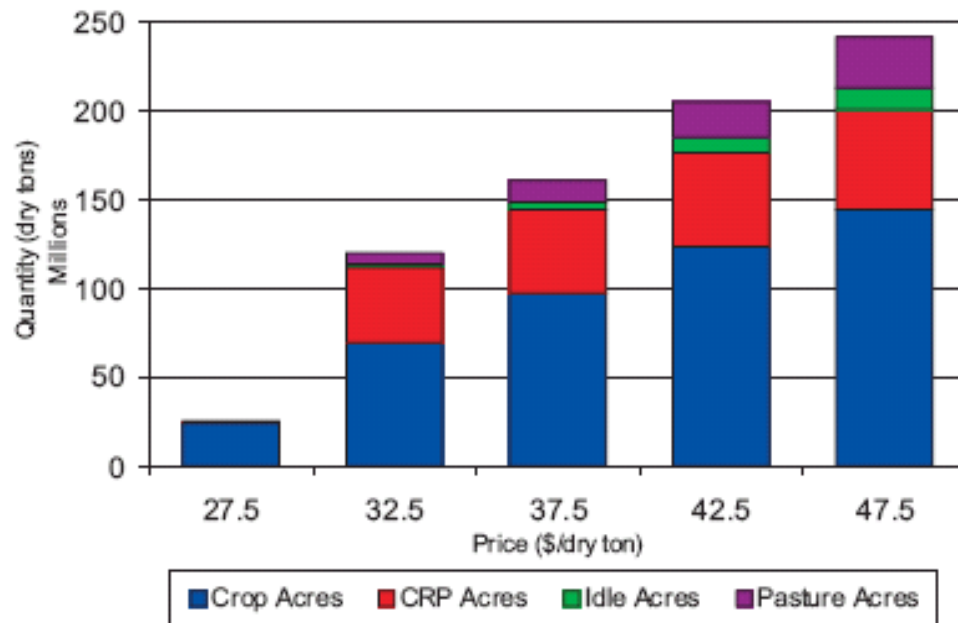
**Source:** (Ugarte et al. 10-22)

The results clearly show that sustained prices for biomass of \$30-\$40 per dry ton (dt) will encourage farmers with active cropland and cropland enrolled in the CRP to divert that land to grow bioenergy crops (i.e. switchgrass, poplar trees and willow trees). In fact, bioenergy crops become major field crops, consuming between 5.7% and 12.1% of active cropland, depending on the scenario. Additionally, movement of acres out of existing field crops and into bioenergy crops results in

higher farmgate prices for corn, sorghum, wheat and other commodities and higher annual net farm income.

While the model is illustrative of the potential economic and land-use impacts bioenergy production may have on U.S. agriculture and the CRP at various farmgate prices for biomass, it is inherently limited by the unavailability of data regarding existing and future demand for biomass. The model is a supply-side analysis tool only. As such, the model is limited to predicting how the existing farm sector may respond to a hypothetical biomass price, but cannot be used to infer what the farmgate biomass price may be in any given year.

As a final result, the model was used to generate a supply curve for biomass, indicating how much biomass would be produced at various farmgate prices, and what land types the biomass would be produced on.



Source: (Reproduced from Ugarte et al. 19)

**Figure 4-2 Biomass Supply Curve**

As can be seen from Figure 4-2, at low biomass prices, land will first be diverted to biomass production from acres used to grow less profitable field crops. As the farmgate price for biomass approaches \$30/dt, the combined profits from biomass production and the prorated CRP rental rate (75% of standard rental rate) exceed the standard rental rate and CRP lands begin to be diverted to biomass production. Only at extremely high biomass prices is it profitable to grow biomass on idle lands and pasturelands. The extent that CRP lands are used to grow biomass will necessarily depend on the degree the rental rate is prorated for biomass producing acres, the farmgate price for biomass, and the relative profitability of field crops specific to particular regions. Scenarios exploring alternate administrative options for the CRP were not explored in this research.

#### **4.8.2 University of Tennessee Agricultural Policy Analysis Center (APAC)**

The Agricultural Policy Analysis Center developed the POLYSYS model to simulate the effects of changes in government policy on U.S. agriculture. The model is often used to determine the economic effects of proposed changes to federal farm assistance programs included in Farm Bill legislation. Prior to the 2008 Farm Bill proceedings, APAC used the model to assess the impact of eliminating the CRP program on crop prices, net farm income for the agriculture sector, land-use changes, and federal payments (Ugarte and Hellwinckel). Impacts are determined relative to the USDA 2006 Baseline Forecast (US-USDA, “Agricultural Baseline Projections”).

POLYSYS was used to model a situation where the CRP was not reauthorized by federal legislation. As CRP contracts expire, landowners could choose to either bring the land back into active crop production or leave the land idle. Landowners are assumed to make profit-maximizing decisions and will revert land to production if profitable.

For the period from 2006-2015, researchers predicted that 37% (16.5 million acres) of the total acreage in the CRP would revert to production if the program were discontinued. The remainder either remains idle or is cost-prohibitive to divert to production. Nearly 71% of the acreage leaving the CRP would be planted with the predominant field crops in the United States: corn, wheat and soybeans. As acreage for the major field crops increases, the model predicts increased production of each crop, reduced farmgate prices, and increased export volumes. As prices fall, net farm income falls, and federal loan deficiency payments and counter-cyclical payments rise, thereby offsetting any savings from reduced CRP rental rates. In 2015, the annual effects of eliminating the CRP result in annual government payments that are 34% higher and net farm income that is 2.3% lower than the USDA 2006 Baseline

Forecast. Over the entire 10 year period, eliminating the CRP results in an additional \$32.6 billion in government payments, despite a savings of \$12.6 billion in CRP rental payments, and an overall reduction in net farm income of \$9.0 billion. Model results are summarized in Table 4-9.

**Table 4-9 Economic Effects of Eliminating the CRP**

	Model Results	Reference Case	Eliminate CRP
Cropland (Million Acres)	Corn	84.5	87.0
	Wheat	58.5	60.0
	Soybeans	70.5	75.5
Crop Prices (\$/bu)	Corn	2.60	2.29
	Wheat	3.55	2.92
	Soybeans	6.10	5.20
Exports (Million bu/yr)	Corn	2,375	2,558
	Wheat	1,125	1,262
	Soybeans	975	1,153
Government Payments (Billion \$/yr)	Loan Deficiency	1.1	4.9
	Counter Cyclical	1.4	3.0
	Other (CRP Payments)	3.6	2.0
	Total	11.2	15.1
Farm Income (Billion \$/yr)	8-Crop Production Value	69.76	64.14
	Livestock Feed Cost	25.19	23.85
	Net Farm Income	53.51	52.26

**Source: (Ugarte and Hellwinckel)**

APAC also ran a simulation to determine the economic effects if the CRP program were expanded to include 45 million acres of land. Model results indicate that increased participation in the CRP reduces the land available for crop production, driving up prices for the 8 major field crops. As prices rise, government farm assistance payments tend to decrease, while CRP rental payments increase. Over the

ten-year period of 2006-2015, government payments decrease \$1.5 billion dollars to \$8.3 billion and net farm income increases \$1.7 billion to \$55.2 billion.

APAC also conducted a retrospective analysis on policy provisions on the 1996 Farm Bill using POLYSYS (Ugarte and Walsh). Following the passage of the 1996 Farm Bill, prices for agricultural commodities plummeted and in 1999, direct government payments accounted for 48% of all net income in agriculture.

Government payments were seven times larger than net cash income for the eight major crops. APAC used POLYSYS to explore whether government farm assistance payments from 1996 to 2000 would have been significantly reduced if dedicated bioenergy crops had been encouraged.

Diverting land from traditional field crops to bioenergy crops results in lower production of the 8 major field commodities, driving prices up and reducing government assistance payments. Model simulations demonstrated that a farmgate price of \$30/dt for biomass would have driven producers to plant 9.42 million acres of switchgrass instead of other field crops. As expected, crop prices for other crops increased, resulting in an increase of market returns from \$21.5 to \$25.1 billion dollars and a decrease in government payments of \$936 million. Interestingly, the government could have subsidized growing switchgrass at a rate of \$56.5/dt and still achieved higher net farm income and lower government assistance payments than actually occurred between 1996 and 2000. While lands enrolled in the CRP were not included in this analysis, later research (Ugarte et al.) indicates that encouraging bioenergy crops on both existing cropland and CRP lands can result in government savings in the form of reduced farm assistance payments and reduced CRP rental payments.

#### **4.8.3 Bioenergy Feedstock Development Program (BFDP)**

The Bioenergy Feedstock Development Program at Oak Ridge National Laboratory (<http://bioenergy.ornl.gov/>) has conducted research on biomass production, harvesting, storage and conversion to bioenergy for nearly 30 years. Much research has focused on the environmental, energy, and economic consequences of converting existing cropland, particularly marginal lands unsuitable for traditional monoculture row crops, to produce biomass (Downing, et al.; Graham et al., “Environmental Benefits”; Tolbert and Downing; Green et al.). In particular, redirecting cropland enrolled in the CRP to grow biomass has been explored as a means to boost the environmental benefits of the CRP, increase net farm income, and reduce the cost of the program (Ugarte and Walsh; Walsh, Becker and Graham).

Since the inception of the CRP, the program has been criticized both for its high cost and the fact that arable cropland is removed from productive use, limiting a farmer’s flexibility to respond to changing market conditions by planting crops in a given year. As part of the 1995 Farm Bill proceedings, a proposal was introduced that allowed landowners to grow biomass on acres enrolled in the CRP in return for a reduced rental rate. This proposal was later approved as part of the 2002 Farm Bill. The BFDP (Walsh, Becker and Graham) analyzed two administrative program options to determine the effects of the proposal on program cost and farmgate prices for biomass.

The two administrative options are as follows:

- **Option 1:** Farmers who opt-in to the program and elect to produce biomass are guaranteed the established CRP rental rate, except in cases where the profits earned from the biomass exceed the CRP rental rate.

- **Option 2:** Farmers who opt-in to the program and elect to grow biomass receive a reduced CRP rental payment and keep any profits earned by growing and selling the biomass.

Provided biomass yields, production costs, and CRP rental rates, researchers found that both administrative options act as a subsidy for biomass and reduce the associated farmgate price. Also, both administrative options also limit the cost to manage the CRP, but administrative option 1 was found to reduce the cost of the CRP program nearly twice as much as administrative option 2. Researchers determined that allowing CRP acres to produce biomass, while still providing a rental payment, effectively lowers the cost to administrate the program and benefits bioenergy producers by making biomass available at lower prices.

#### **4.9 Summary of the 2008 Farm Bill**

The 2008 Farm Bill sets the general direction for farm policy for 5-7 years and provides the best opportunity for comprehensive agricultural reform. The rapid increase in domestic production of corn ethanol has led to concerns about the environmental and economic sustainability of biofuels. Various reform proposals, many based on the body of research examining the CRP, were considered in the 2008 Farm Bill. The final piece of legislation incorporated some aspects of the proposals, but avoided wholesale change to the CRP. The next chapter examines how the CRP might be modified to allow for increased domestic production of biofuels.

## **Chapter 5**

### **5 RESEARCH GOALS AND METHODOLOGY**

#### **5.1 Introduction**

The 2008 Farm Bill process presented an opportunity to redefine the goals and administration of the Conservation Reserve Program (CRP) in response to both the changing face of the agricultural sector and deficiencies in the present program structure. As such, there have been a considerable number of proposals regarding the future objectives and management of the CRP from environmentalists, farmers, program administrators and citizens of rural communities (Section 4.5). This research utilizes a custom spreadsheet and a Geographic Information System (GIS) to model how farmer income, program cost, biofuel feedstock potential, and cropland usage are affected by four possible CRP program structures between 2007 and 2016. This chapter outlines the four CRP program structures tested and describes the structure of the analysis, major assumptions and data sources, the development of the GIS model and model strengths and weaknesses. Chapter 6 presents the results obtained from the GIS model for each of the four scenarios.

#### **5.2 Conservation Reserve Program Structures**

A review of the existing structure of the CRP, program deficiencies (Sections 3.1 - 3.4) and program changes suggested during development of the 2008 Farm Bill (Section 4.5) was conducted to develop four possible program structures for

the CRP that may be implemented between 2007 and 2016. The documented success of the CRP as it exists today, coupled with broad support from farmers, environmentalists and program administrators, may starkly limit the ability of legislators to implement wholesale change or eliminate the program. As such, the four scenarios are conservative and modify the existing CRP program guidelines to allow alternative uses of enrolled acres – subject to constraints identified in each of the four scenarios and prevailing CRP goals – but do not alter the fundamental structure of the CRP. Each of the four scenarios prioritizes biofuel feedstock development as a policy goal over other CRP objectives (i.e. wildlife habitat renewal, land preservation, erosion control) but strives to respect the environmental mandate of the CRP.

#### **5.2.4 Scenario 1: CRP Reauthorized With No Changes**

The structure of the Conservation Reserve Program remains effectively unchanged following passage of the 2008 Farm Bill, but participants are allowed one opportunity to renegotiate their enrollment and opt out of the CRP if desired. CRP rental rates are assumed to remain static throughout the 10-year contract period in contrast to the fixed rental rate previously received by landowners. Acreage caps, conservation cover crops and funding levels remain identical to the existing program.

#### **5.2.5 Scenario 2: First-Generation Biofuel Feedstock Growth**

The structure of the Conservation Reserve Program is altered to allow farmers to use up to 25% of their contracted CRP land to grow corn or soybeans that can be used to produce ethanol or biodiesel. The annual CRP rental rate is reduced in proportion to the amount of land used to grow corn or soybeans. Acres enrolled in either the Conservation Reserve Enhancement Program (CREP), the Farmable

Wetlands Program (FWP) or selected conservation covers would be ineligible for use to grow corn or soybeans.

#### **5.2.6 Scenario 3: Second-Generation Biofuel/Biomass Feedstock Growth**

The structure of the Conservation Reserve Program is altered to allow farmers to use up to 25% of their contracted CRP land to grow switchgrass or hybrid poplar trees that can be used as biomass feedstock for electricity generation or cellulosic ethanol production. The annual CRP rental rate is reduced in proportion to the amount of land used to grow biomass crops. Again, acres enrolled in either the Conservation Reserve Enhancement Program (CREP), the Farmable Wetlands Program (FWP) or selected conservation covers would be ineligible for use to grow biomass crops.

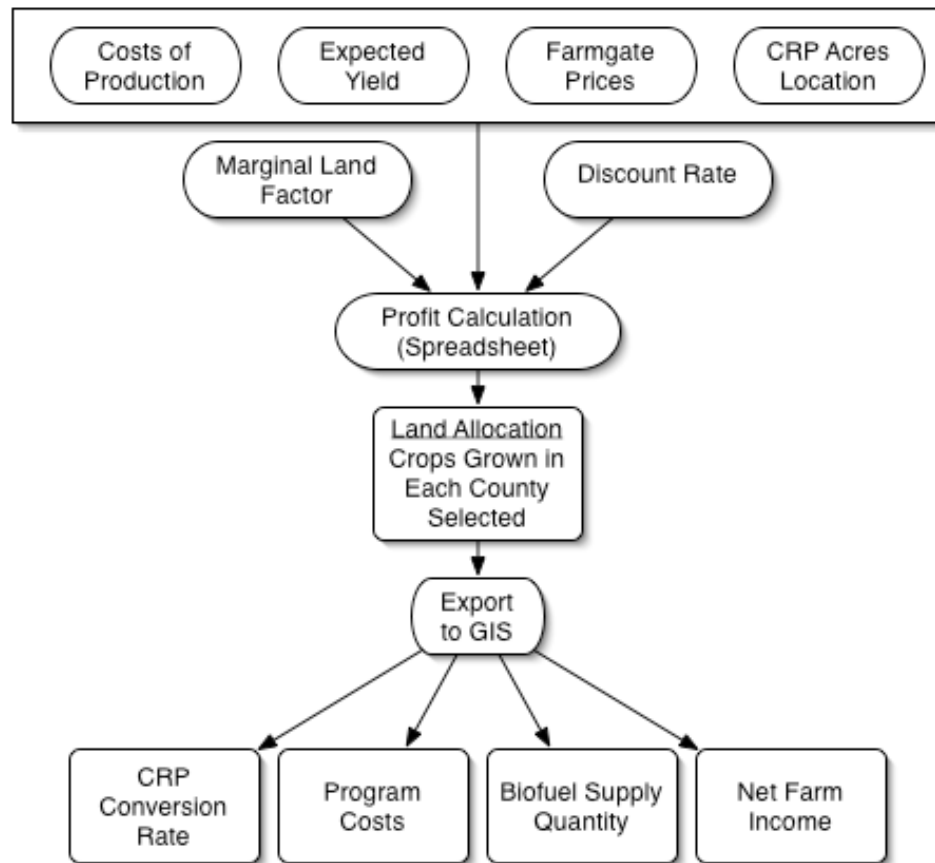
#### **5.2.7 Scenario 4: Working-Lands Conservation Program**

The structure of the Conservation Reserve Program is altered to allow farmers to use up to 25% of their contracted CRP land to grow any of the major field crops – corn, soybeans, wheat, oats, barley, sorghum, rice, cotton – or biomass crops. Acres enrolled in either the Conservation Reserve Enhancement Program (CREP), the Farmable Wetlands Program (FWP), selected conservation covers or classified as highly erodible land by program administrators would be ineligible to participate. The annual CRP rental rate is reduced in proportion to the amount of land used to grow other crops. Additionally, farmers will be required to grow crops using practices consistent with the conservation objectives of the CRP.

### **5.3 Research Methodology**

The analysis performed in this work utilizes a Microsoft Excel spreadsheet developed by the author to predict how acres currently enrolled in the CRP may be allocated during the 2007-2016 period given different program restrictions, crops, land productivity, costs of production, crop yield, and expected crop prices. The model operates at the county level throughout the Lower 48 United States and can calculate both the costs and revenue associated with growing any of the seven major field crops (corn, soybeans, wheat, cotton, sorghum, barley, oats), two biomass crops (hybrid poplar trees, switchgrass) or enrolling the land in the CRP and collecting annual rental rates.

The spreadsheet model performs a 10-year net present-value comparative profitability analysis among all of the land-use options for acres enrolled in the CRP, selects the most profitable option for each county given the model parameters, then allocates all eligible CRP acres in the county to that option. The results from the spreadsheet are exported to a Geographic Information System to display how land in the CRP is allocated at the national level and calculate national CRP conversion rates, program costs, net farm income, and biofuel supply potential. Figure 5-1 depicts the structure of the analysis in graphical format.



**Figure 5-1 Research Methodology Overview**

### 5.3.1 Modeling Framework and Theory

Without environmental, economic, or programmatic restrictions on acres enrolled in the CRP, it is assumed that landowners will allocate CRP land to the most profitable use available. The allocation of CRP land will therefore be determined by the relative profitability of growing field crops, biomass crops, collecting annual CRP rental rates or selling the land within a given time period. Because biomass crops have multi-year crop cycles, it is necessary to compare the discounted revenues and cost of production of the different land use choices over a number of years, taking into

account variability in location, crop yield, expected crop prices, economic expectations (represented by a discount rate), land productivity, and CRP program incentives, to determine which land use is the most profitable for the given time period. Comparing the net present value (NPV) of the profit associated with different land use choices over a given time period provides a simple method to predict how CRP land may be allocated given different program scenarios (Ugarte et al.; Graham et al., “GIS-Based Modeling System”).

The net present value for an acre of CRP land over a given time period ( $n$  years) is calculated by subtracting the costs of production,  $C_t$ , from the revenue,  $R_t$ , in each year, then discounting and summing the annual net profits, as shown in Equation [1].

$$NPV = \sum_{t=1}^n \frac{1}{(1+r)^t} (R_t - C_t) \quad \text{Eq. [1]}$$

The costs of production depend on the type of crop grown ( $H$ ), and vary spatially depending on location (counties) ( $L$ ), soil conditions ( $S$ ), climate ( $W$ ), irrigation practices ( $I$ ), seed selection ( $P$ ), farm equipment ( $E$ ) and farming technique ( $T$ ), among other variables.

$$C = f\{H, L, S, W, I, P, E, T, \dots\} \quad \text{Eq. [2]}$$

The USDA Economic Research Service tabulates historical costs of production for major field crops in major farming regions in the lower 48 states (US-USDA, “Commodity Costs”) and other researchers have estimated costs of production for biomass crops (Ugarte et al., 40-41). Enrollment in the CRP program is considered to be costless for the landowner. As a result, costs of production depend only on the type of crop grown and the location of the land. Linear extrapolations of historical data

yield estimated costs of production for any given future year,  $t$ . The intercept varies for each farming region and crop and is simply the annual cost of production reported in that farming region in 2006.

$$C_t = C(H, L) \cdot t + C_o(H, L) \quad \text{Eq. [3]}$$

The revenue of different land use choices is projected based on the type of crop grown ( $H$ ), expected farm gate price ( $F_p$ ), productivity of the land ( $P_l$ ), and average yield ( $Y$ ), among other variables.

$$R = f\{H, F_p, P_l, Y, \dots\} \quad \text{Eq. [4]}$$

For any given year,  $t$ , yields are calculated for each crop in each county,  $L$ , based on a linear extrapolation of national historical data. The slope, or the average annual change in yield, for each crop is calculated from a 10-year historical record of data. The intercept varies for each county and is simply the yield reported in that county in 2006,  $Y_o(L)$ .

$$Y(H, L)_t = \Delta Y_{10\text{yr}}(H) \cdot t + Y_o(L) \quad \text{Eq. [5]}$$

Nominal price forecasts,  $F_p(H)_t$ , for the 2007-2016 period are published by the USDA and FAPRI for major field crops (FAPRI, “Agricultural Outlook”; US-USDA, “Agricultural Baseline Projections”). Nominal biomass prices are incorporated into the model as user variables. Land productivity is represented as a fractional yield,  $P_l$ , calculated by multiplying predicted yield,  $Y(H, L)_t$  by a value between zero and one. The revenue in a given year is calculated according to Equation 6.

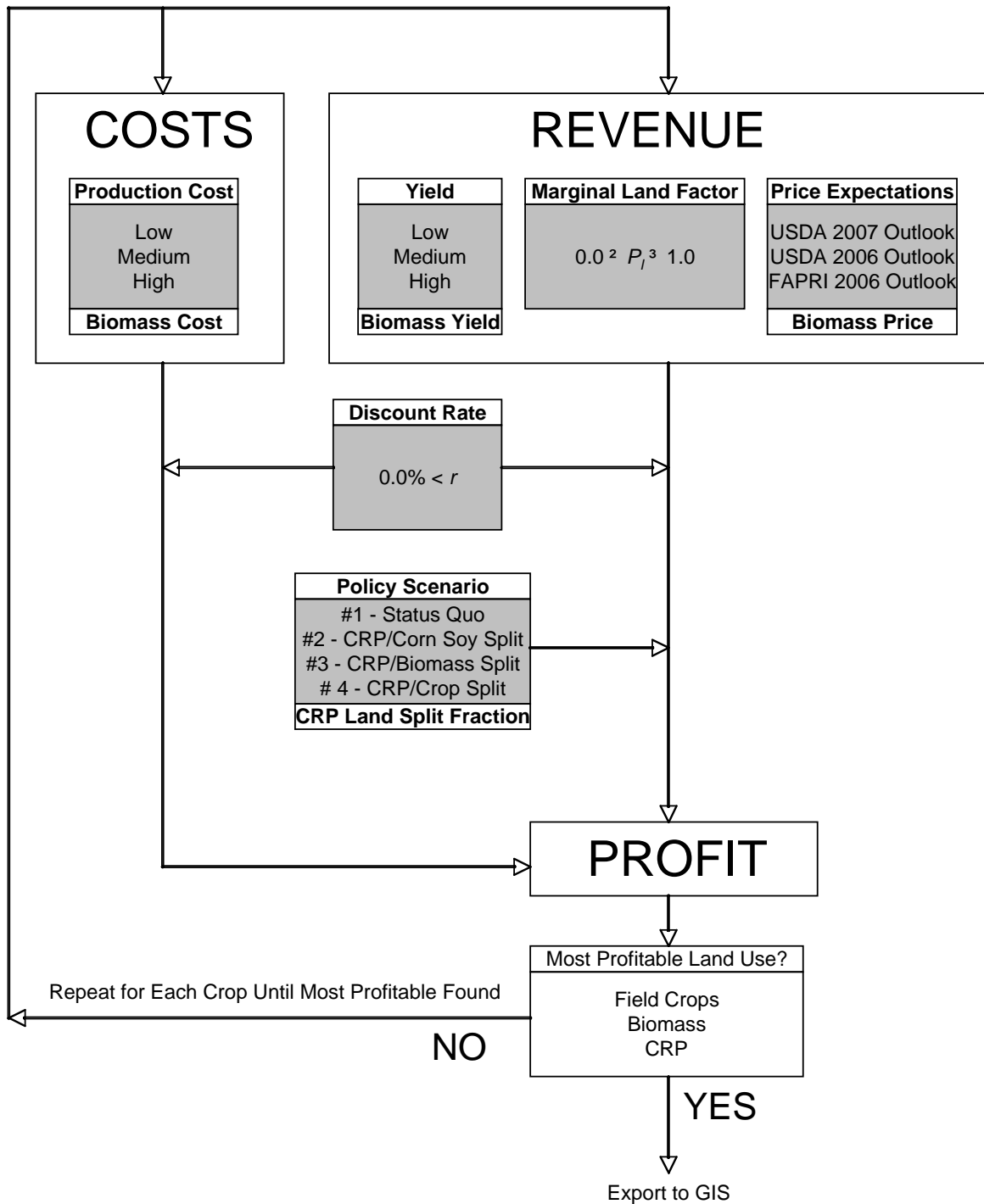
$$R_t = P_l \cdot Y(H, L)_t \cdot F_p(H)_t \quad \text{Eq. [6]}$$

Combining Equations [1] through [6] results in the equation below that is used to calculate profitability of growing each of seven field crops (corn, wheat,

soybeans, sorghum, cotton, barley and oats), two biomass crops (hybrid poplar and switchgrass) or enrolling in the CRP for each county in the United States.

$$NPV = \sum_{t=1}^n \frac{1}{(1+r)^t} [P_l \cdot Y(H,L)_t \cdot F_p(H)_t - (C(H,L) \cdot t + C_o(H,L))] \quad \text{Eq. [7]}$$

Figure 5-2 shows how the spreadsheet model operates to select the most profitable land use for acres enrolled in the CRP based on the model inputs. For each county in the United States, the model separately computes the costs and revenues for each land use option for each year between 2007 and 2016. The discount rate and policy scenario, which directly modify the costs and revenue associated with each land use option, are then integrated into the model and the 10-year discounted profit is calculated according to Eq. [7]. The model selects the most profitable land-use option and then repeats the process for the next county.



**Figure 5-2 Diagram of Spreadsheet Analysis Method**

A Geographic Information System (GIS) was the primary tool used to quantify the land-use changes associated with each of the alternative scenarios. The results from the NPV profitability analysis in the spreadsheet model were first exported to the GIS. Basic overlay analysis was used to combine individual layers of data defining the county boundaries, farm resource regions, location of CRP lands, and results from the spreadsheet model to depict the projected land-use pattern for a given scenario. After the land-use pattern was developed for each scenario, the GIS was used to perform calculations to estimate the CRP program cost, potential savings, expected biofuel supply quantity, and net farm income.

#### **5.4 Model Parameters and Data Sources**

The model provides a robust framework for exploring the effect of different program structures, anticipated costs of production, farmgate prices, crop yields, and the general economic environment on the Conservation Reserve Program. As this analysis assumes that farmers will make land use decisions to maximize individual profit, decisions will be heavily dependent on economic conditions over the course of the 10-year CRP contract period extending from 2007-2016. Key economic variables considered by farmers will include the cost of production of crops, the farmgate price paid for those crops, the CRP rental rate, and the relative value of money (represented by a discount rate). Additional factors affecting land-use decisions include annual precipitation and water availability, expected yield, erodibility of the land, and an individual farmer's willingness to assume financial risk.

Given the high degree of uncertainty, the model is configured not only to allow analysis of four (4) separate program structures (Section 5.2) over a 10-year period given straight line extrapolations of existing variables, but also to explore the

sensitivity of the forecasts to changes in production costs, farmgate prices, and the general economic environment. The majority of these variables are forecasted using a straight-line approximation over the period from 2007-2016 but includes 95% confidence intervals throughout the analysis to assess the degree of uncertainty. The user can select whether to use the average value or the high or low values forecasted within the 95% confidence interval to test the sensitivity of the projections. Table 5-1 describes the general model variables used in the analysis.

**Table 5-1 Model Parameters and User-Adjustable Values**

<b>Model Parameter</b>	<b>Possible Values</b>
Discount Rate	4.0%, 6.5%, 9.0%, or any percentage from 0-100%
Expected Crop Prices	USDA Agricultural Forecast 2007 USDA Agricultural Forecast 2006 FAPRI Agricultural Outlook 2006
Biomass Price	Any Number (\$/dt)
Costs of Production	Low, Average, High (based on crop type)
Crop Yield Growth	Low, Average, High (based on crop type)
Biomass Yield Growth	Any percentage between 0-100%
Land Productivity	Fractional value between 0 and 1
CRP Land Split	Fractional value between 0 and 1
CRP Policy Scenario	4 different program proposals

The spreadsheet model developed for this research is a deterministic model, only designed to calculate how the CRP will be affected by different program structures (i.e. CRP land sharing), economic conditions (i.e. discount rates, future crop prices), and yield expectations input by the user. Model calculations are based on linear extrapolation of historical data and user input variables, which vary spatially for each county in the United States. Data on the location of CRP acres, expected yield,

cost of production, and forecast farmgate prices of agricultural commodities was collected from a variety of sources and merged with spatial map data to create the GIS layers necessary for the profitability analysis. A description of the data sources, layers developed and major assumptions is provided in the following sections.

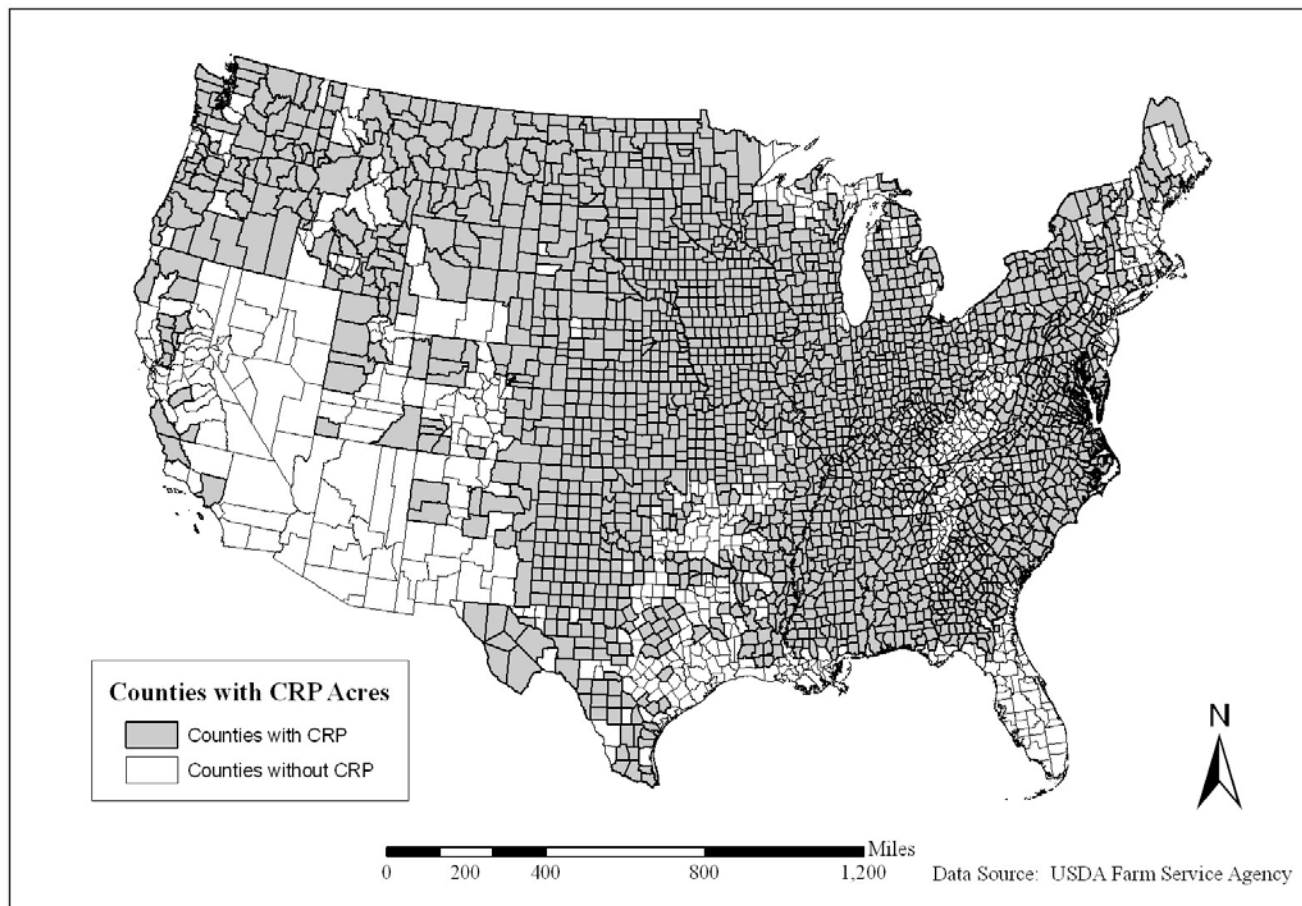
#### **5.4.1 CRP Enrollment, Rental Rates, and Locations**

CRP program data as of January 31<sup>st</sup>, 2007 was obtained from the USDA Farm Service Agency (FSA) for active CRP contracts in each county in the United States. Data provided included the average rental rate for each county, the total number of acres enrolled in the CRP, the number of contracts, the type of contract (i.e. general sign-up, continuous sign-up, or CREP), the type of conservation practice installed, and the Erodibility Index (EI) of the land enrolled.<sup>6</sup> The CRP program data collected was used to establish the initial conditions of the CRP prior to the 10-year analysis period and develop GIS layers for spatial analysis. Figure 5-3, Figure 5-4, and Figure 5-5 show the counties with acres enrolled in the CRP, the percentage of cropland in each county enrolled in the CRP, and the average rental rate for CRP acres in each county.

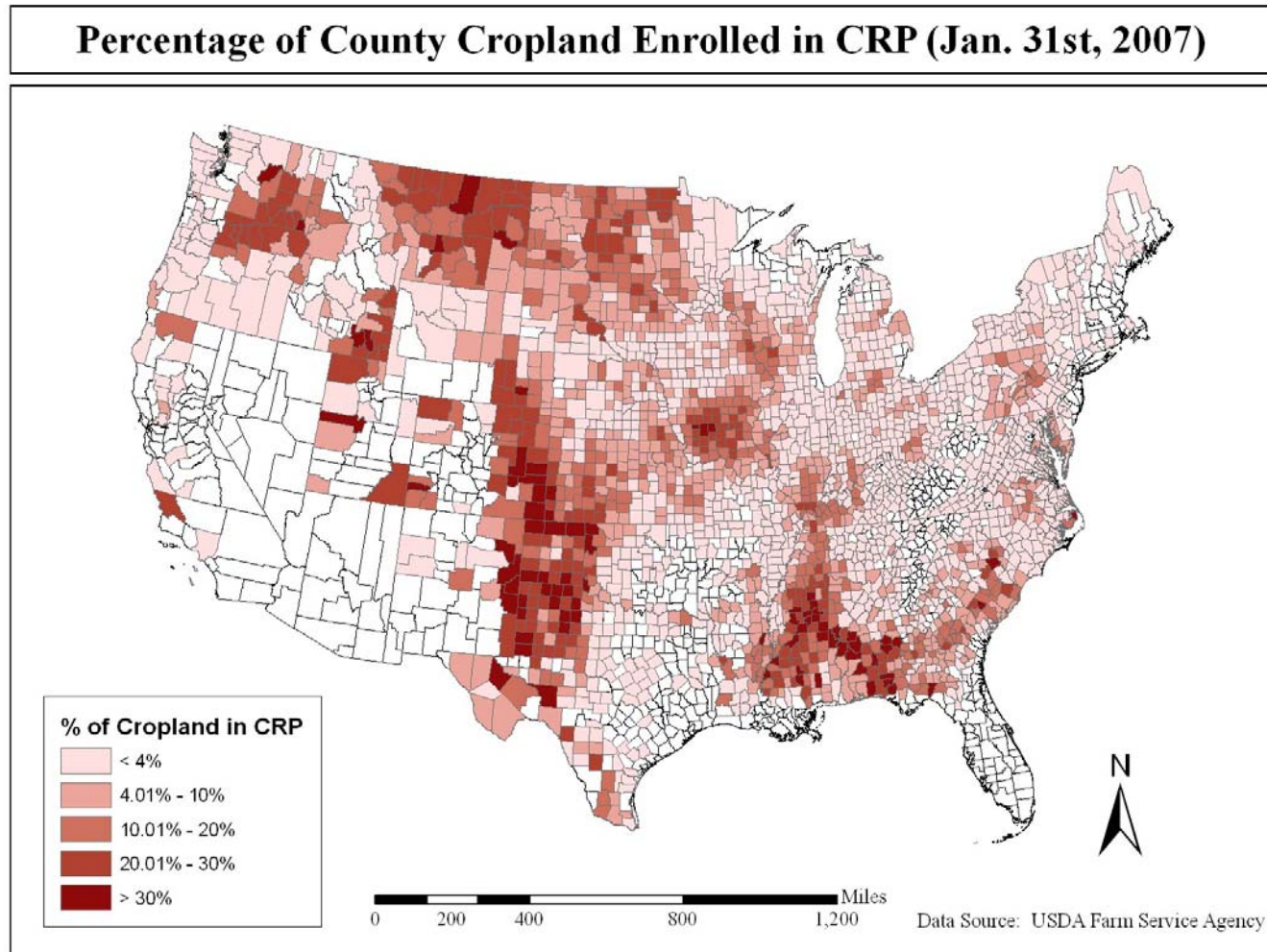
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<sup>6</sup> Of the 2089 counties reporting CRP contracts, 508 of them had no reported data due to privacy concerns (less than 4 contracts per county). However, the total number of acres not reported is only 53,924 or a trivial 0.15% of total CRP enrollment. Counties with privacy restrictions were therefore eliminated from further analysis.

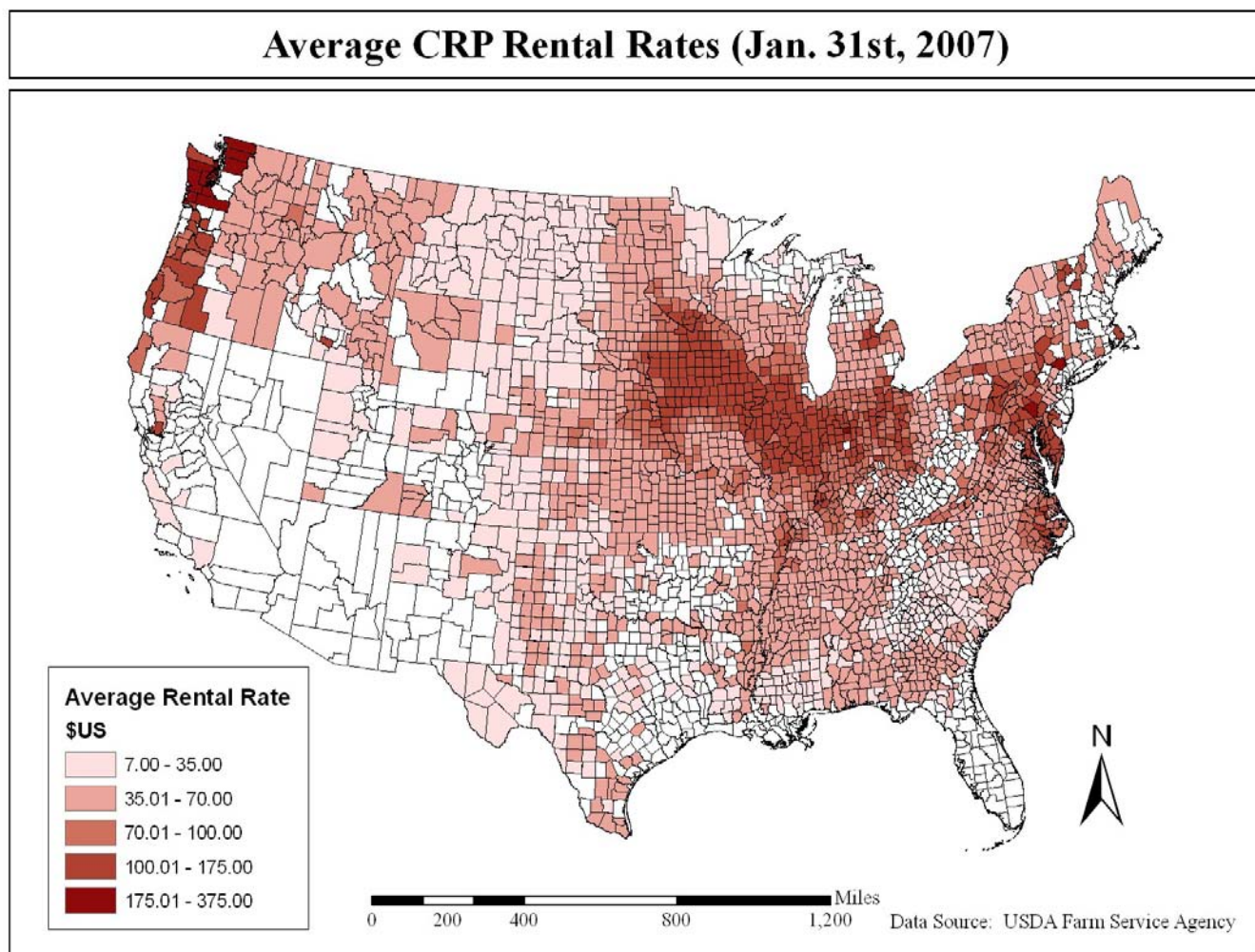
### Counties with Acres in Conservation Reserve Program (Jan. 31st, 2007)



**Figure 5-3 Counties With Acres Enrolled in the CRP**



**Figure 5-4 Percentage of County's Cropland Enrolled in the CRP**



**Figure 5-5 Rental Rates for Acres Enrolled in the CRP**

Additionally, the CRP program data was used to ascertain the amount of potentially convertible land in the CRP based on the permanence of the conservation practice installed. Acreages enrolled in the Conservation Reserve Enhancement Program (CREP) or Farmable Wetlands Program (FWP) to meet wildlife or environmental objectives and land transformed into trees, riparian buffers, filterstrips, wetlands, or wildlife habitat were characterized as permanent conservation practices and deemed non-convertible. All other lands could potentially be converted back into productive cropland if not enrolled in the CRP.<sup>7</sup> Because tabulations of conservation practices are only available at the state and national level, county level estimates of convertible land were calculated by multiplying the number of CRP acres in the county by the fraction of CRP acres in the respective state that are convertible. Table 5-2 shows the type of conservation practices and the potential amount of convertible acreage available nationally throughout the CRP. The 25,731,699 acres of potentially convertible land enrolled in the CRP is the base acreage used for evaluating changes to the program structure of the CRP in this analysis.

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<sup>7</sup> This does not imply that these acres will be converted, only that the cover crop is grass-based and could easily be tilled and prepared for farming. Environmental considerations, high erosion rates, low soil quality, an unexpired CRP contract or poor farming returns will prevent conversion to farming.

**Table 5-2 Estimates of CRP Acreage Potentially Convertible to Cropland**

Code	Description	Total # of Acres	Convertible?
	<u>New Grass Plantings</u>		
CP1	Introduced	3,378,845	YES
CP2	Native	7,161,153	YES
	<u>New Tree Plantings</u>		
CP3	Softwoods	405,465	NO
CP3A	Longleaf Pine/Hardwoods	712,340	NO
CP4	Wildlife Habitat	2,612,723	NO
CP5	Field Windbreaks	84,823	NO
CP6/CP7	Diversions/Erosion Control Structures	1,281	NO
CP8	Grass Waterways	124,637	YES
CP9	Shallow Water for Wildlife	52,001	NO
CP10	Existing Grass	15,296,973	YES
CP11/CP32	Existing Trees	1,163,677	NO
CP12	Wildlife Food Plots	87,371	NO
CP15	Contour Grass Strips	83,608	YES
CP16	Shelterbelts	33,086	NO
CP17	Living Snow Fences	5,255	NO
CP18	Salinity Reducing Vegetation	307,067	NO
CP13/CP21	Filterstrips	1,049,368	NO
CP22	Riparian Buffers	797,161	NO
	<u>Wetland Restoration</u>		
CP23	Floodplain	1,752,854	NO
CP23A	Non-floodplain	26,500	NO
CP24	Cross Wind Trap Strips	752	NO
CP25	Rare and Declining Habitat	1,240,656	NO
	<u>Farmable Wetland Program</u>		
CP27	Wetland	47,969	NO
CP28	Buffer	114,766	NO
	<u>Marginal Pasture Buffers</u>		
CP29	Wildlife	28,610	NO
CP30	Wetland	19,161	NO
CP31	Bottomland Hardwood Trees	33,384	NO
CP33	Upland Bird Habitat Buffers	142,725	NO
	Other	527	NO
	<b>Total CRP Acreage</b>	<b>36,764,738</b>	
	<b>Total CREP Acreage</b>	<b>917,470</b>	
	<b>TOTAL CONVERTIBLE LAND</b>	<b>25,731,699</b>	

**Source: (US-USDA, FY2006 CRP Summary Report)**

#### 5.4.2 Major Field Crops and Associated Growing Regions

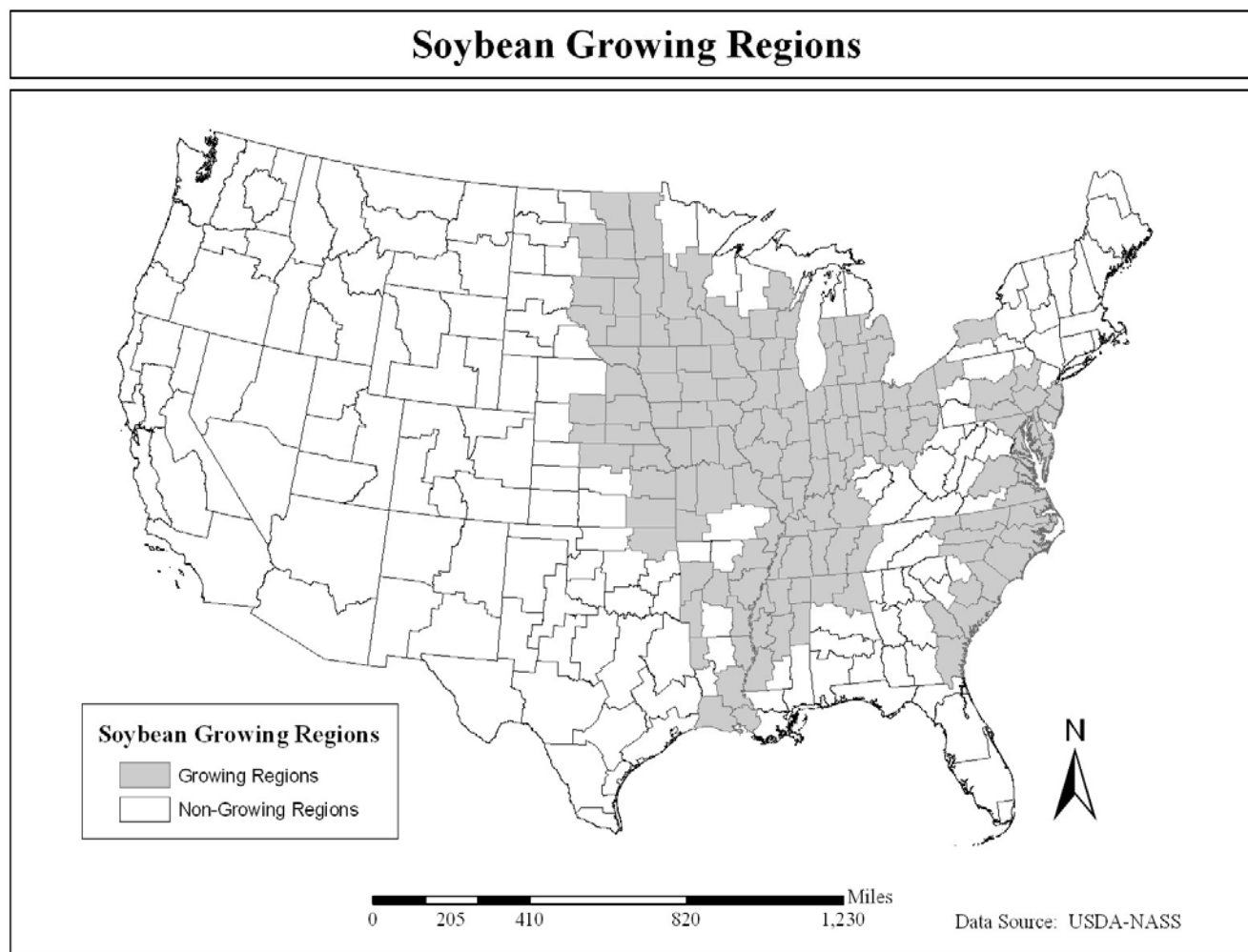
The land-use decisions facing farmers will depend on the growing regions of major field crops and biomass crops. The growing regions of the major field crops – corn, soybeans, wheat, oats, barley, sorghum, and cotton – were identified based on crop production data obtained from the National Agriculture Statistics Service (US- USDA, “Data and Statistics”). Each county was required to maintain a minimum amount of crop acreage from year to year for that crop to be included in the analysis. Table 5-3 shows the selection criteria used to identify which counties are primary producers of the seven major field crops.

**Table 5-3 Criteria for Determining Growing Regions of Major Field Crops**

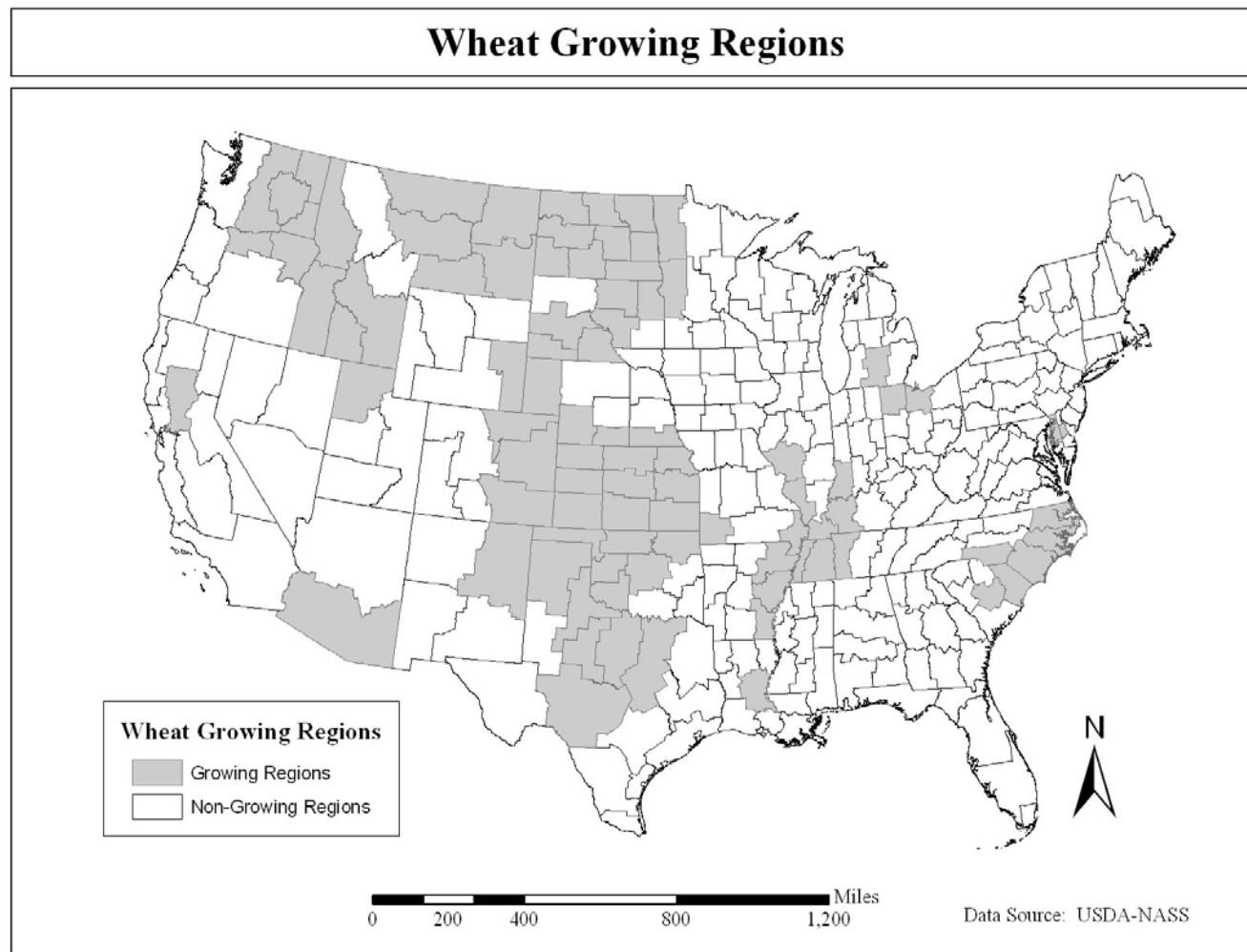
<b>Field Crop</b>	<b>Minimum # of Acres</b>	<b>OR Minimum % of County Cropland</b>
Corn	20,000	10%
Soybeans	15,000	10%
Wheat	15,000	10%
Oats	2,500	N/A
Barley	2,500	N/A
Sorghum	5,000	N/A
Cotton	10,000	N/A

Biomass crops – switchgrass and hybrid poplar – are not grown in sufficient quantity to determine appropriate growing regions from production data. Major growing regions for switchgrass and hybrid poplar were identified at Oak Ridge National Laboratory in the 1990’s and those results were replicated for this analysis (Ugarte et al. 5). Maps of the geographic growing regions of the major field crops and biomass crops used in the analysis are displayed in Figure 5-6 through Figure 5-14.

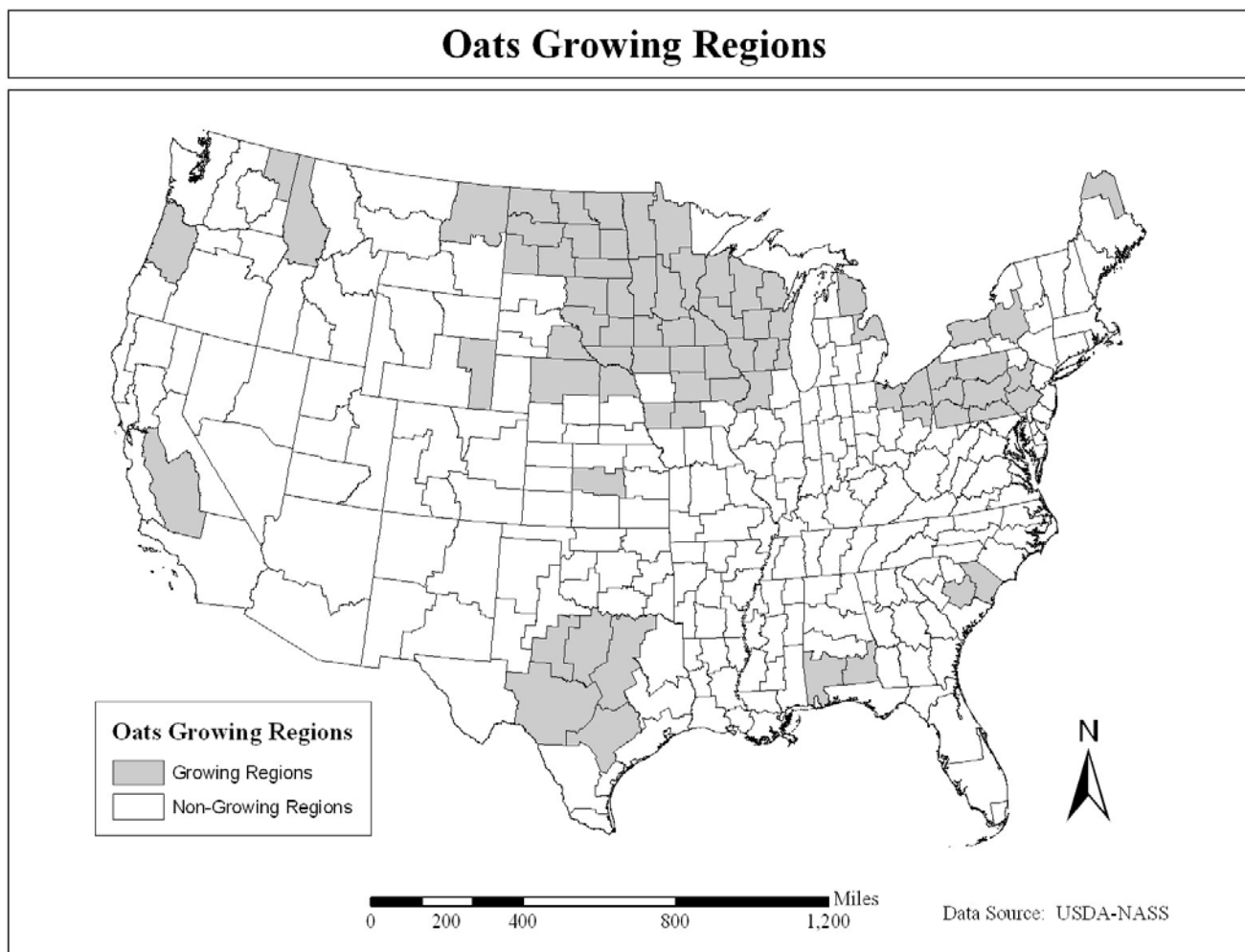
**Figure 5-6 Major Corn Producing Regions in the United States**



**Figure 5-7 Major Soybean Producing Regions in the United States**

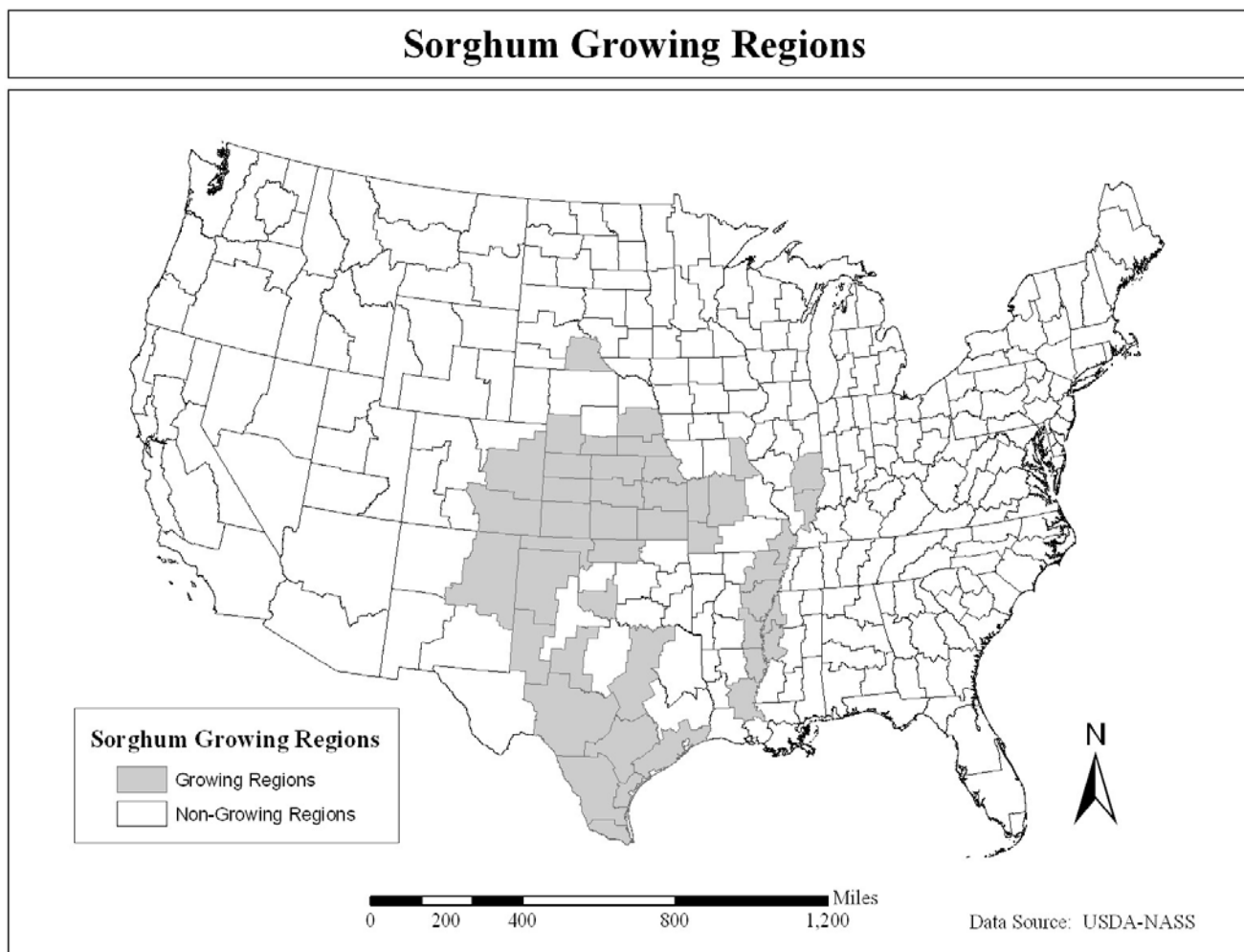


**Figure 5-8 Major Wheat Producing Regions in the United States**

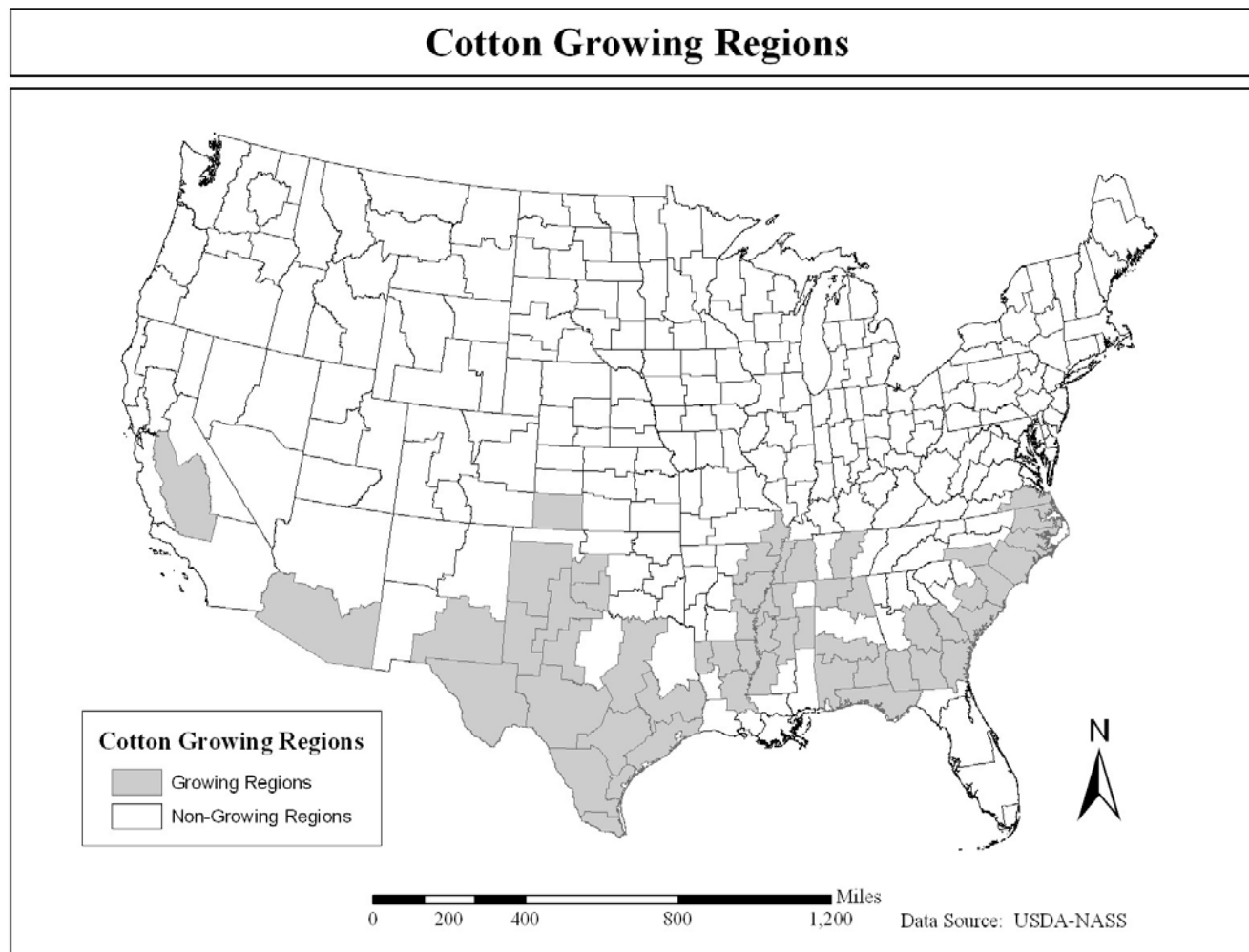


**Figure 5-9 Major Oats Producing Regions in the United States**

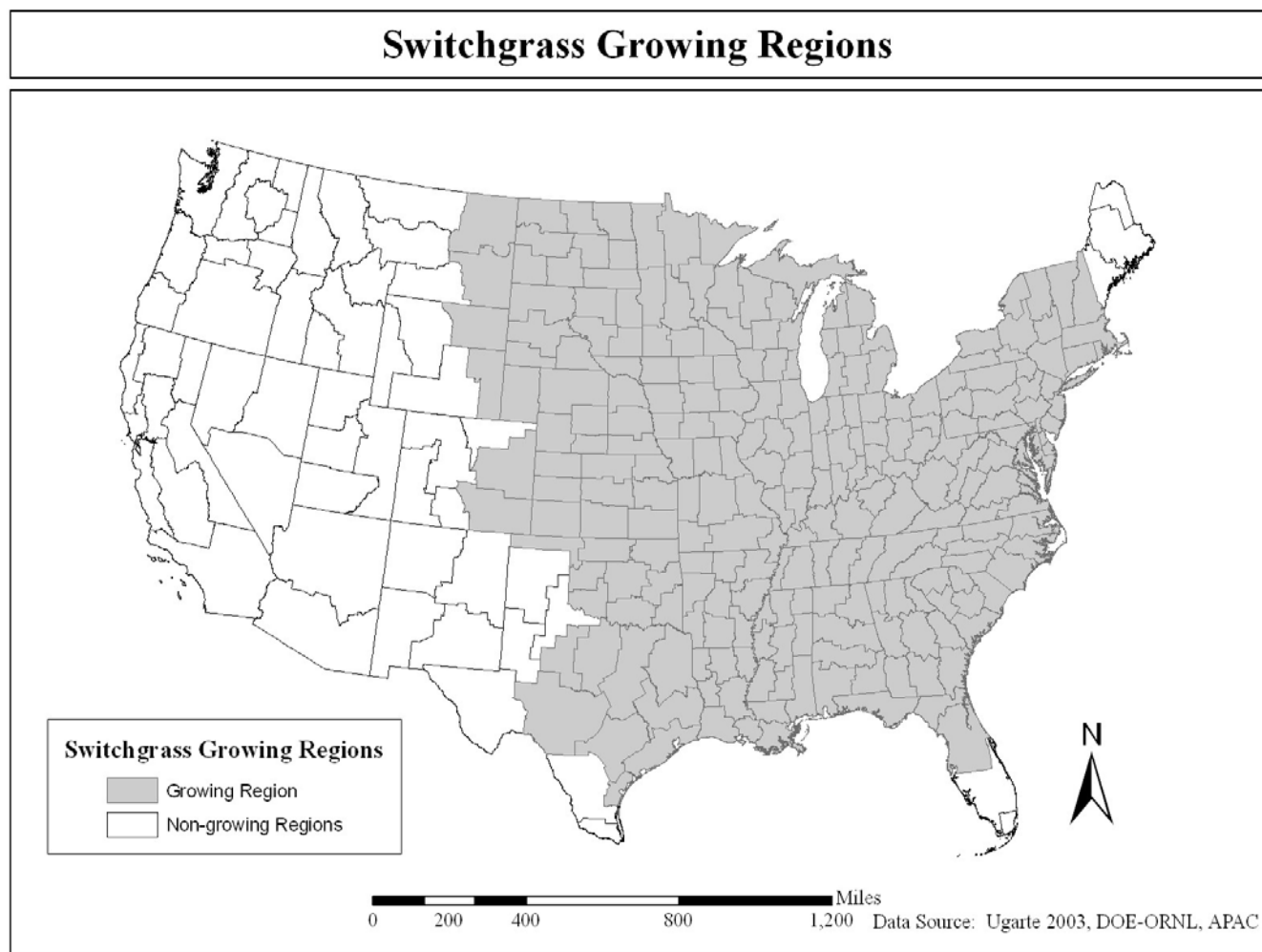
**Figure 5-10 Major Barley Producing Regions in the United States**



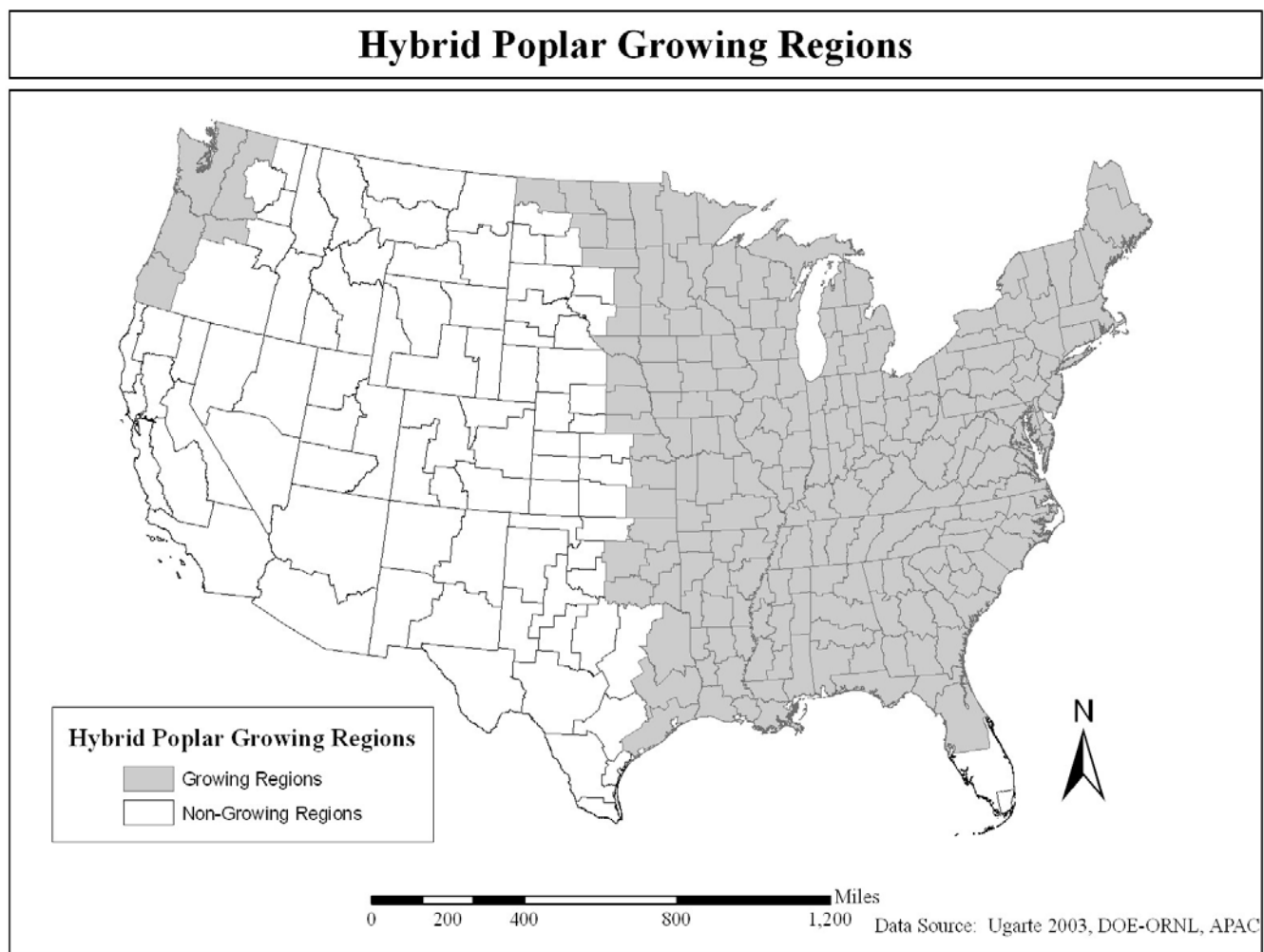
**Figure 5-11 Major Sorghum Producing Regions in the United States**



**Figure 5-12 Major Cotton Growing Regions in the United States**



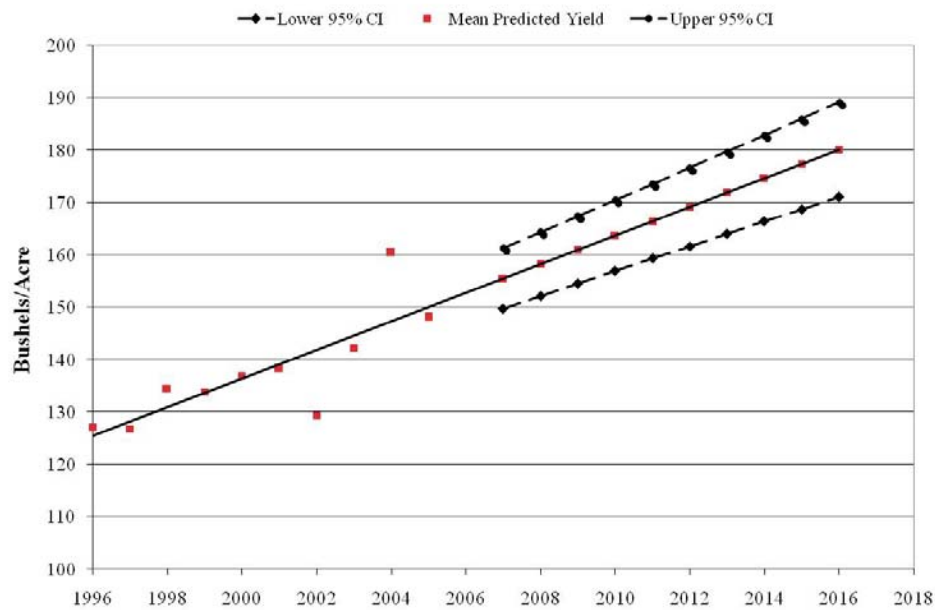
**Figure 5-13 Potential Regions for Growing Switchgrass in the United States**



**Figure 5-14 Potential Regions for Growing Hybrid Poplar in the United States**

### 5.4.3 Expected Yields for Major Field and Biomass Crops

Expected yields for each of the 7 major field crops during the period 2007-2016 were forecast using a straight-line regression analysis based on national historical yield data obtained from the National Agricultural Statistics Service (NASS) for the years 1996-2005. For all major field crops, the average national yield increased year-over-year from 1996 to 2005 and is anticipated to continue increasing in the future. 95% confidence intervals were calculated for each crop yield forecast to assess the degree of uncertainty associated with the projections and test the sensitivity of the forecasts in the final analysis. Figure 5-15 shows a graph of the forecast for corn yield with 95% confidence intervals, while Table 5-4 provides the forecasted values and 95% confidence intervals for each of the 7 major field crops.



Source: (NASS)

**Figure 5-15 Expected Yields for Corn**

**Table 5-4 Forecasted Yields for Seven Major Field Crops**

	Lower CI	Mean Yield (bu/ac)	Upper CI	Lower CI	Mean Yield (bu/ac)	Upper CI
Year	Wheat			Corn		
2007	37.62	43.09	48.55	149.63	155.46	161.29
2008	37.27	43.43	49.60	152.07	158.19	164.31
2009	36.89	43.78	50.67	154.49	160.92	167.35
2010	36.51	44.13	51.75	156.89	163.66	170.42
2011	36.12	44.48	52.83	159.27	166.39	173.50
2012	35.73	44.82	53.92	161.64	169.12	176.60
2013	35.33	45.17	55.01	163.99	171.85	179.71
2014	34.93	45.52	56.10	166.33	174.58	182.84
2015	34.53	45.87	57.20	168.66	177.32	185.97
2016	34.12	46.21	58.30	170.98	180.05	189.12
	Soybeans			Sorghum		
2007	35.47	40.74	46.01	51.61	58.93	66.26
2008	35.08	41.06	47.05	50.34	58.22	66.10
2009	34.67	41.38	48.09	49.03	57.51	65.98
2010	34.26	41.70	49.14	47.70	56.79	65.89
2011	33.84	42.01	50.19	46.35	56.08	65.81
2012	33.42	42.33	51.25	44.97	55.37	65.76
2013	32.99	42.65	52.31	43.58	54.65	65.72
2014	32.57	42.97	53.37	42.18	53.94	65.70
2015	32.14	43.28	54.43	40.77	53.23	65.69
2016	31.71	43.60	55.50	39.35	52.51	65.68
	Barley			Oats		
2007	59.59	64.89	70.19	60.27	64.95	69.64
2008	59.68	65.58	71.49	60.24	65.53	70.83
2009	59.74	66.28	72.82	60.20	66.12	72.03
2010	59.80	66.97	74.15	60.15	66.70	73.24
2011	59.84	67.67	75.50	60.10	67.28	74.46
2012	59.87	68.36	76.85	60.04	67.86	75.68
2013	59.90	69.06	78.21	59.98	68.44	76.90
2014	59.93	69.75	79.58	59.91	69.02	78.13
2015	59.95	70.45	80.95	59.84	69.60	79.35
2016	59.97	71.14	82.32	59.78	70.18	80.58
	Lower CI	Mean Yield (lbs/ac)	Upper CI			
	Cotton					
2007	781.61	828.07	874.54			
2008	800.83	847.35	893.86			
2009	820.04	866.62	913.19			
2010	839.25	885.89	932.53			
2011	858.45	905.16	951.88			
2012	877.64	924.44	971.23			
2013	896.83	943.71	990.59			
2014	916.00	962.98	1009.96			
2015	935.18	982.25	1029.33			
2016	954.34	1001.53	1048.71			

Biomass yield growth (stated as a percentage over the previous year) is a user-selectable variable. Biomass yields during the period 2007-2016 are forecast using estimated average yield data for separate regions of the country (Ugarte et al. 7) multiplied by the annual yield growth rate. Table 5-5 provides the estimated average annual yield<sup>8</sup> used in this analysis for switchgrass and hybrid poplar trees, grouped by Farm Production Region as described in Table 5-6.

**Table 5-5 Estimated Average Annual Yields for Biomass Crops**

<b>Farm Production Region</b>	<b>Average Yield (dt/ac/year)</b>		<b>Hybrid Poplar Production Cycle (years)</b>
	<b>Switchgrass</b>	<b>Hybrid Poplar</b>	
Northeast	4.70	3.99	10
Appalachia	5.84	3.56	10
Corn Belt	5.98	4.63	10
Lake States	4.80	4.41	10
Southeast	5.49	4.50	8
Southern Plains	4.30	3.75	8
Northern Plains	3.47	3.83	10
Pacific Northwest	--	5.73	6

**Source: (Ugarte et al. 7)**

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<sup>8</sup> Depending on the biomass crop, production cycles and harvest frequency may span multiple years. For this analysis, half of the switchgrass field is harvested every other year and hybrid poplars are harvested after 6-10 years depending on region.

**Table 5-6 Farm Production Regions**

<b>Farm Production Region</b>	<b>States Included</b>
Northeast	CT, NH, NJ, NY, MA, ME, PA, RI, VT
Appalachia	DE, KY, MD, NC, TN, VA, WV
Corn Belt	IA, IL, IN, MO, OH
Lake States	MI, MN, WI
Southeast	AL, AR, FL, GA, LA, MS, SC
Southern Plains	CO, KS, NE, OK, TX
Northern Plains	MT, ND, SD, WY
Pacific Northwest	OR, WA

**Source:** (Ugarte, et al. 7)

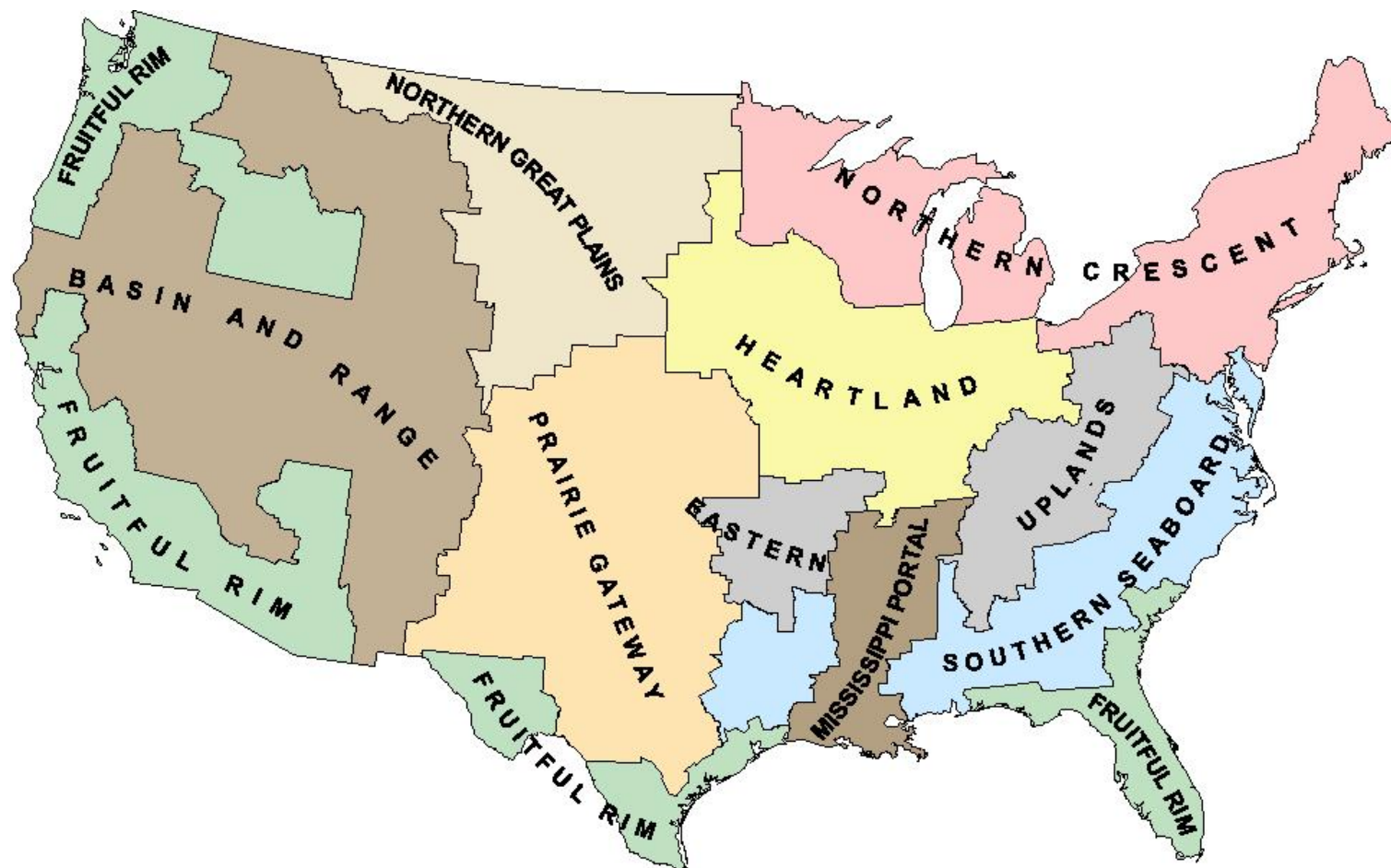
#### **5.4.4 Costs of Production for Major Field and Biomass Crops**

Costs of production for each of the 7 major field crops during the period 2007-2016 were forecast using a straight-line regression analysis based on regional cost of production data obtained from the USDA-ERS for the years 1996-2005 (US-USA, “Commodity Costs”). Regional data is aggregated according to ERS Farm Resource Regions shown in Figure 5-16, and in some circumstances according to commodity-specific Farm Resource Regions delineated by state boundaries and described in Table 5-7.

**Table 5-7 Farm Resource Regions for Barley and Oats**

<b>Field Crop</b>	<b>Farm Production Region</b>	<b>States Included</b>
Barley	North East	MD, PA, VA
	Northern Plains	MN, MT, ND, SD, WY
	North West	ID, OR, WA
Oats	North Central	IA, IL, MI, MN, OH, WI
	North East	NY, PA
	Northern Plains	KS, NE, ND, SD

**Source:** (US-USA, “Commodity Costs”)



Source: (US-USDA, “ERS Mapping and Spatial Data Center: Digital Map Gallery”)

**Figure 5-16 ERS Farm Resource Regions**

The USDA conducts producer cost surveys every 4-8 years and publishes updates each year incorporating estimates of annual price, acreage, and production changes. Since 1996, data has been collected annually for specific commodities as part of the Agricultural Resource Management Survey (ARMS). Table 5-8 shows the most recent cost of production survey for the 7 major field crops. Historical costs of production from 1996-2005 were extrapolated for the period from 2007-2106 for each field crop in each Farm Resource Region. 95% confidence intervals were calculated for each crop yield forecast to assess the degree of uncertainty associated with the projections and test the sensitivity of the forecasts in the final analysis.

**Table 5-8 Cost of Production Survey Years for Major Field Crops**

<b>Field Crop</b>	<b>Most Recent Cost of Production Survey</b>
Corn	2005
Soybeans	2006
Wheat	2004
Cotton	2003
Sorghum	2003
Barley	2003
Oats	2005

**Source: (US-USDA, “Commodity Costs”)**

Historical costs of production for biomass crops are not available from the USDA due to lack of large-scale plantings of these crops in the United States. Researchers at Oak Ridge National Laboratory evaluated management practices for biomass crops in different regions of the United States and developed cost estimates for planting and harvesting switchgrass, hybrid poplar, and willow trees in 2003. These costs (adjusted for inflation to 2007 US dollars) are listed in Table 5-9 for each

Farm Production Region previously described in Table 5-6. Due to the multiyear production cycles and to allow direct comparison to other field crops, the Net Present Value of the costs of production over the entire biomass production cycle (10 years for Switchgrass, and 6-10 years for Hybrid Poplar) has been converted to a fixed annual payment assuming a 6.5% discount rate.

**Table 5-9 Estimated Costs of Production for Biomass Crops**

Farm Production Region	Annual Cost (\$/ac/year)		Hybrid Poplar Production Cycle (years)
	Switchgrass	Hybrid Poplar	
Northeast	139.66	139.66	10
Appalachia	146.81	146.81	10
Corn Belt	139.17	139.17	10
Lake States	135.49	135.49	10
Southeast	173.35	173.35	8
Southern Plains	166.38	166.38	8
Northern Plains	133.82	133.82	10
Pacific Northwest	--	236.80	6

**Source:** (Ugarte et al. 7)

#### **5.4.5 Expected Prices for Major Field and Biomass Crops**

The relative profitability of utilizing CRP acres to grow major field or biomass crops is highly dependent on the farmgate price received by the farmer in the year the crop is harvested. The highly volatile nature of world agricultural commodity markets, complicated by regional weather factors, commodity support programs, trade restrictions, existing inventories and transportation costs, makes forecasting farmgate prices for crops highly uncertain. Recent shifts in cropland acreage in the United States into corn production to satisfy growing demand for ethanol have dramatically

shifted the farmgate prices for most of the 7 major field crops and contribute to greater uncertainty of long term price forecasts for agricultural commodities.

Publicly available forecasts of the farmgate price of major field crops in the United States over the period 2007-2016 from the USDA and FAPRI were utilized in this analysis. The USDA Agricultural Projections to 2015 (February 2006), USDA Agricultural Projections to 2016 (February 2007), and the FAPRI U.S. and World Agricultural Outlook (2006) are each incorporated into the calculation spreadsheet as a user-selectable variable and can be utilized to evaluate the sensitivity of the proposed CRP program structures to different price forecasts. The spreadsheet model does not calculate how these price forecasts may be affected by changes to the CRP program structures over the evaluated period from 2007 – 2016.

Table 5-10 shows the details of each of the price forecasts over the period 2007-2016. The base year of the forecasts was assumed to be a relatively minor factor in the forecast results, so the base year for forecasts published in 2006 was shifted to 2007 to allow for equivalent comparison between the three forecasts over the 2007-2016 period. Additionally, the USDA is prohibited from publishing price forecasts for cotton, so price forecasts for cotton provided by FAPRI were incorporated into all three forecasts.

**Table 5-10 Field Crop Price Forecasts (2007 - 2016)**

<b>USDA Agricultural Projections to 2015 (2006)</b>											
Crop	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Wheat	\$/bushel	3.15	3.10	3.10	3.20	3.25	3.35	3.40	3.45	3.50	3.55
Corn	\$/bushel	2.00	2.20	2.45	2.55	2.60	2.60	2.60	2.55	2.60	2.60
Soybeans	\$/bushel	5.15	5.40	5.70	5.85	5.95	6.05	6.05	6.05	6.10	6.10
Cotton	\$/pound	0.483	0.511	0.515	0.513	0.515	0.522	0.536	0.554	0.565	0.576
Sorghum	\$/bushel	1.80	2.00	2.20	2.30	2.35	2.35	2.35	2.30	2.35	2.35
Barley	\$/bushel	2.40	2.55	2.70	2.75	2.75	2.75	2.75	2.70	2.75	2.75
Oats	\$/bushel	1.40	1.45	1.50	1.55	1.55	1.55	1.55	1.55	1.55	1.55
<b>USDA Agricultural Projections to 2016 (2007)</b>											
Crop	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Wheat	\$/bushel	4.35	4.45	4.25	4.25	4.35	4.40	4.45	4.50	4.55	4.55
Corn	\$/bushel	3.00	3.50	3.60	3.75	3.55	3.50	3.45	3.40	3.35	3.35
Soybeans	\$/bushel	5.90	7.00	7.25	7.30	7.00	6.90	6.80	6.80	6.75	6.75
Cotton	\$/pound	0.483	0.511	0.515	0.513	0.515	0.522	0.536	0.554	0.565	0.576
Sorghum	\$/bushel	3.00	3.00	3.35	3.50	3.30	3.25	3.20	3.15	3.10	3.10
Barley	\$/bushel	2.89	3.50	3.60	3.70	3.55	3.45	3.45	3.40	3.35	3.35
Oats	\$/bushel	1.85	2.40	2.45	2.50	2.35	2.25	2.20	2.15	2.10	2.10

**Table 5-10 Continued**

<b>FAPRI U.S. and World Agricultural Outlook (2006)</b>											
Crop	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Wheat	\$/bushel	3.30	3.39	3.45	3.55	3.61	3.66	3.69	3.72	3.75	3.77
Corn	\$/bushel	2.08	2.20	2.30	2.38	2.44	2.46	2.47	2.48	2.48	2.49
Soybeans	\$/bushel	4.96	5.25	5.45	5.48	5.52	5.57	5.59	5.58	5.56	5.54
Cotton	\$/pound	0.483	0.511	0.515	0.513	0.515	0.522	0.536	0.554	0.565	0.576
Sorghum	\$/bushel	1.96	2.04	2.11	2.18	2.23	2.26	2.28	2.31	2.34	2.37
Barley	\$/bushel	2.60	2.66	2.73	2.75	2.77	2.76	2.75	2.76	2.77	2.79
Oats	\$/bushel	1.64	1.69	1.74	1.79	1.82	1.84	1.85	1.86	1.86	1.87

**Source:** (US-USDA, “Agricultural Baseline Projections”; FAPRI, “Agricultural Outlook”)

Neither historical prices nor price forecasts are available for biomass crops. Instead, the model incorporates a biomass price parameter (\$/dry ton) that must be specified by the user. Due to the relative uncertainty surrounding biomass price forecasts, the model assumes a variety of prices between \$10-\$60/dry ton depending on the scenario. This price range would make biomass competitive with coal (See Table 5-11) when used for electricity generation and is expected to be the minimum price range to make growing biomass crops revenue-neutral and encourage farmers to switch to biomass crops.

**Table 5-11 Price and Energy Content of Primary Fuels (2007 Dollars)**

<b>Fuel Type</b>	<b>Units</b>	<b>Energy Content (MMBtu/unit)</b>	<b>Average Price (\$/unit)</b>	<b>Average Price (\$/MMBtu)</b>
Natural Gas	1,000 cubic foot	1.028	8.11	7.89
Coal	short ton	20.341	25.40	1.25
Crude Oil	barrel	5.800	67.35	11.61
Gasoline	barrel	5.157	119.70	23.21
Diesel	barrel	5.769	121.38	21.04
Electricity	MWh	3.412	91.40	26.79
Biomass	dry ton	17.200	30.00	1.74

**Source: (AER 2007)**

## 5.5 Nationwide Program Calculation Methodology

After the land-use pattern was calculated for each scenario with the spreadsheet model, a GIS software package was used to synthesize the results for each county in the United States and estimate the CRP program cost, potential program savings, expected 10-year harvests of biomass, corn, and soybeans, and net farm income. Maps depicting the conversion of CRP acres to crop production at the county

level (See Chapter 6) were also created to allow spatial evaluation of the results and identify regional or climate specific trends.

### 5.5.1 Program Cost

Annual CRP program cost,  $P_{CRP,I}$ , was calculated as the average CRP rental rate,  $U$ , multiplied by the number of CRP acres in each county,  $A_C$ , summed over all counties in the continental United States with CRP contracts,  $n$ .

$$P_{CRP,I} = \sum_{i=1}^n (U_i \cdot A_{C,i}) \quad \text{Eq. [8]}$$

Annual program costs for the CRP are calculated to be \$1.047 billion as of January 31, 2007. CRP administrative costs are small relative to the rental payments made to program participants for contracted CRP acres and are excluded from the estimate of total program costs and Eq. [8]. Multi-year program costs are estimated using the annual program costs and discount rate,  $r$ , assumed for each scenario to calculate the net present value over the 10-year analysis period.

$$NPV(P_{CRP}) = \sum_{t=1}^{10} \frac{1}{(1+r)^t} (P_{CRP,t}) \quad \text{Eq. [9]}$$

### 5.5.2 Program Cost Savings

Annual program cost savings result from reduced rental payments to landowners. Converting CRP contracted acres to alternate uses that do not receive a rental payment (i.e. bioenergy crops) or withdrawing acres under CRP contract from the program both result in reduced rental payments. For each scenario, the annual CRP program cost savings,  $S_{CRP,I}$ , was calculated as the average CRP rental rate,  $U$ , multiplied by the number of CRP acres converted to alternate uses or removed from

the program,  $A_R$ , summed over all counties in the continental United States with CRP contracts,  $n$ .

$$S_{CRP,1} = \sum_{i=1}^n (U_i \cdot A_{R,i}) \quad \text{Eq. [10]}$$

Multi-year program costs are estimated using the annual program savings and discount rate,  $r$ , assumed for each scenario to calculate the net present value over the 10-year analysis period.

$$NPV(S_{CRP}) = \sum_{t=1}^{10} \frac{1}{(1+r)^t} (S_{CRP,t}) \quad \text{Eq. [11]}$$

The acres enrolled in the CRP in a given county in a given program year is related to the acres enrolled in the same county in a previous program year.

$$A_{C,t} = A_{C,t-1} - A_{R,t} \quad \text{Eq. [12]}$$

As of January 31, 2007, the total number of potentially convertible acres enrolled in the CRP was estimated at 23,887,293. This number differs slightly from the total number of convertible acres enrolled nationally in the CRP in Section 5.4.1 due to rounding estimates when dividing program acres among individual states and counties.

### 5.5.3 Net Farm Income

Net farm income is the annual profit a landowner receives from the usage of the land, after all costs have been accounted for. Since CRP contracted acres are left idle with few maintenance costs, the annual rental payment is assumed to contribute directly to the annual profit and net farm income. For landowners who choose to grow biomass or field crops on all or a portion of CRP contracted acres, the net farm income for a given acre,  $N(a)$ , was calculated as the revenue from growing a

particular crop,  $R(H)$ , minus the cost,  $C(H)$ , plus any annual rental payment for that acre,  $U(a)$ . In cases where field or biomass crops are grown on a portion of the contracted program acre, the annual rental payment is reduced by a factor,  $b/c$ , proportional to the ratio of land used to grow field or biomass crops,  $b$ , to the total contracted CRP acreage,  $c$ .

$$N(a) = \left( R(H) - C(H) + \left( 1 - \frac{b}{c} \right) \cdot U(a) \right) \quad \text{Eq. [13]}$$

National annual net farm income,  $N_{CRP}$ , was calculated by summing the net farm income on each acre,  $N(a)$ , over all acres in a particular county,  $m$ , and counties in the continental United States with CRP contracts,  $n$ .

$$N_{CRP} = \sum_{j=1}^n \sum_{i=1}^m N(a)_{i,j} \quad \text{Eq. [14]}$$

10-year net farm income was estimated by summing the annual net farm income,  $N_{CRP}$ , over the 10-year analysis period.

$$N_{CRP,10} = \sum_{t=1}^{10} N_{CRP,t} \quad \text{Eq. [15]}$$

The 10-year net farm income for CRP contracted acres as of January 31, 2007 was calculated to be \$7.526 billion. This figure only includes income accruing from annual program rental payments, since CRP contracted acres were prohibited from growing biomass or field crops.

#### 5.5.4 10-year Harvests for Biomass, Corn and Soybeans

Yields are forecast for each year during the period 2007-2016 for each county in the continental United States as part of the spreadsheet model. Depending on the CRP scenario selected, acres may be allocated to 1<sup>st</sup> generation bioenergy crops

(corn, soybeans), 2<sup>nd</sup> generation biomass crops (switchgrass, hybrid poplar trees) or any of the other field crops. Acres allocated to corn, soybeans, switchgrass or hybrid poplar trees in any of the scenarios are assumed to be utilized for bioenergy feedstocks and not redirected to other end uses. The 10-year harvest for biomass, corn, and soybeans was calculated by summing the annual yields  $Y(H,L)_t$  for each crop in each county in the continental United States,  $n$ . As of January 31, 2007, no biomass harvests were recorded on CRP contracted acres.

$$Y(H,L)_{10} = \sum_{t=1}^{10} \sum_{i=1}^n Y(H,L)_{n,t} \quad \text{Eq. [16]}$$

### 5.5.5 Biofuel Supply Quantity

Biomass, corn and soybeans produced on CRP contracted acres are assumed to be utilized for bioenergy/biofuel applications and not diverted to other end uses. It is not clear whether biomass produced on CRP contracted acres would be more likely to be combusted directly to produce heat for industrial processes and electricity generation or converted into liquid biofuels. This analysis focuses on liquid biofuels and calculates the potential biofuel supply quantity based on the conversion of all biomass, corn and soybean feedstocks into ethanol and biodiesel respectively.

Potential biofuel supply quantities over the analysis period (2007-2016),  $B(H)_{10}$ , for each scenario are calculated by multiplying the total 10-year yield of the crop (corn, soybeans, or biomass),  $Y(H,L)_{10}$ , by a conversion factor based on ethanol and biodiesel refining practices,  $X_H$ .

$$B(H)_{10} = Y(H,L)_{10} \cdot X_H \quad \text{Eq. [17]}$$

The conversion factor,  $X_H$ , varies widely depending on the feedstock and refining technique, so average industry estimates listed in Table 5-12 were used for this analysis.

**Table 5-12 Feedstock to Biofuel Conversion Factors**

<b>Biofuel</b>	<b>Feedstock</b>	<b>Units</b>	<b>Refinery Yield (gal/unit)</b>
Ethanol	Corn	Bushel	2.68
Ethanol	Woody Biomass	Dry ton	90
Biodiesel	Soybeans	Bushel	1.31

**Source: (US-DOE, “GREET Operating Manual, v.1.7, Table 4.17”; Shapouri and Gallagher 11; US-EPA “Comprehensive Analysis of Biodiesel”)**

## **5.6 Discussion of Model Capabilities and Limitations**

All models are intended to simulate real-world conditions and provide guidance to users about the effect of certain parameters on the variable of interest. Any model is constrained by the modeling framework selected, validity of assumptions, the accuracy of baseline conditions, and parameter values entered by the user. A brief discussion of the modeling framework, capabilities and limitations of the model developed for this research relative to other types of models is provided below.

### **5.6.1 Modeling Frameworks**

Models can be broadly categorized into one of three general modeling frameworks:

*Deterministic* – This modeling framework is based on a defined mathematical relationship among independent variables where a single estimate represents the value of each variable, without

any room for random variation. As a result, a selected set of inputs will always yield an identical result.

*Stochastic* – This modeling framework is again based on a defined mathematical relationship among independent variables, but a probability distribution with a range of values represents the value of each variable. A stochastic model will provide the most likely result given a selected set of inputs and may vary slightly between simulations. Unlike deterministic models, a stochastic model provides an estimate of the level of uncertainty of a given result.

*Constrained Optimization* – This type is based on multiple defined mathematical relationships among independent and dependent variables solved simultaneously to yield an optimal result. These models can be designed to be either deterministic or stochastic and are generally the most robust type of model for policy analysis where optimization of certain parameters is desired (i.e. total cost, people affected, etc.). Constraints, inputs and model assumptions can all be varied based on the policy scenario.

The model developed for this research is fundamentally a deterministic model, based on the assumption that landowners will allocate CRP land to the most profitable use available (See Section 5.3.1). Land is allocated to the use that will yield the largest net present value over the period from 2007-2016 given a policy scenario and specified set of model inputs. 95% confidence intervals for the mean projections for yield and cost of production of major field crops are incorporated into the modeling framework to allow for limited analysis of the sensitivity of results to changes in yield or cost of projection estimates.

### **5.6.2 Model Capabilities**

Incorporating a deterministic net present value profit maximization modeling framework, the model developed for this research is an extremely versatile foundation for simulating the effects of different policy parameters on the CRP. With

four separate CRP policy scenarios, seven major field crops and two biomass crops, plus the capability to adjust the yield forecast, cost of production forecast, and price forecast for each crop, the model provides a very flexible set of inputs to allow the user to evaluate a wide variety of potential scenarios.

Unlike many other agricultural simulation models, the model developed for this research is focused explicitly on the allocation of land in the CRP to conservation or agricultural practices and allows policy scenarios to be examined independent of other agricultural policies or developments. Since the CRP is designed around the use of long-term contracts, fundamental changes to program policies necessitate evaluation separate from the annual fluctuations of national and international agriculture markets to make optimal program-specific recommendations.

While most biomass or agricultural models operate at a regional or national level (US-USDA, “Agricultural Baseline Projections”; FAPRI, “Agricultural Outlook”; Ugarte et al.), this model estimates land allocation at the county-level and then aggregates into national program-wide results. As a result, the model quantifies spatial variation more precisely and allows for more sophisticated analysis of regional effects of program policies implemented at the national level.

### **5.6.3 Model Limitations**

The deterministic model framework is well suited for the type of analysis conducted in this research, but it is important to understand the limitations of the model to adequately interpret results.

The model operates exclusively on lands enrolled in the CRP as of January 31, 2007 and does not include cropland outside the CRP dedicated to other uses. Consequently, this model does not incorporate interactions between CRP land

allocation and other areas of the agricultural sector such as livestock, food processing or trade. As a result, the model cannot quantify many of the effects in the greater agricultural markets (i.e. crop prices, crop acreage shifts) of large shifts of acreage out of the CRP. While this is a major limitation of the model, the amount of potentially convertible land enrolled in the CRP is small relative to total cropland in the United States (~5.9%) and shifting acreage out of the CRP would have a limited effect on greater agricultural markets (Ugarte and Hellwinckel). Where incorporation of these effects is deemed desirable, the user is expected to account for them as much as possible by altering the inputs to the model to reflect the interactions.

Due to the complexity incorporating year-to-year variations of CRP program acres resulting from expiring contracts and uncertainty of future sign-ups given the program funding appropriated as part of the 2008 Farm Bill, the model utilizes a fixed acreage estimate as of January 31, 2007 as the baseline. The model assumes that any major shift in program policy to allow users to grow biomass or field crops would be predicated by a one-time offer to all CRP contract holders to either opt-out of the CRP or opt-in to the biomass contract provisions. Consequently, the model evaluates all policy proposals over a 10-year period relative to the base acreage as of January 31, 2007 and does not account for year-to-year fluctuations in the base acreage amount.

The model is necessarily limited by the degree of sophistication programmed into the model. Any model is designed to approximate or simulate real-world results given a limited number of parameters, but cannot account for all variations or influences that actually occur. The model used for this research is a simplified approximation of the dynamics that drive land-owners to participate in the

CRP or allocate the land to other uses. Some of the simplifying assumptions incorporated into the model and not discussed elsewhere (See Section 5.4) include:

- 1) CRP rental rates remain static during the analysis period.
- 2) All variables pertaining to the relative health of the economy and farmer's cost of capital are lumped into a single factor, the discount rate, which is assumed to remain fixed over the analysis period.
- 3) No government sponsored agricultural payments, subsidies, or tax credits except for the CRP rental rates contribute to farmer income.
- 4) Farmers are not permitted to opt-out of the CRP

Finally, the model offers a great degree of flexibility for the user to modify inputs and evaluate the effects on the CRP. However, the model cannot determine whether the inputs or the results are sensible. Any results must be judged by the user relative to the reasonableness of the model scenario parameters to any real-world counterparts. For instance, the model can evaluate a program scenario given any crop price forecast, but the validity of the results must be judged relative to the likelihood the crop price forecast may actually occur.

## **Chapter 6**

### **6 CONSERVATION RESERVE PROGRAM PROPOSAL RESULTS AND ANALYSIS**

#### **6.1 Introduction**

As part of this research, four CRP program scenarios (Section 5.2) were evaluated to determine how each scenario would affect program enrollment, program costs, net farm income, and biofuel supply potential. Initially, identical model parameters were selected for each of the program scenarios to compare the proposed program structures under similar conditions. These results were used to refine further analysis specific to each program scenario and examine the effects of varying individual model parameters to achieve stated policy goals relating to program enrollment, program costs, net farm income, and biofuel supply potential.

#### **6.2 Comparison of Program Scenarios**

Each of the scenarios was initially evaluated with an identical set of model parameters. Model parameters were selected in accordance with a fairly conservative set of economic assumptions in an attempt to isolate effects resulting from the different program scenarios and limit the effects of other parameters. Table 6-1 describes the model parameters assumed in the analysis.

**Table 6-1 Comparison of Program Scenarios - Model Parameters**

<b>Model Parameter</b>	<b>Selected Value</b>
Discount Rate	6.5%
Expected Crop Prices	USDA Agricultural Forecast 2007
Biomass Price	\$30/dry ton
Costs of Production	Average (Straight-Line Forecast)
Crop Yield Growth	Average (Straight-Line Forecast)
Biomass Yield Growth	0% (No improvements in annual yield)
Land Productivity	0.8 (Yields assumed 80% of typical cropland)
CRP Land Split	0.25 (Crops grown on 25% of contracted acre)
CRP Policy Scenario(s)	1. CRP Reauthorization with Contract Opt-Out 2. 1 <sup>st</sup> Generation Biofuel Crops with Land Split 3. 2 <sup>nd</sup> Generation Biofuel Crops with Land Split 4. Any Crop with Land Split

#### **6.2.1 CRP Conversion Rates for Each Program Scenario**

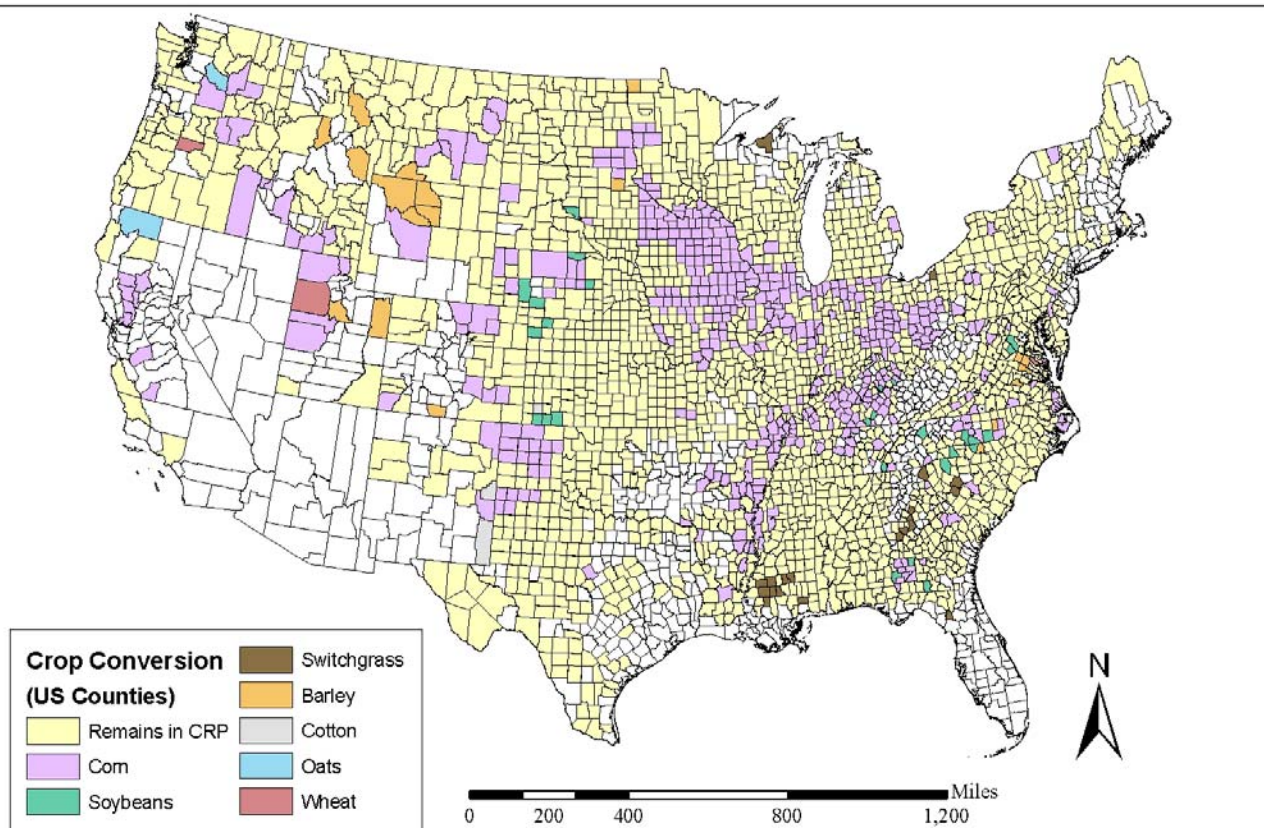
Estimated CRP conversion rates for each program scenario are presented in Table 6-2, along with the end-use of each converted acre. Under similar model parameters, Table 6-2 demonstrates that the choice of program scenario has a stark effect on the number of contracted acres that will be converted to alternate uses, given the assumptions listed in Table 6-1. When program participants are allowed the opportunity to completely opt-out of contracts (Scenario #1), 5.7 million acres are converted to alternate crops. In scenarios that allow limited conversion of contracted acres (25%) to field crops (Scenarios #2 and #4), program participants convert the maximum amount of land allowed to the most profitable field crop. Scenario #3, which allows only dedicated biomass crops to be grown on 25% of CRP contracted acres, results in almost no conversion of CRP acres.

**Table 6-2 CRP Conversion Rates and End-Use for Each Program Scenario (USDA 2007 Baseline Forecast)**

Scenario	% of CRP	Acres Converted	Biomass (%)	Corn (%)	Soybeans (%)	Other (%)
Scenario #1	23.88	5,704,166	0.14	88.39	3.94	7.54
Scenario #2	5.75	1,372,388	0.00	95.91	4.09	0.00
Scenario #3	0.01	1,973	100.00	0.00	0.00	0.00
Scenario #4	5.97	1,426,042	0.14	88.39	3.94	7.54

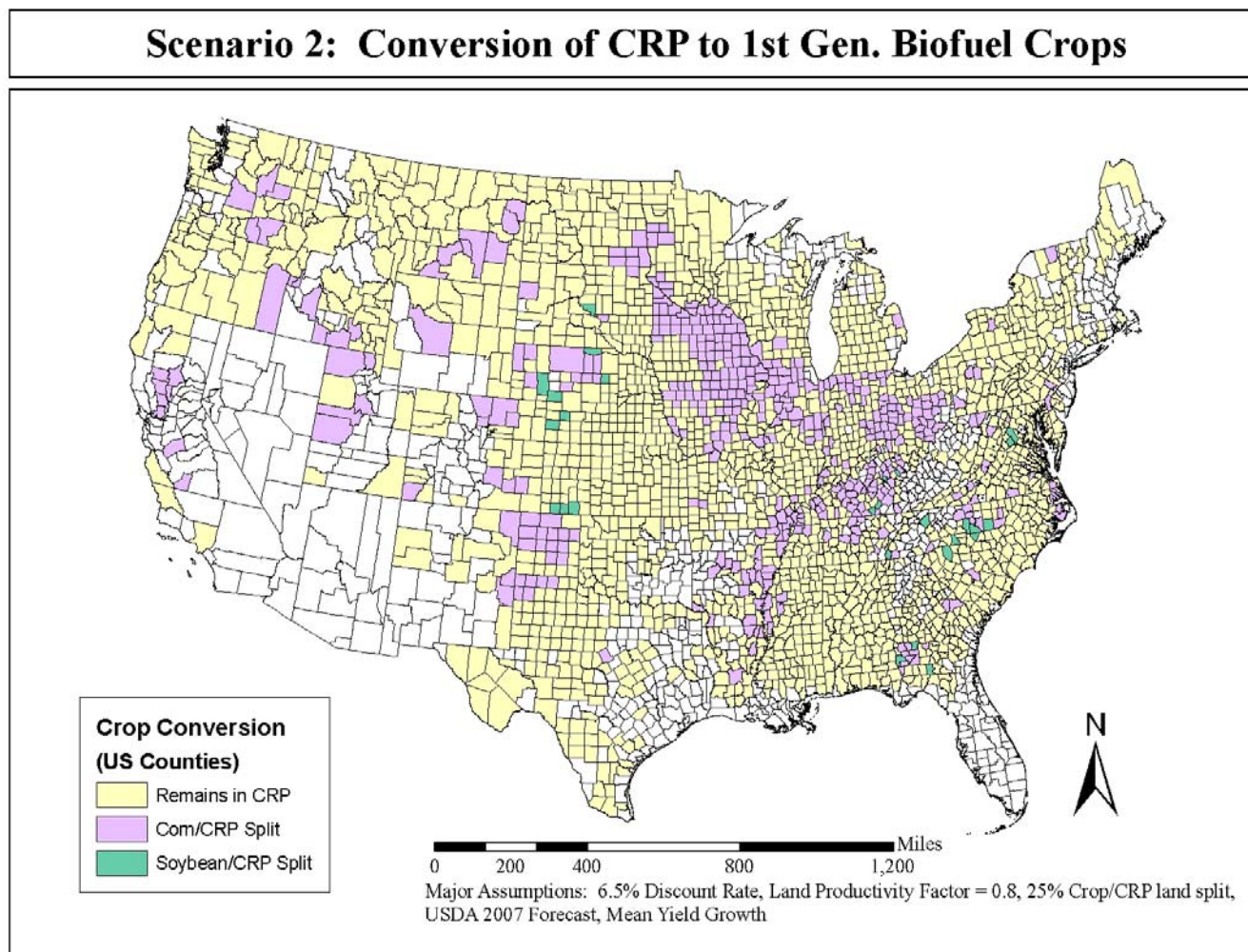
As seen in Table 6-2, the vast majority of converted acres are diverted to growing corn, with smaller amounts diverted to soybeans and other field crops. National maps of the converted acres (Figure 6-1, Figure 6-2, and Figure 6-4) indicate that nearly all of the converted acres occur in the rain-fed, Mid-western Heartland region. Despite high CRP rental rates in this region (See Figure 5-5), high prices for corn incorporated in the USDA 2007 Baseline Forecast provide higher returns to farmers on marginal CRP land than supplied by just the annual rental rate and encourage landowners to explore alternate uses for CRP acres. The low conversion rate of CRP acres to biomass crops in Scenario #3 indicates that at a biomass price of \$30/dt, 10-year returns remain lower than the sum of the CRP annual rental rates, except in a few counties in the southeastern United States (Figure 6-3).

### Scenario 1: Unrestricted Conversion of CRP to Cropland



Major Assumptions: 6.5% Discount Rate, \$30/dt biomass, CRP Land Productivity Factor = 0.8

Figure 6-1 Map of Results - Program Scenario #1 - USDA 2007 Baseline



**Figure 6-2 Map of Results - Program Scenario #2 - USDA 2007 Baseline**

### Scenario 3: Conversion of CRP to 2nd Gen. Biofuel Crops

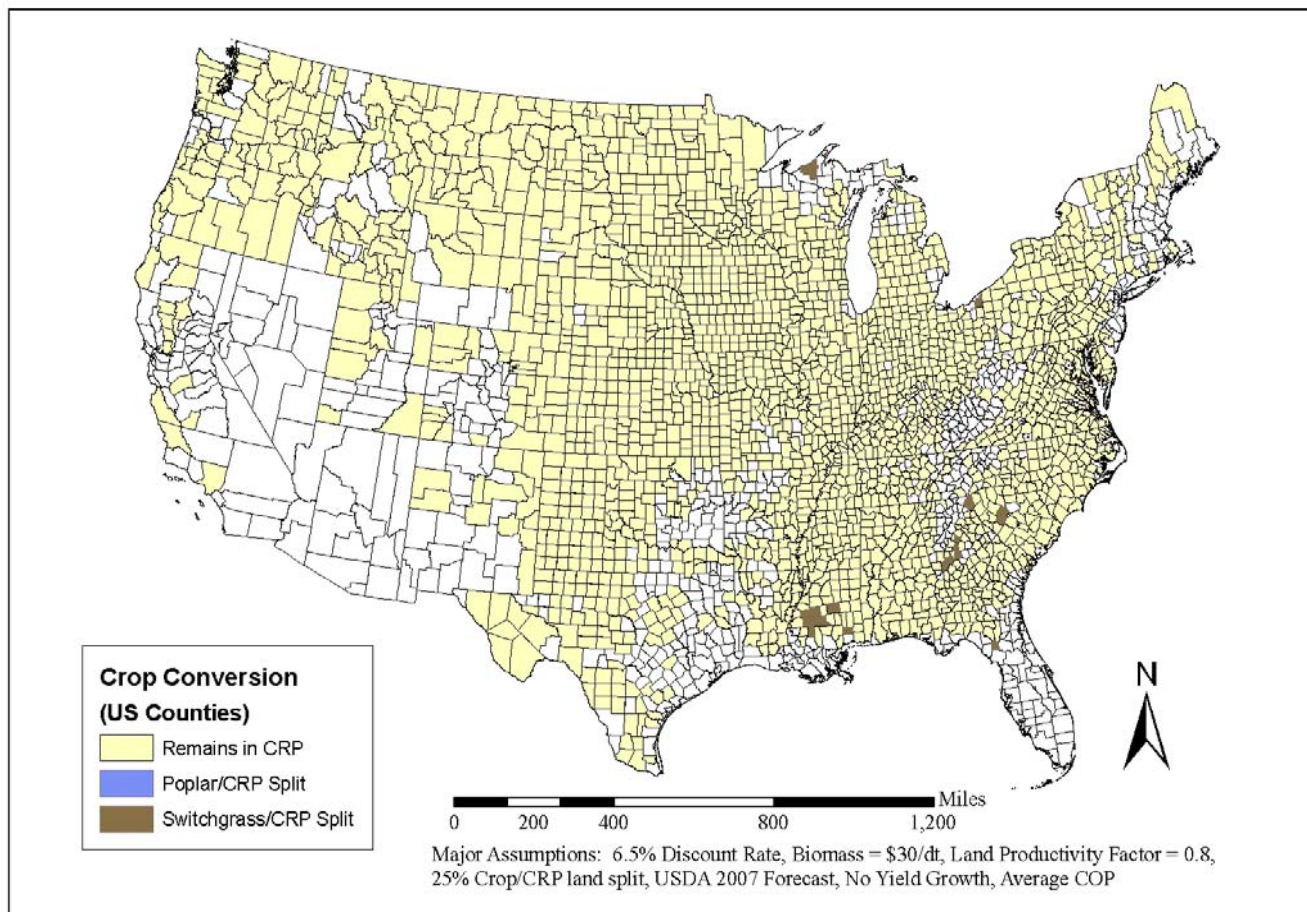


Figure 6-3 Map of Results - Program Scenario #3 - USDA 2007 Baseline

### Scenario 4: Fractional Conversion of CRP to Cropland

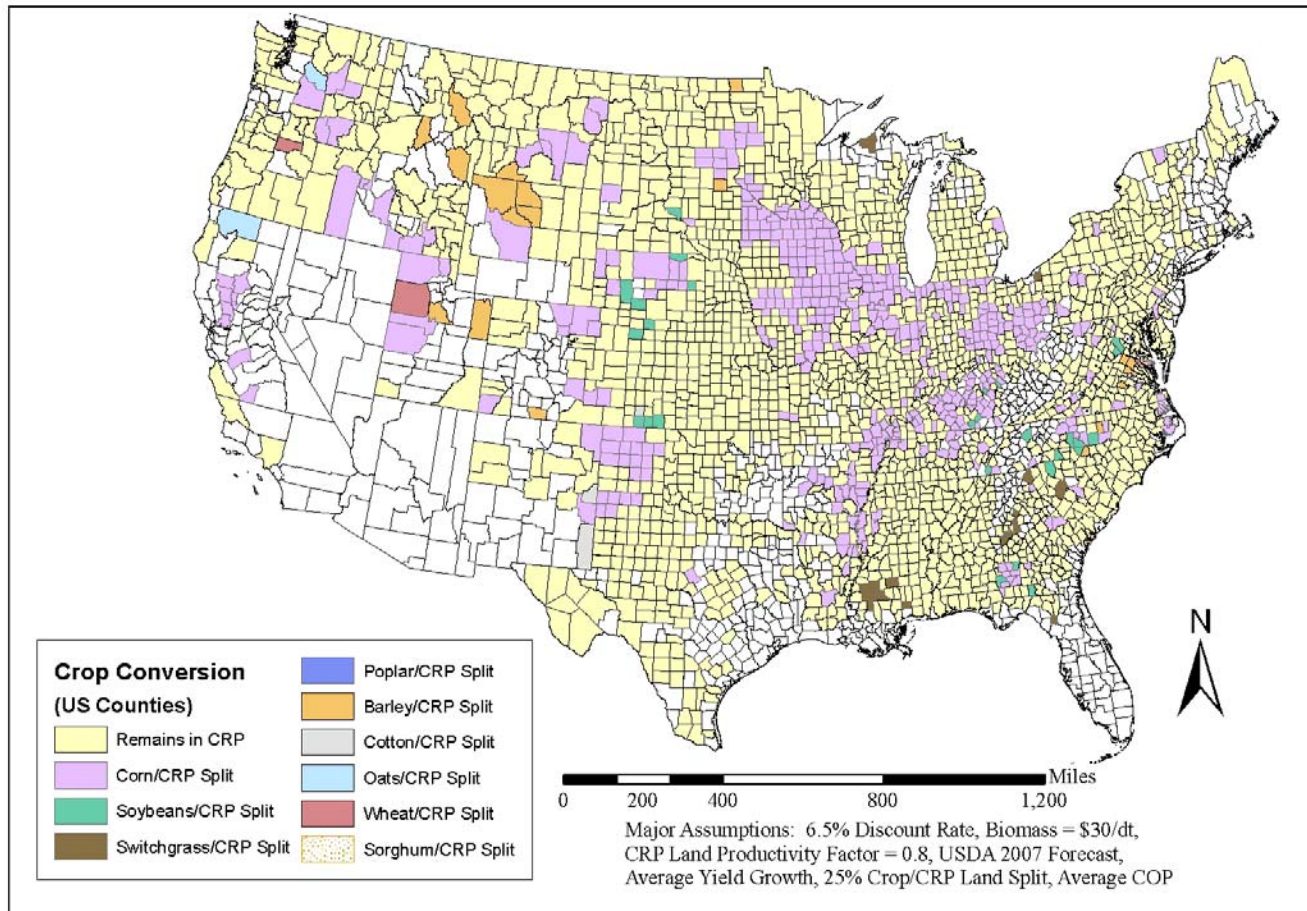


Figure 6-4 Map of Results - Program Scenario #4 – USDA 2007 Baseline

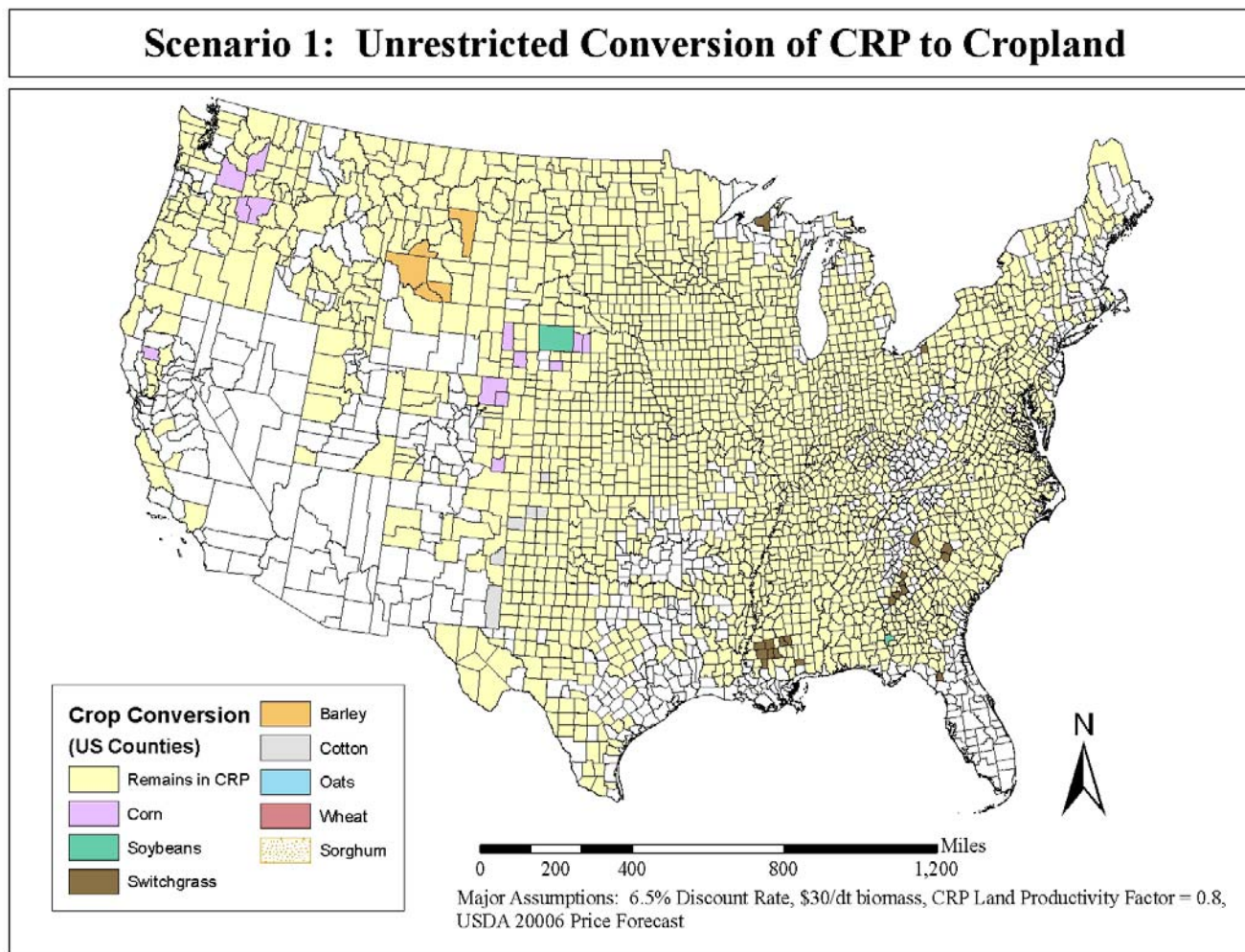
Utilizing either the USDA 2006 Baseline or FAPRI U.S. and World Agricultural Outlook (2006) results in much smaller estimates of the number of contracted acres that will be converted to alternate uses, as seen in Table 6-3 and Table 6-4. This is primarily due to the lower forecasted prices for corn. The lower price forecasts reduce the profitability of growing corn relative to accepting CRP rental payments, making continued participation in the CRP more profitable in all corn growing counties except a few in eastern Colorado and the Pacific Northwest (See Figure 6-5 and Figure 6-6). Despite the lower price forecasts for field crops, growing dedicated biomass crops remains profitable only in a few isolated counties in the southeastern United States (See Figure 6-7).

**Table 6-3 CRP Conversion Rates and End-Use for Each Program Scenario (USDA 2006 Baseline Forecast)**

Scenario	% of CRP	Acres Converted	Biomass (%)	Corn (%)	Soybeans (%)	Other (%)
Scenario #1	5.19	1,239,667	0.64	57.62	0.49	41.26
Scenario #2	0.75	180,087	0.00	99.16	0.84	0.00
Scenario #3	0.01	1,973	100.00	0.00	0.00	0.00
Scenario #4	1.30	309,917	0.64	57.62	0.49	41.26

**Table 6-4 CRP Conversion Rates and End-Use for Each Program Scenario (FAPRI U.S. and World Agricultural Outlook 2006)**

Scenario	% of CRP	Acres Converted	Biomass (%)	Corn (%)	Soybeans (%)	Other (%)
Scenario #1	3.75	895,057	0.88	41.00	0.67	57.44
Scenario #2	0.39	93,253	0.00	98.38	1.62	0.00
Scenario #3	0.01	1973	100.00	0.00	0.00	0.00
Scenario #4	0.94	223,764	0.88	41.00	0.67	57.44



**Figure 6-5 Map of Results - Program Scenario #1 - USDA 2006 Baseline**

## Scenario 2: Conversion of CRP to 1st Gen. Biofuel Crops

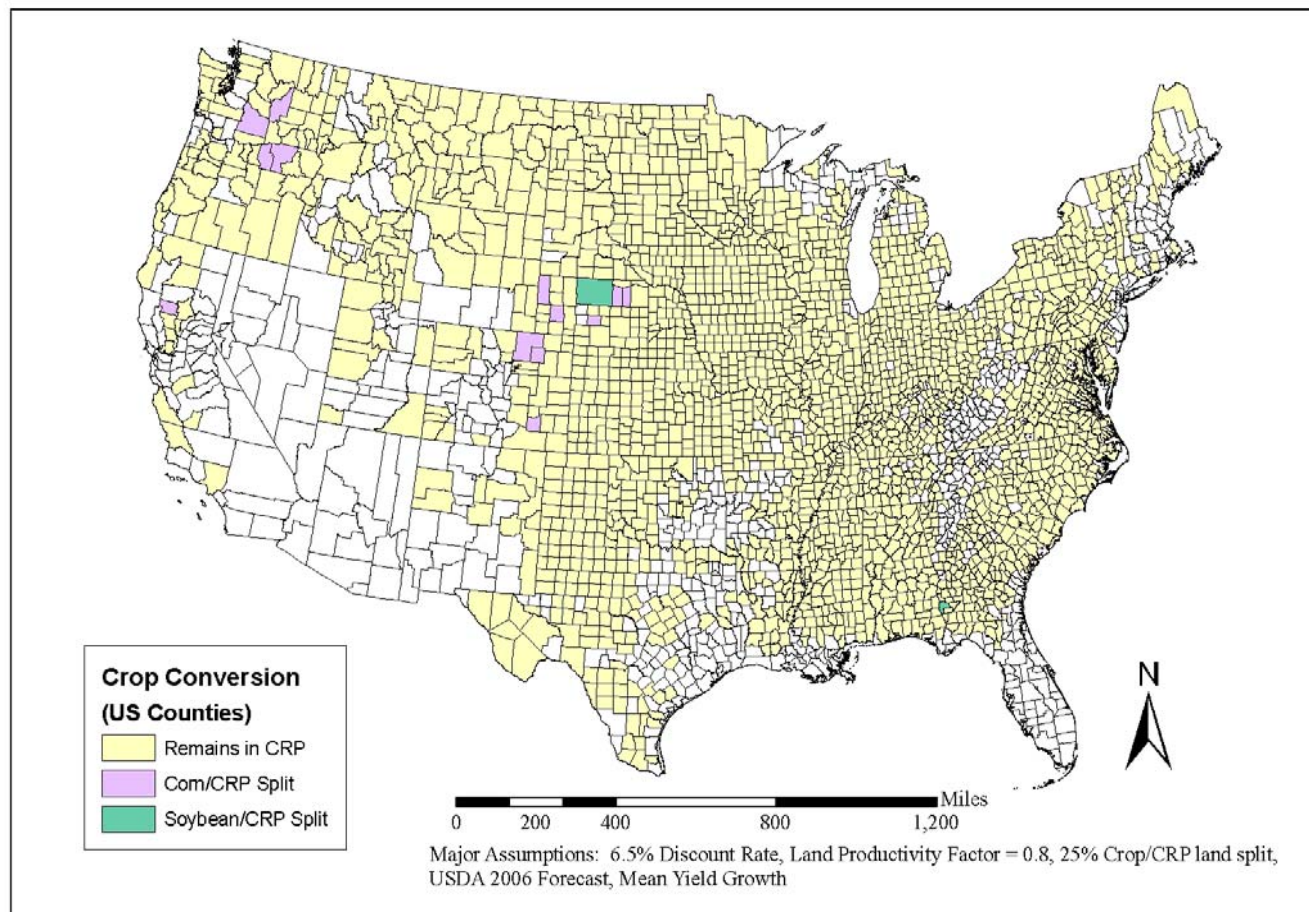


Figure 6-6 Map of Results - Program Scenario #2 - USDA 2006 Baseline

### Scenario 3: Conversion of CRP to 2nd Gen. Biofuel Crops

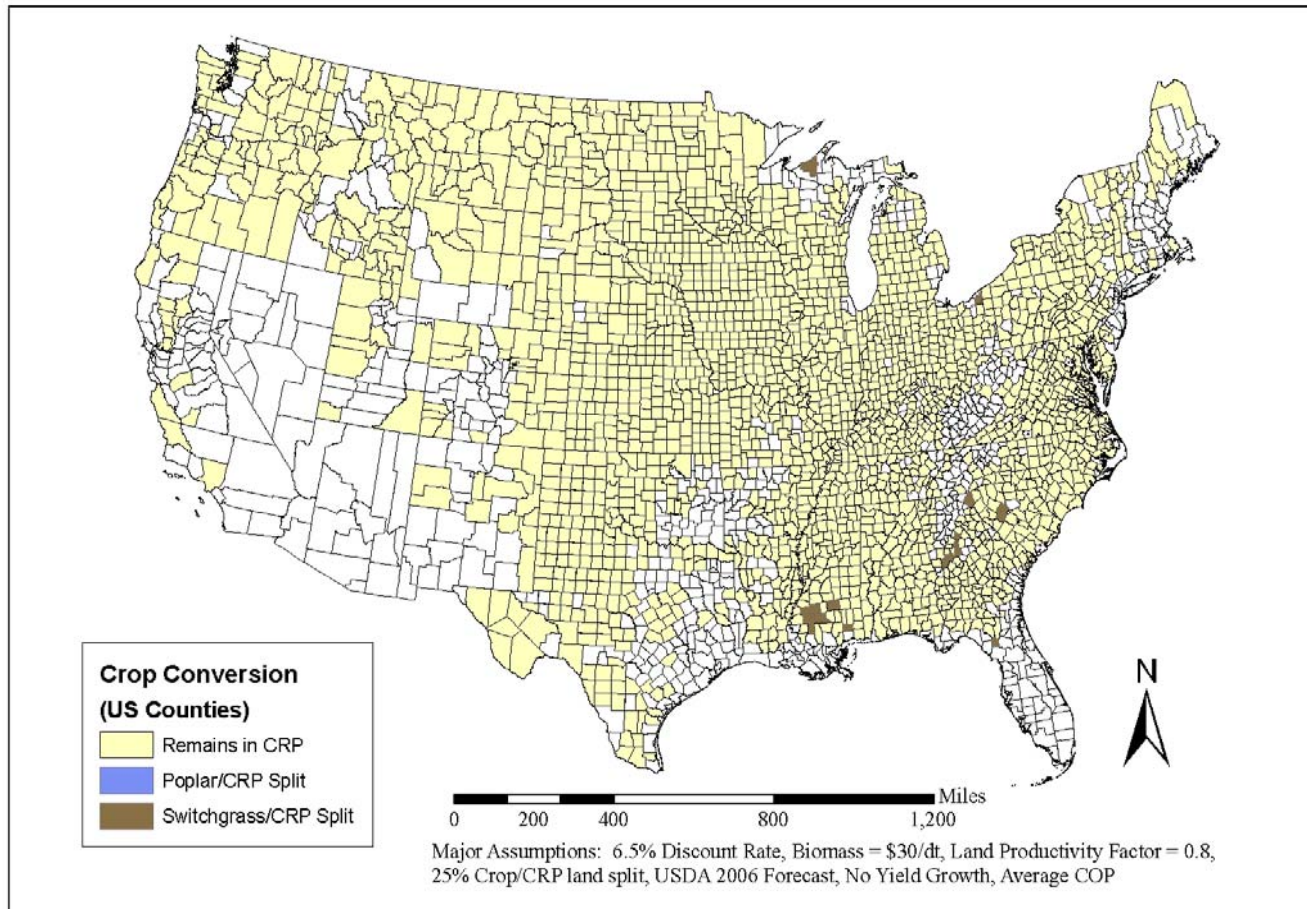


Figure 6-7 Map of Results - Program Scenario #3 - USDA 2006 Baseline

### 6.2.2 Program Costs and Savings

Annual program costs are reduced by scenarios which encourage conversion of CRP acres to other profitable uses and reduce the magnitude of the rental payments to landowners. Table 6-5 shows the annual program cost for the four scenarios evaluated, given the assumptions listed in Table 6-1.

**Table 6-5 CRP Program Costs and Savings for Each Program Scenario (USDA 2007 Baseline Forecast)**

<b>Scenario</b>	<b>% of CRP</b>	<b>Acres Converted</b>	<b>Program Cost (\$/yr)</b>	<b>Program Savings (\$/yr)</b>
Scenario #1	23.88	5,704,166	\$763,246,204	\$283,689,747
Scenario #2	5.75	1,372,388	\$978,108,387	\$68,827,552
Scenario #3	0.01	1,973	\$1,046,892,316	\$43,601
Scenario #4	5.97	1,426,042	\$976,013,470	\$70,922,446

As would be expected, program savings are higher in those scenarios with the highest conversion rates. In Scenario #1, 23.88% of CRP lands are converted to alternate uses (primarily growing corn in the mid-western Heartland region – See Figure 6-1), resulting in reduced rental payments of nearly \$284 million per year. In scenarios with restrictions on the amount of land that can be converted to other uses (Scenarios #2 and #4), rental payment savings are roughly proportional to the amount of acreage redirected from the CRP.

Utilizing either the USDA 2006 Baseline or FAPRI U.S. and World Agricultural Outlook (2006) again results in much smaller estimates of the magnitude of program savings, as shown in Table 6-6 and Table 6-7. While this can be partially attributed to lower overall CRP conversion rate resulting from lower price forecasts,

annual rental payments are also drastically lower for contracted acres located in portions of the country outside the Heartland region (See Figure 5-5). Since converted acres in Scenarios #2 and #4 are located primarily in low rental rate regions in eastern Colorado and the Pacific Northwest (See Figure 6-5 and Figure 6-6), converted acres reduce program costs less than an equivalent number of acres in the Heartland region.

Table 6-8 shows the ERS Farm Resource Regions with the highest rental rates, and their overall contribution to the total annual cost of rental rates for the CRP.

**Table 6-6 CRP Program Costs and Savings for Each Program Scenario (USDA 2006 Baseline Forecast)**

<b>Scenario</b>	<b>% of CRP</b>	<b>Acres Converted</b>	<b>Program Cost (\$/yr)</b>	<b>Program Savings (\$/yr)</b>
Scenario #1	5.19	1,239,667	\$998,661,166	\$48,274,751
Scenario #2	0.75	180,087	\$1,039,258,065	\$7,677,852
Scenario #3	0.01	1,973	\$1,046,892,316	\$43,601
Scenario #4	1.30	309,917	\$1,034,867,230	\$12,068,687

**Table 6-7 CRP Program Costs and Savings for Each Program Scenario (FAPRI U.S. and World Agricultural Outlook 2006)**

<b>Scenario</b>	<b>% of CRP</b>	<b>Acres Converted</b>	<b>Program Cost (\$/yr)</b>	<b>Program Savings (\$/yr)</b>
Scenario #1	3.75	895,057	\$1,011,928,828	\$35,007,089
Scenario #2	0.39	93,253	\$1,042,609,353	\$4,326,564
Scenario #3	0.01	1,973	\$1,046,892,316	\$43,601
Scenario #4	0.94	223,764	\$1,038,184,145	\$8,751,772

**Table 6-8 Average CRP Rental Rates and Program Costs by ERS Farm Resource Region**

<b>Farm Production Region</b>	<b>Rental Payment (\$/ac/year)</b>	<b>% of Convertible CRP Acres</b>	<b>% of Annual CRP Rental Rates</b>
Basin and Range	\$43.57	6.45%	5.73%
Eastern Uplands	\$55.94	0.56%	0.64%
Fruitful Rim	\$61.40	7.92%	9.92%
Heartland	\$95.90	13.47%	26.35%
Mississippi Portal	\$48.89	1.27%	1.26%
Northern Crescent	\$65.38	2.73%	3.65%
Northern Great Plains	\$34.36	26.22%	18.38%
Prairie Gateway	\$40.23	40.65%	33.36%
Southern Seaboard	\$47.63	0.74%	0.72%

### **6.2.3 Net Farm Income**

The net present value of 10-year farm income, inclusive of any CRP rental payments and profit from using all or a portion of CRP land for alternate uses, was calculated for each of the program scenarios. Due to the calculation methodology employed in this analysis, contracted acres are only reallocated to alternate uses if the net farm income increases. Table 6-9 shows the net present value of 10-year net farm income and the percentage increase relative to a program where all contracted acres remain in the CRP. Using the assumptions provided in Table 6-1 for these scenarios, the greatest gains in net farm income result from redirecting contracted CRP acres to grow corn and other field crops. If landowners were permitted to grow dedicated biomass crops (Scenario #3), gains in net farm income are negligible at a biomass farmgate price of \$30 per dry ton.

**Table 6-9 10-Year Net Farm Income for Each Program Scenario (USDA 2007 Baseline Forecast)**

<b>Scenario</b>	<b>% of CRP</b>	<b>Acres Converted</b>	<b>NPV Net Farm Income (\$/10 yrs)</b>	<b>% Increase</b>
Scenario #1	23.88	5,704,166	\$10,284,622,973	36.65%
Scenario #2	5.75	1,372,388	\$8,207,586,822	9.05%
Scenario #3	0.01	1,973	\$7,526,266,174	0.00%
Scenario #4	5.97	1,426,042	\$8,215,910,659	9.16%

Utilizing either the USDA 2006 Baseline or FAPRI U.S. and World Agricultural Outlook (2006) again results in much smaller estimates of the increases in net farm income, as shown in Table 6-10 and Table 6-11. The price forecasts predict lower farmgate prices than the USDA 2007 Baseline, thereby resulting in smaller increases in net farm income. Results from the alternative price forecasts imply that any proposal to change the CRP program guidelines would have a limited effect on net farm income and program changes may not be warranted.

**Table 6-10 10-Year Net Farm Income for Each Program Scenario (USDA 2006 Baseline Forecast)**

<b>Scenario</b>	<b>% of CRP</b>	<b>Acres Converted</b>	<b>NPV Net Farm Income (\$/10 yrs)</b>	<b>% Increase</b>
Scenario #1	5.19	1,239,667	\$7,713,725,081	2.49%
Scenario #2	0.75	180,087	\$7,555,401,390	0.39%
Scenario #3	0.01	1,973	\$7,526,266,174	0.00%
Scenario #4	1.30	309,917	\$7,573,735,033	0.63%

**Table 6-11 10-year Net Farm Income for Each Program Scenario (FAPRI U.S. and World Agricultural Outlook 2006)**

<b>Scenario</b>	<b>% of CRP</b>	<b>Acres Converted</b>	<b>NPV Net Farm Income (\$/10 yrs)</b>	<b>% Increase</b>
Scenario #1	3.75	895,057	\$7,647,794,395	1.62%
Scenario #2	0.39	93,253	\$7,539,151,406	0.17%
Scenario #3	0.01	1,973	\$7,527,094,482	0.01%
Scenario #4	0.94	223,764	\$7,557,252,362	0.41%

#### **6.2.4 Biofuel Supply Potential**

In each of the program scenarios modeled for this research, converted acres were allocated to the most profitable crop. In circumstances where crops grown on CRP lands were either corn, soybeans, or biomass, all material harvested from the lands are assumed to be converted to biofuels at the conversion rates listed in Table 5-12. For each scenario, the total number of gallons of biofuels produced from CRP contracted acres during the 2007-2016 period is listed in Table 6-12. The total energy contained in the ethanol and biodiesel produced from feedstocks grown on CRP land (quadrillion btu) is also compared to the forecast U.S. demand for gasoline and diesel in the same period, respectively (AEO 2007).

**Table 6-12 10-year Biofuel Supply Potential (USDA 2007 Baseline Forecast)**

Fuel Type	Units	Scenario			
		#1	#2	#3	#4
Cellulosic Ethanol	(billion gal)	0.039	0.000	0.010	0.010
Corn Ethanol	(billion gal)	25.444	6.629	0.000	6.361
Total Ethanol	(quads)	2.147	0.559	0.001	0.537
<i>% of Gasoline Demand</i>		<i>1.206%</i>	<i>0.314%</i>	<i>0.000%</i>	<i>0.302%</i>
Biodiesel	(billion gal)	0.182	0.046	0.000	0.046
Total Biodiesel	(quads)	0.023	0.006	0.000	0.006
<i>% of Diesel Demand</i>		<i>0.034%</i>	<i>0.009%</i>	<i>0.000%</i>	<i>0.009%</i>

### 6.3 Biofuel Supply Curves

Results shown in Table 6-12 indicate that biofuels developed from biomass (i.e. cellulosic ethanol) compose a relatively small portion of the 10-year total of biofuels produced, despite the fact that native biomass plants (i.e. switchgrass, hybrid poplar) are deemed extremely suitable for growing on many contracted CRP acres (Downing et al.). As discussed in Section 6.2.1, the low conversion rate of CRP acres to biomass crops indicates that at a biomass price of \$30/dt, 10-year returns remain lower than the sum of profits from alternate uses, either collecting CRP rental rates or utilizing land to grow another crop. However, development of a more efficient or inexpensive process for producing cellulosic ethanol from biomass could dramatically increase demand and the farmgate price for biomass, resulting in more landowners electing to grow biomass than keep land enrolled in the CRP. Estimated CRP conversion rates, along with the end-use of each converted acre, are presented in Table 6-13 for Scenario #1 given varying farmgate prices for biomass.

**Table 6-13 CRP Conversion Rates and End-Use for Varying Farmgate Biomass Prices (USDA 2007 Baseline Forecast)**

Biomass Price (\$/dt)	% of CRP	Acres Converted	Biomass (%)	Corn (%)	Soybeans (%)	Other (%)
\$10	23.85	5,696,276	0.00	88.51	3.94	7.55
\$20	23.85	5,696,276	0.00	88.51	3.94	7.55
\$30	23.88	5,704,166	0.14	88.39	3.94	7.54
\$35	25.92	6,191,609	8.34	81.17	3.58	6.90
\$40	62.88	15,019,738	67.38	28.94	1.09	2.59
\$50	75.22	17,966,763	79.85	18.14	0.36	1.65
\$60	75.75	18,093,089	82.13	16.24	0.00	1.63

Biomass rapidly becomes the most profitable use of CRP land when the farmgate price rises above \$30/dt. Table 6-13 shows that higher biomass farmgate prices encourage landowners to convert significant quantities of contracted CRP acres to biomass production. Interestingly, biomass is more profitable to grow on a vast majority of CRP acres at high farmgate prices even than corn, despite the fact that the price forecasts for corn incorporated into the USDA 2007 Baseline Forecast are relatively higher than earlier years. Utilizing the USDA 2006 Baseline Forecast, Table 6-14 indicates that lower CRP conversion rates are anticipated, primarily due to the lower farmgate prices for corn. However, once again biomass rapidly becomes the most profitable use of CRP land when the farmgate price rises above \$30/dt.

**Table 6-14 CRP Conversion Rates and End-Use for Varying Farmgate Biomass Prices (USDA 2006 Baseline Forecast)**

Biomass Price (\$/dt)	% of CRP	Acres Converted	Biomass (%)	Corn (%)	Soybeans (%)	Other (%)
\$10	5.16	1,231,777	0.00	57.99	0.49	41.52
\$20	5.16	1,231,777	0.00	57.99	0.49	41.52
\$30	5.19	1,239,667	0.64	57.62	0.49	41.26
\$35	7.63	1,822,868	32.43	39.19	0.33	28.06
\$40	50.69	12,107,599	90.24	5.49	0.05	4.22
\$50	67.88	16,212,250	94.25	3.13	0.00	2.63
\$60	68.44	16,345,909	94.29	3.10	0.00	2.61

Table 6-13 and Table 6-14 show how the farmgate price of biomass influences the CRP conversion rates nationally. As seen in Figure 6-1, utilizing the USDA 2007 baseline forecast at a biomass price of \$30/dth, CRP contracted acres are primarily converted to growing corn in the Heartland region, with few acres converted in other areas of the country. As the farmgate price for biomass rises above \$30/dt, acres with lower rental rates in the Southern Seaboard, Northern Great Plains, and Prairie Gateway regions are increasingly converted to growing biomass. Figure 6-8, Figure 6-9, and Figure 6-10 show that biomass production regions with the lowest CRP rental rates are selectively converted to biomass production at lower farmgate prices for biomass than regions with higher rental rates (i.e. Heartland). Regions of the country where biomass yields are lower (i.e. Fruitful Rim and Basin and Range regions), are not converted to biomass production even at very high biomass farmgate prices.

### Scenario 1: Unrestricted Conversion of CRP to Cropland

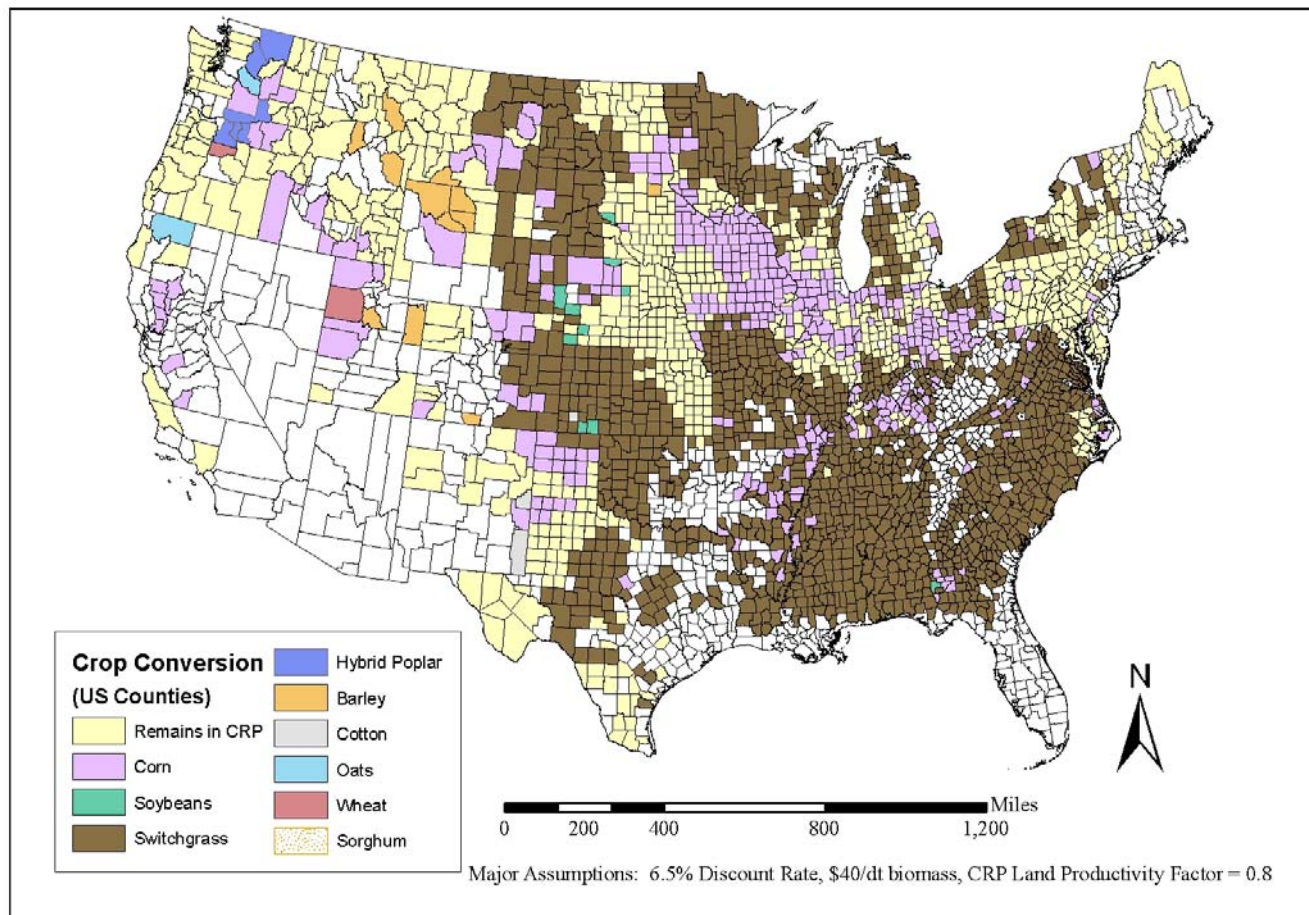
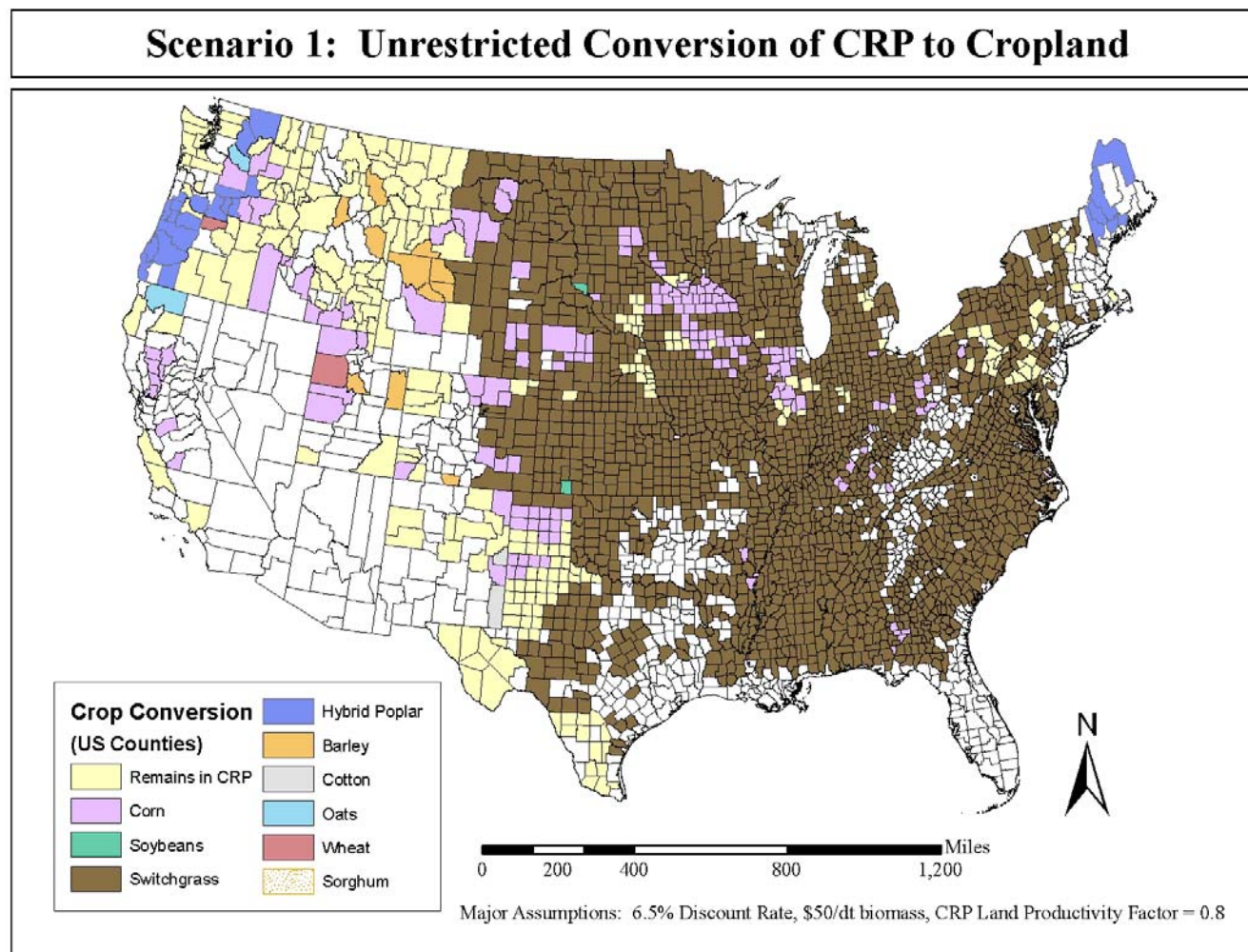
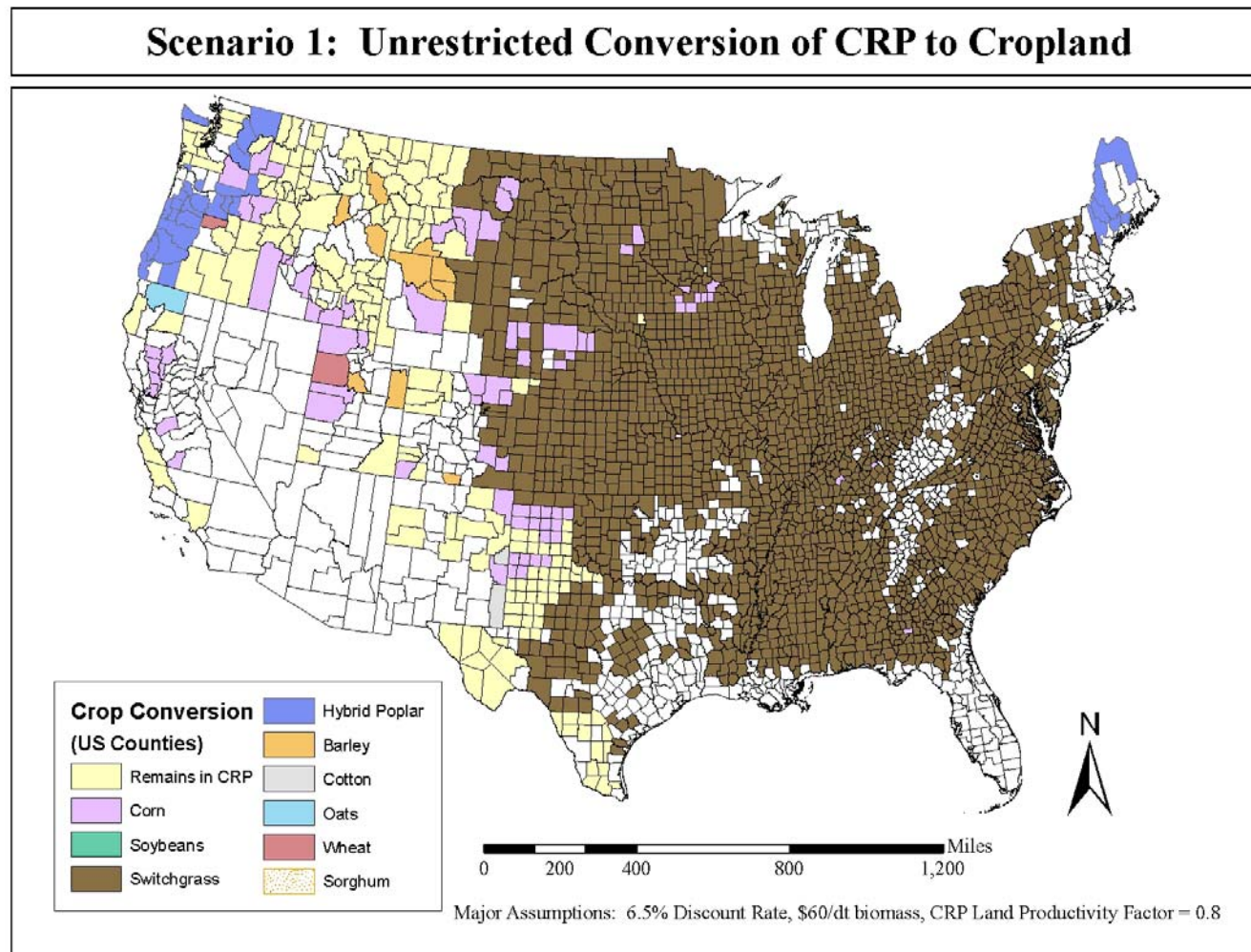


Figure 6-8 Map of Results - Program Scenario #1 - \$40/dt Biomass

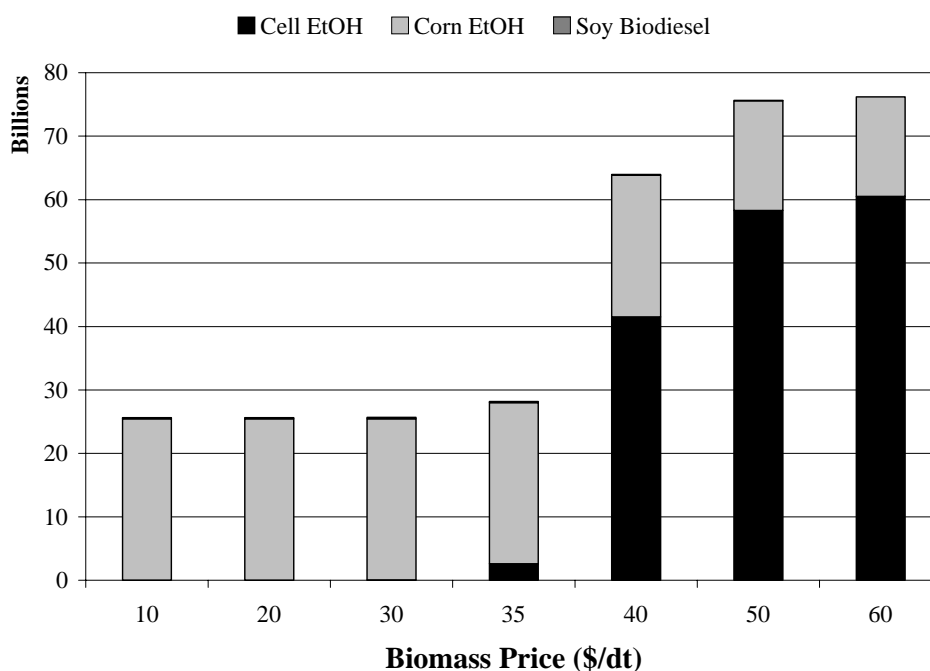


**Figure 6-9 Map of Results - Program Scenario #1 - \$50/dt Biomass**

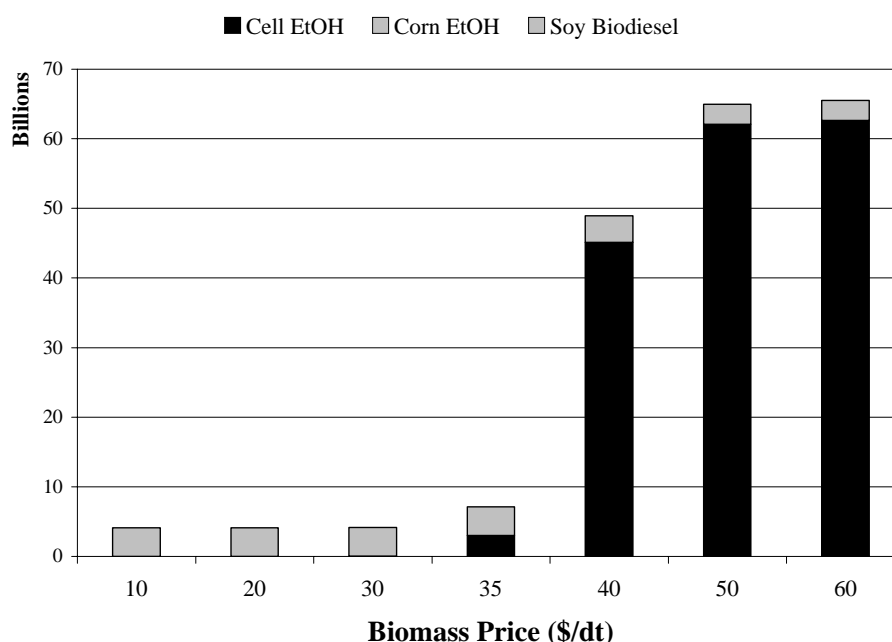


**Figure 6-10 Map of Results - Program Scenario #1 - \$60/dt Biomass**

Biomass conversion rates at varying biomass prices from Table 6-13 and Table 6-14 were combined with biofuel conversion factors listed in Table 5-12 to generate supply curves for biofuels originating from CRP lands. Figure 6-11 and Figure 6-12 show the amount of both 1<sup>st</sup> generation (i.e. ethanol and biodiesel derived from corn and soybeans respectively) and 2<sup>nd</sup> generation (i.e. ethanol derived from biomass) biofuels that could be produced on CRP contracted acres from 2007 – 2016 given different biomass prices and USDA price forecasts. At high biomass prices, large quantities of biomass become available for biofuel production. At low biomass prices, 1<sup>st</sup> generation feedstocks are the predominant source of biofuels and their availability is highly dependent on the forecasted price for corn and soybeans.



**Figure 6-11 10-year Biofuel Supply Curve - USDA 2007 Baseline**



**Figure 6-12 10-year Biofuel Supply Curve - USDA 2006 Baseline**

#### **6.4 Marginal Land Analysis**

An environmental benefits index is utilized to select acres suitable for enrollment in the CRP. Highly erodible lands, environmentally sensitive cropland and marginal pastureland receive higher EBI scores and are preferentially included in the program. Consequently, many of the acres enrolled in the CRP consist of marginal land with poor nutrient content or high soil erosion not suited to support high yields or returns of typical field crops. Native plants (i.e. switchgrass) are more suited to the undesirable conditions found on marginal lands so yields of typical biomass crops are less affected when grown on CRP acres than typical field crops.

The model was used to explore how marginal lands would affect the usage of CRP contracted acres for alternate uses, primarily growing field or biomass crops. A Marginal Land Factor that varies between 0 and 1 was included as a parameter in

the analysis. A value of 1 represents a plot of land that will produce the average yield found on typical cropland acres in the county for standard field crops (i.e. corn, soybeans, wheat), while a value of 0 represents a plot of land that cannot sustain field crops and yields no harvest. Yields of biomass crops are assumed to be unaffected by the marginal land factor since they are native plants suited to growth on marginal lands. Table 6-15 shows the model parameters used to explore the effects of marginal land.

**Table 6-15 Marginal Land Factor Analysis - Model Parameters**

<b>Model Parameter</b>	<b>Selected Value</b>
Discount Rate	6.5%
Expected Crop Prices	USDA Agricultural Forecast 2007
Biomass Price	\$30/dry ton
Costs of Production	Average (Straight-Line Forecast)
Crop Yield Growth	Average (Straight-Line Forecast)
Biomass Yield Growth	0% (No improvements in annual yield)
Land Productivity	0.4, 0.6, 0.8, 1.0
CRP Land Split	0.25 (Crops grown on 25% of contracted acre)
CRP Policy Scenario(s)	1. CRP Reauthorization with Contract Opt-Out 2. 1 <sup>st</sup> Generation Biofuel Crops with Land Split

In all cases, a marginal land factor closer to zero reduced the amount of contracted acres in the CRP converted to other uses, while a marginal land factor closer to 1 increased the amount of contracted acres converted to other uses. Table 6-16 shows that the number of CRP acres converted to alternate uses in Program Scenario #1 changes from 10,167,763 with a marginal land factor of one, to fewer than 10,000 with a marginal land factor of 0.4. Corn remains the predominate field crop grown on contracted acres, but becomes less profitable to grow as yields and net

returns decrease on lands with low marginal land factors. Additionally, the proportion of converted acres dedicated to biomass becomes larger as the marginal land factor decreases, likely due to the fact that yields of dedicated biomass crops are relatively unaffected by changes in the marginal land factor. Despite the higher proportion of biomass crops at low marginal land factors, the total acres converted remains small due to the limited profitability of biomass crops at a farmgate price of \$30/dry ton. Figure 6-13 through Figure 6-16 show that as the marginal land factor decreases, fewer and fewer contracted acres are converted to alternate uses.

**Table 6-16 Marginal Land Analysis - CRP Conversion Rates and End-Use for Program Scenario #1 (USDA 2007 Baseline Forecast)**

Marginal Land Factor	% of CRP	Acres Converted	Biomass (%)	Corn (%)	Soybeans (%)	Other (%)
1	42.57	10,167,763	0.08	85.13	4.71	10.08
0.8	23.88	5,704,166	0.14	88.39	3.94	7.54
0.6	4.21	1,004,722	0.79	93.03	0.00	6.19
0.5	0.37	87,917	8.97	91.03	0.00	0.00
0.4	0.03	7,890	100	0.00	0.00	0.00

### Scenario 1: Unrestricted Conversion of CRP to Cropland

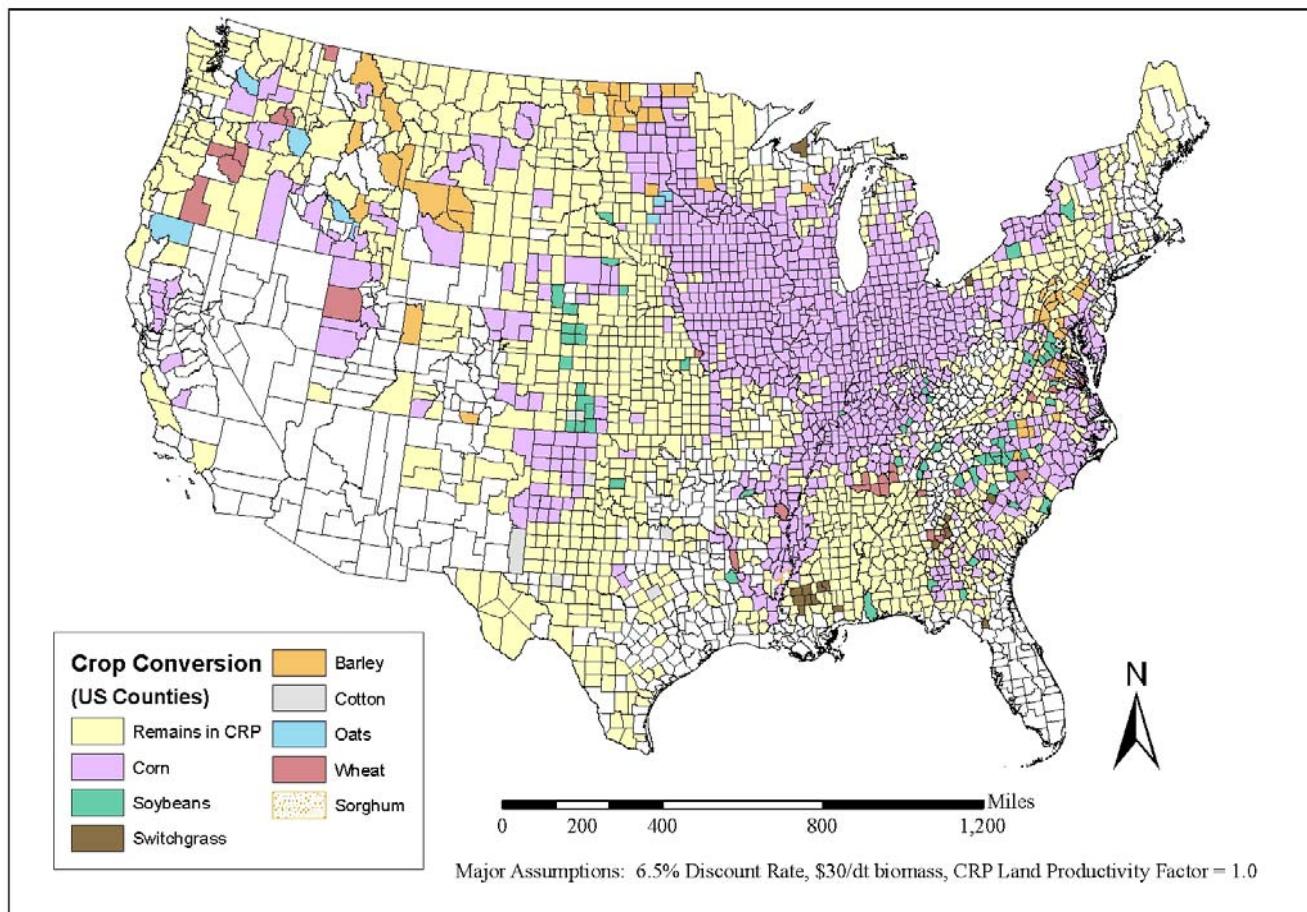
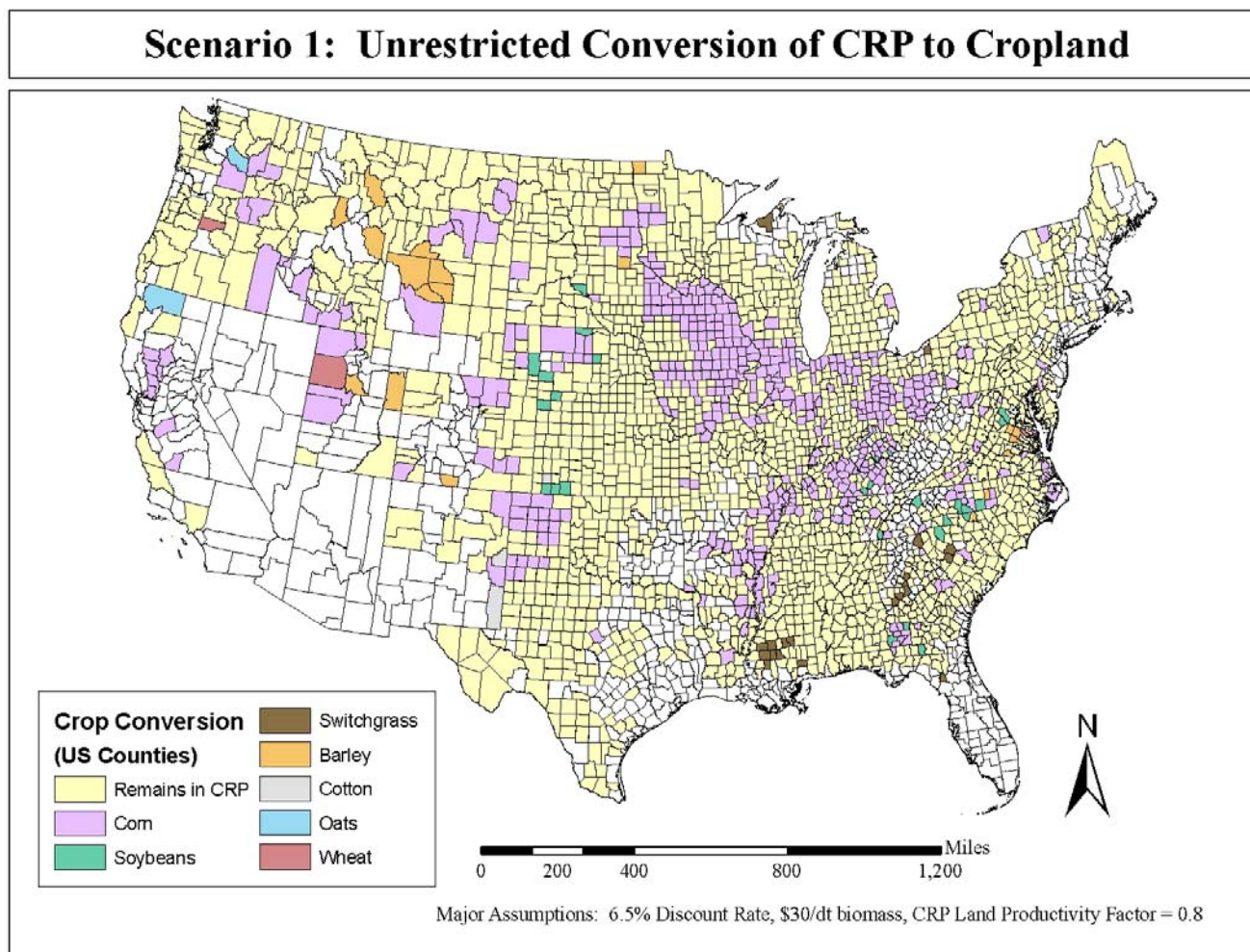
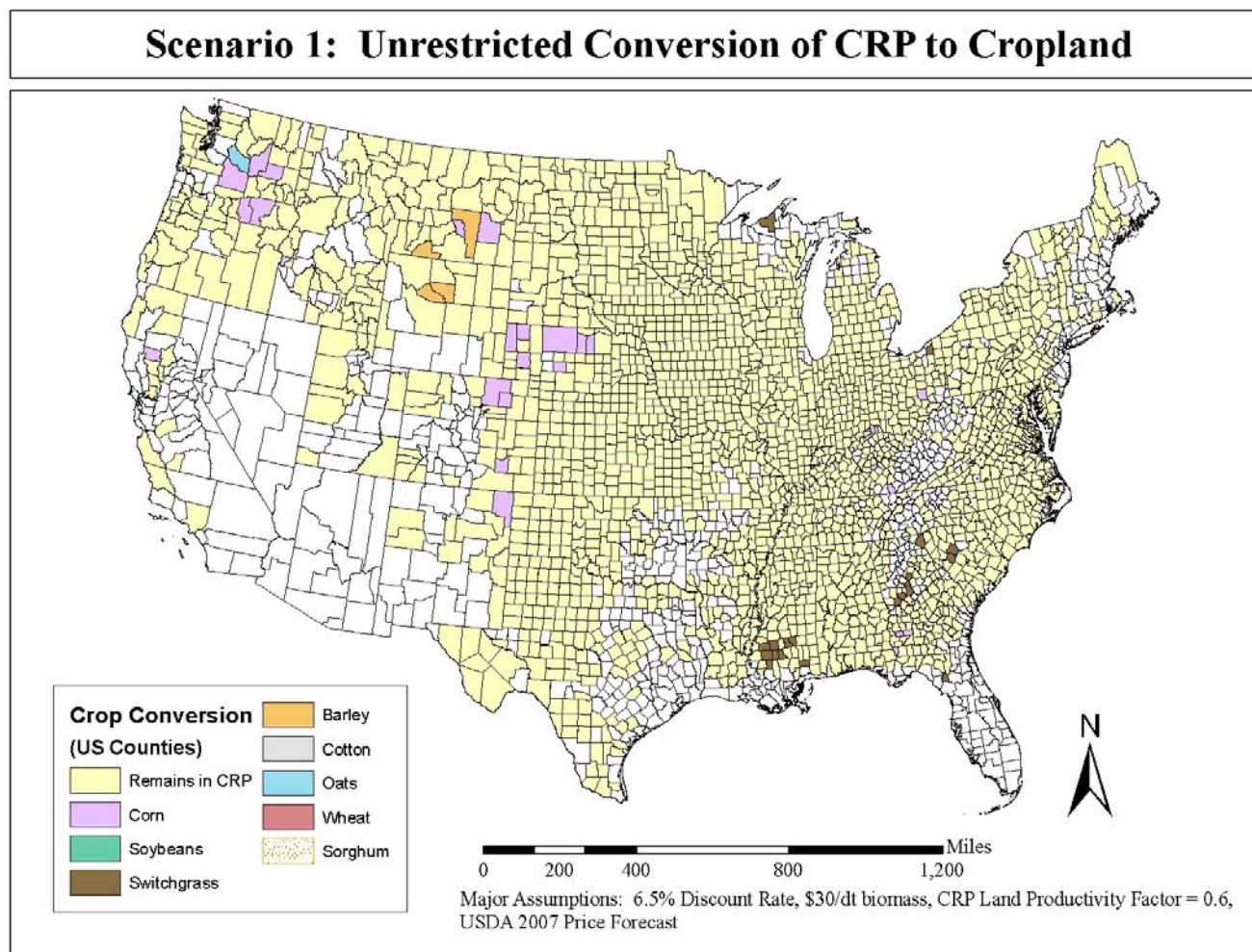


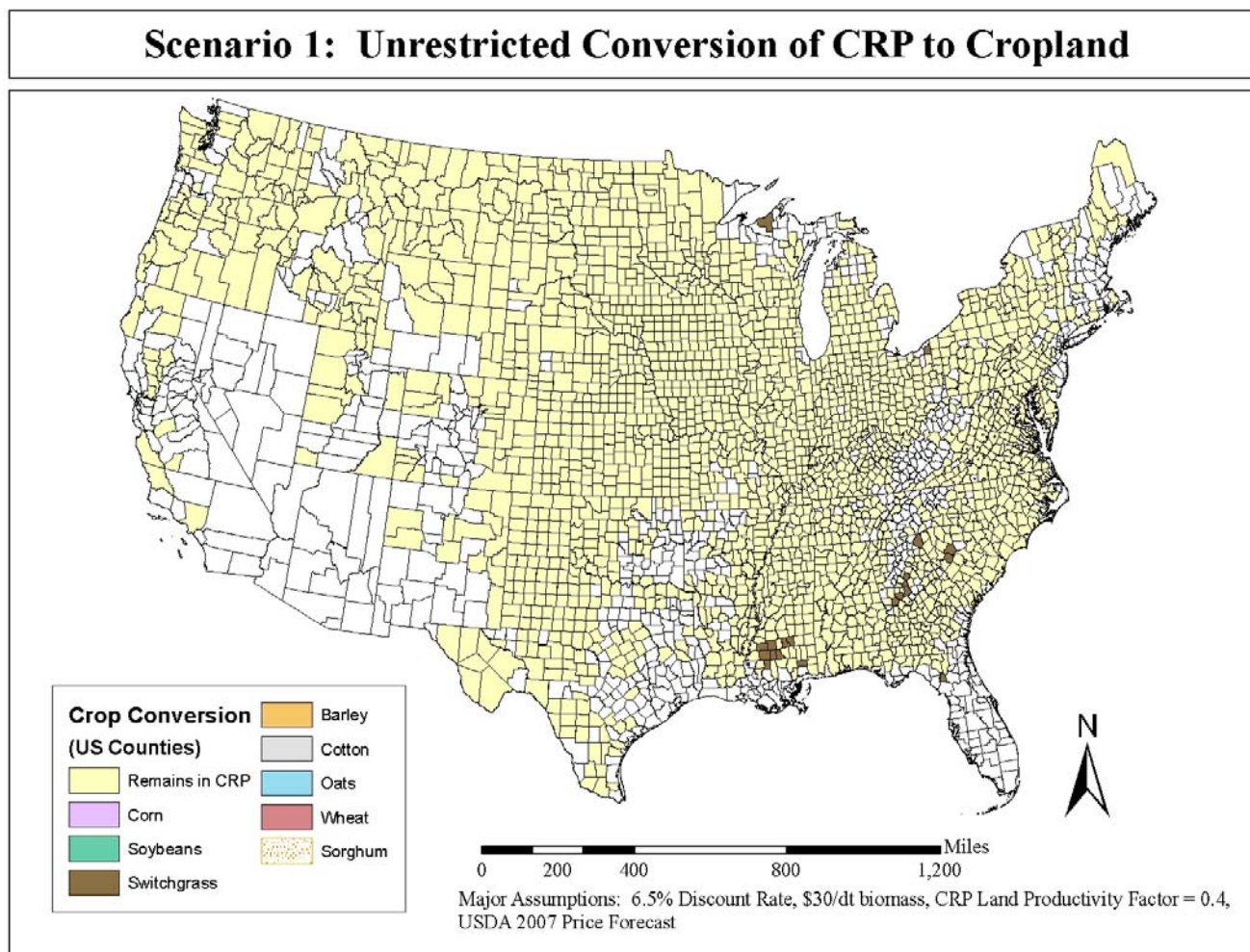
Figure 6-13 Map of Results - Program Scenario #1 - Marginal Land Factor = 1.0



**Figure 6-14 Map of Results - Program Scenario #1 - Marginal Land Factor = 0.8**



**Figure 6-15 Map of Results - Program Scenario #1 - Marginal Land Factor = 0.6**



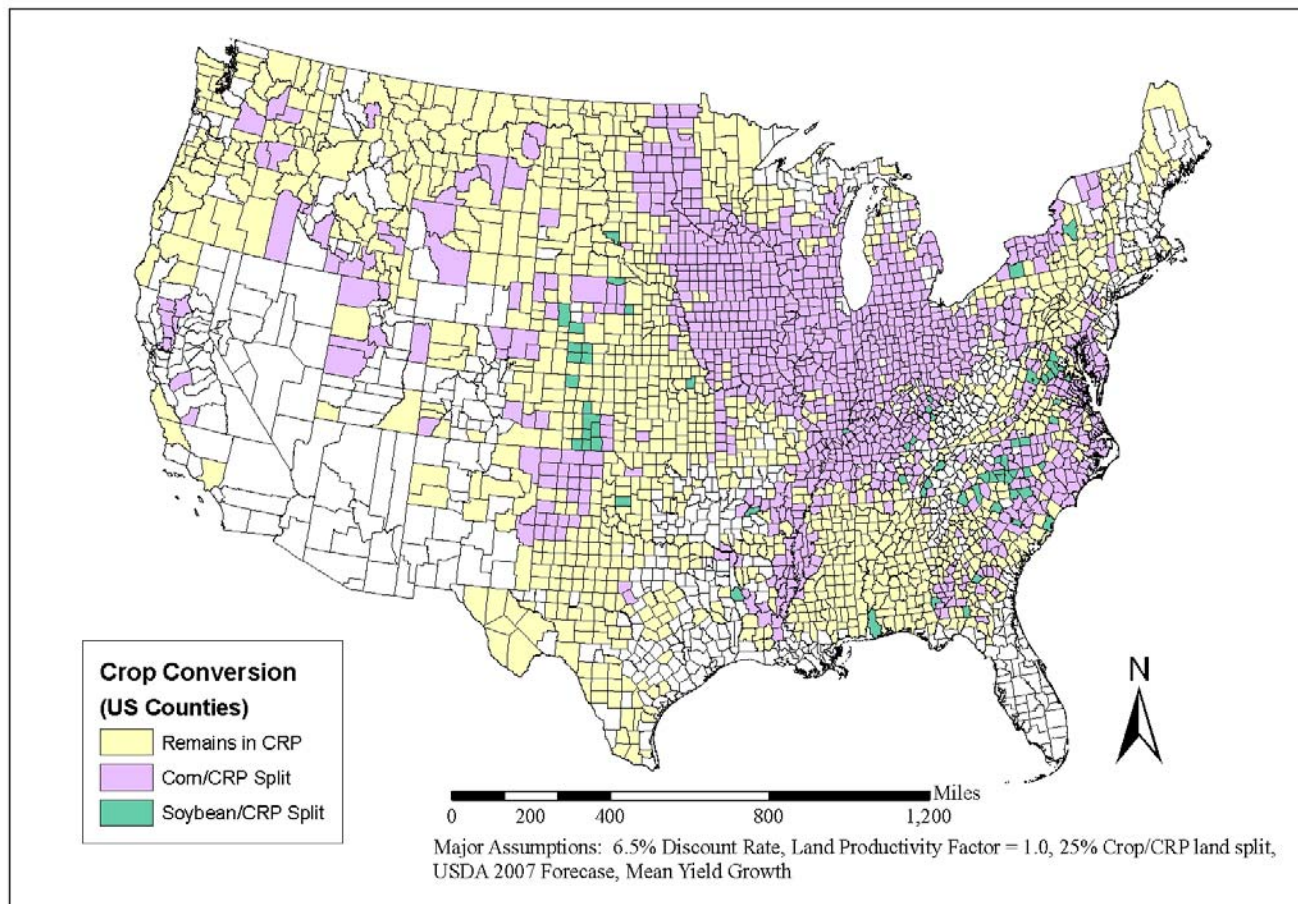
**Figure 6-16 Map of Results - Program Scenario #1 - Marginal Land Factor = 0.4**

The effect of marginal lands was also explored for Program Scenario #2, which limits landowners from converting more than 25% of their acreage to alternate uses. Additionally, landowners are permitted to grow only 1<sup>st</sup> generation biofuel feedstocks (i.e. corn and soybeans). Again, a marginal land factor closer to zero reduced the amount of contracted acres in the CRP converted to other uses, while a marginal land factor closer to 1 increased the amount of contracted acres converted to other uses. Table 6-17 shows that the number of CRP acres converted to alternate uses in Program Scenario #2 changes from 2,330,811 with a marginal land factor of one, to zero with a marginal land factor of 0.4. Corn remains the predominate field crop grown on contracted acres, but becomes less profitable to grow as yields and net returns decrease on lands with low marginal land factors. At a marginal land factor of 0.4, neither corn nor soybeans are profitable to grow on any CRP contracted acres in the United States. Figure 6-17 through Figure 6-20 show that as the marginal land factor decreases, fewer and fewer contracted acres are converted to alternate uses.

**Table 6-17 Marginal Land Analysis - CRP Conversion Rates and End-Use for Program Scenario #2 (USDA 2007 Baseline Forecast)**

Marginal Land Factor	% of CRP	Acres Converted	Biomass (%)	Corn (%)	Soybeans (%)	Other (%)
1	9.76	2,330,811	0.00	94.60	5.40	0.00
0.8	5.75	1,372,388	0.00	95.91	4.09	0.00
0.6	0.98	233,667	0.00	100.00	0.00	0.00
0.4	0.00	0	0.00	0.00	0.00	0.00

## Scenario 2: Conversion of CRP to 1st Gen. Biofuel Crops



**Figure 6-17 Map of Results - Program Scenario #2 - Marginal Land Factor = 1.0**

## Scenario 2: Conversion of CRP to 1st Gen. Biofuel Crops

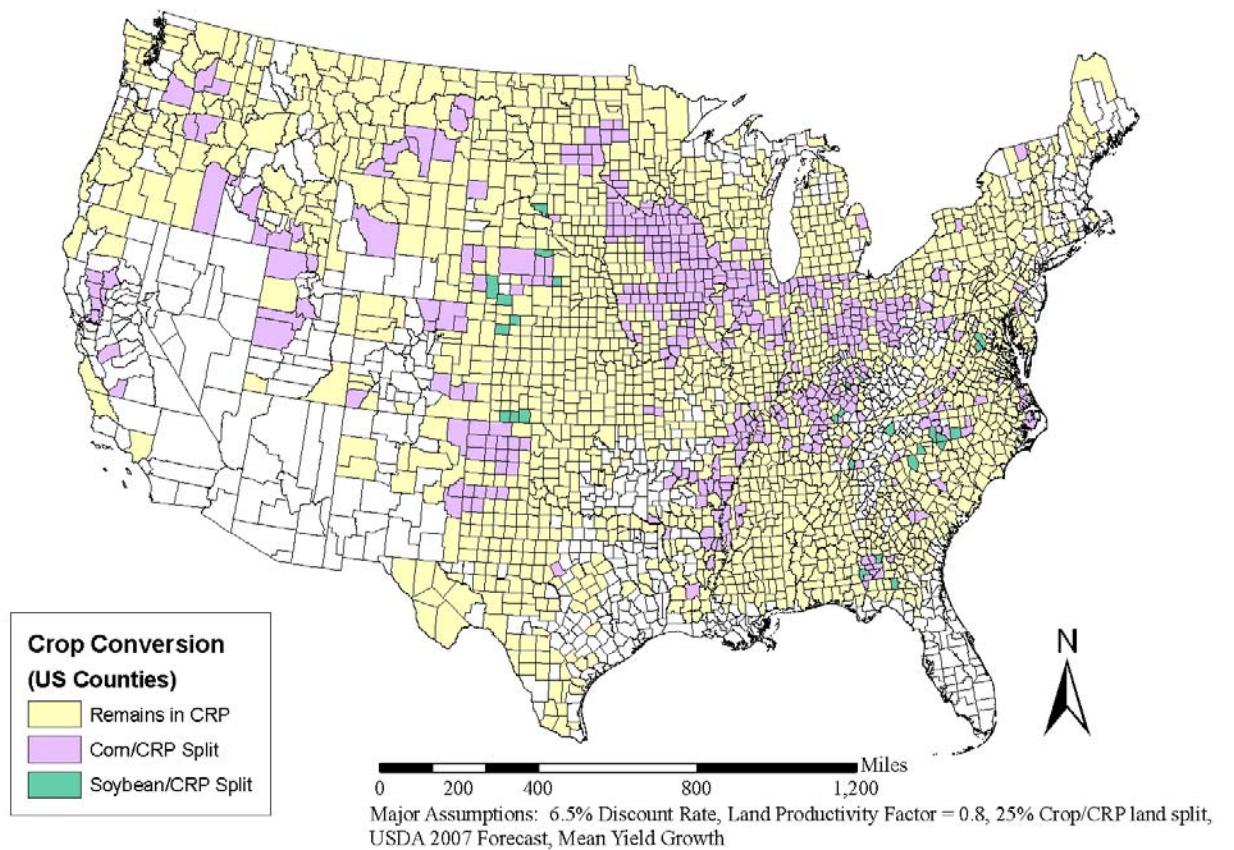
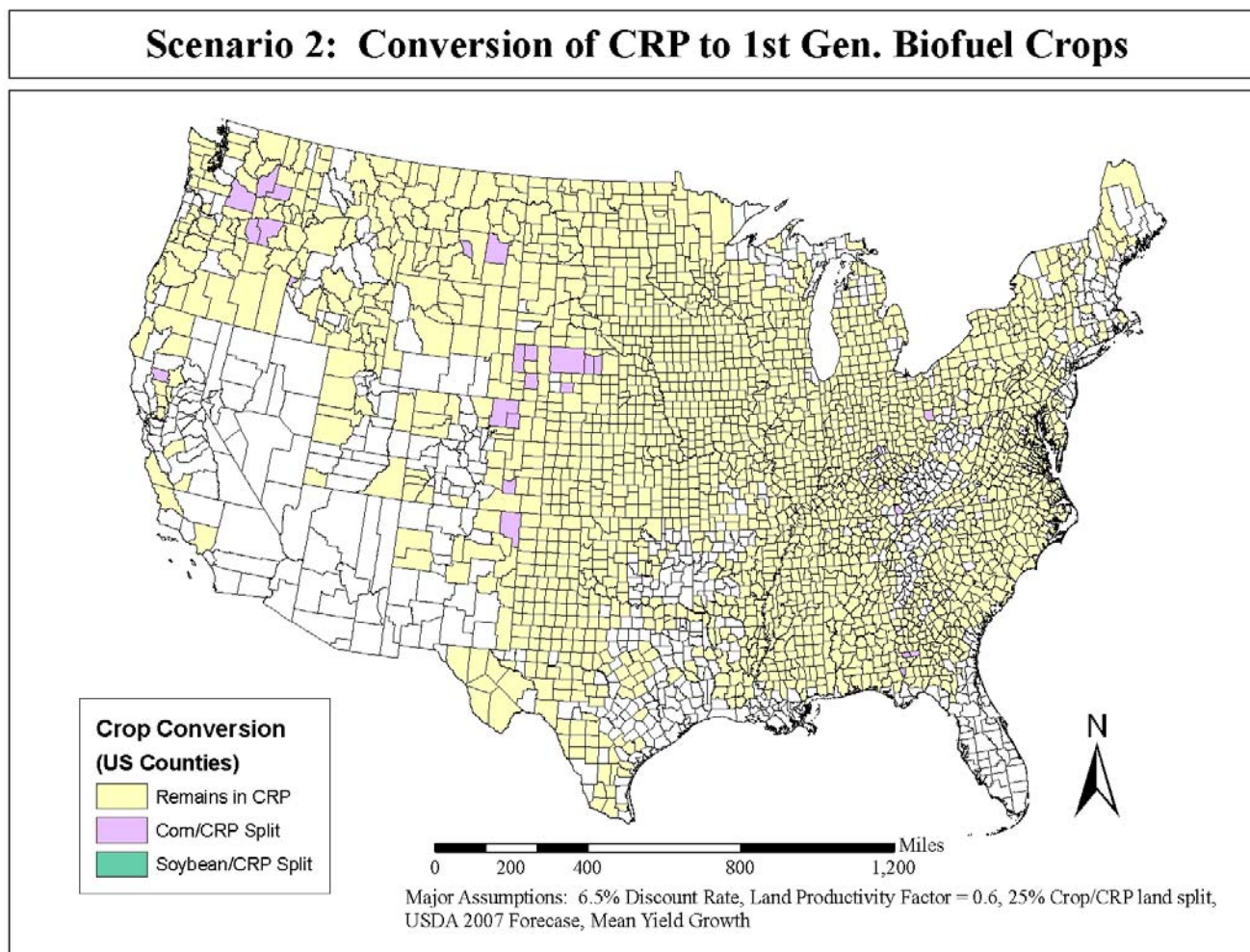
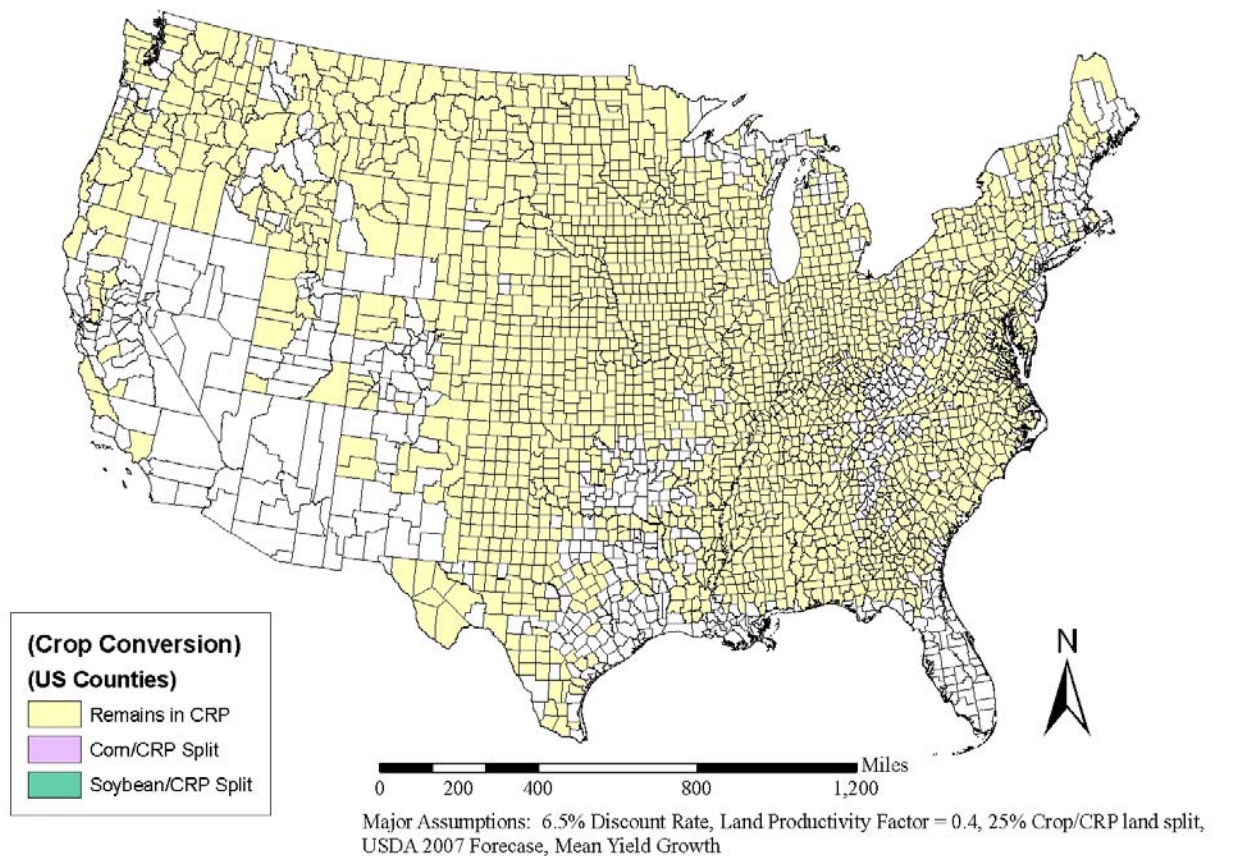


Figure 6-18 Map of Results - Program Scenario #2 - Marginal Land Factor = 0.8



**Figure 6-19 Map of Results - Program Scenario #2 - Marginal Land Factor = 0.6**

## Scenario 2: Conversion of CRP to 1st Gen. Biofuel Crops



**Figure 6-20 Map of Results - Program Scenario #2 - Marginal Land Factor = 0.4**

## 6.5 Biomass Yield Growth Projections

With few large-scale plantings of biomass crops in the United States, most biomass yields are projected from research utilizing small test plots (Ugarte et al.). As a result, biomass yields may increase dramatically from current estimates once farm management practices for planting and harvesting are optimized. The model was used to explore how year-over-year increases in biomass yields may affect the number of CRP acres converted to biomass within Program Scenario #3, where landowners are limited only to growing dedicated biomass crops on 25% of contracted CRP acres. Table 6-18 shows the model parameters used for this analysis.

**Table 6-18 Biomass Yield Analysis - Model Parameters**

<b>Model Parameter</b>	<b>Selected Value</b>
Discount Rate	6.5%
Expected Crop Prices	USDA Agricultural Forecast 2007
Biomass Price	\$30/dry ton
Costs of Production	Average (Straight-Line Forecast)
Crop Yield Growth	Average (Straight-Line Forecast)
Biomass Yield Growth	0%, 0.5%, 1.0%, 2.0%
Land Productivity	0.8 (Yields assumed 80% of typical cropland)
CRP Land Split	0.25 (Crops grown on 25% of contracted acre)
CRP Policy Scenario(s)	3. 2 <sup>nd</sup> Generation Biofuel Crops with Land Split

As a conservative estimate, year-over-year biomass yields were estimated as annual percentages in a range similar to averages forecast for the seven major field crops using historical data. For this analysis, annual biomass yield growth was estimated at 0%, 0.5%, 1.0% and 2.0%. For comparison, the forecast annual yield growth for the seven major field crops is shown in Table 6-19.

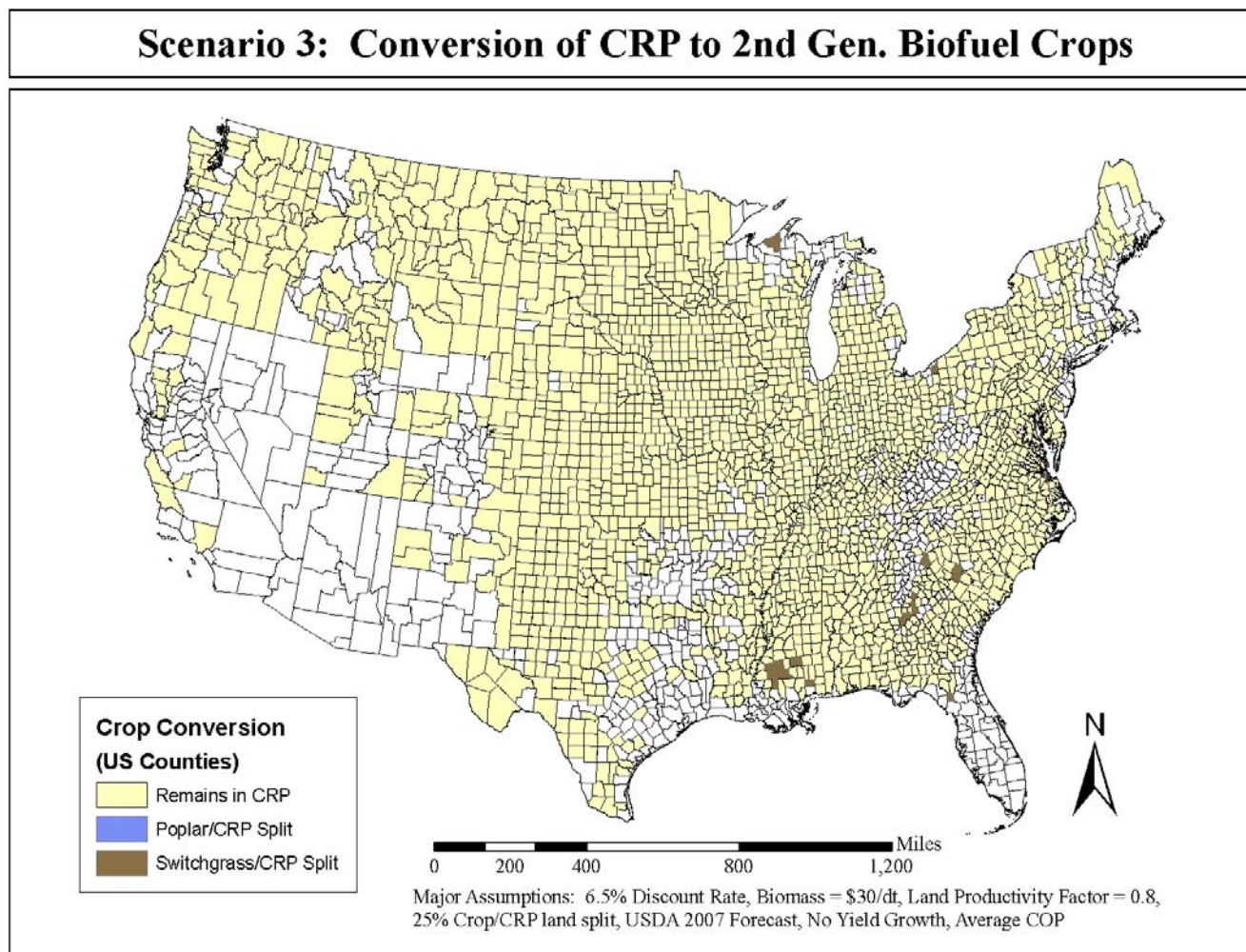
**Table 6-19 Forecasted Annual Yield Growth for Major Field Crops**

Field Crop	Forecast Annual Yield Growth
Wheat	0.78%
Corn	1.64%
Soybeans	0.76%
Cotton	2.14%
Sorghum	-1.27%
Barley	1.03%
Oats	0.86%

At a biomass price of \$30 per dry ton, relatively few contracted CRP acres are converted to growing biomass at any annual biomass yield growth rate. However, Table 6-20 shows that the number of acres converted increases nearly 20-fold from an annual biomass yield growth of 0.0% to 2.0%. Given the model parameters listed in Table 6-19, only 1,973 acres are converted nationally at an annual biomass growth of 0.0%, but 47,325 acres are converted nationally at an annual biomass growth of 2.0%. Figure 6-21 indicates that acres are converted to biomass plants first in the Southern Seaboard region of the United States, where CRP rental rates are low. As biomass yields increase year-over-year, annual returns are higher and it is profitable to grow biomass on more lands in the Southern Seaboard, Uplands and Northern Crescent regions, as seen in Figure 6-22 through Figure 6-24.

**Table 6-20 Biomass Yield Growth Analysis - CRP Conversion Rates for Program Scenario #3 (USDA 2007 Baseline Forecast)**

Annual Biomass Yield Growth	% of CRP	Acres Converted	10-yr Biomass (dt)	10-yr Cellulosic Ethanol (gal)
0.0%	0.01	1,973	108,385	9,754,661
0.5%	0.02	4,200	238,678	21,481,017
1.0%	0.04	8,542	500,660	45,059,356
2.0%	0.20	47,325	2,962,098	266,588,838



**Figure 6-21 Map of Results - Program Scenario #3 - Biomass Yield Growth, 0.0%**

### Scenario 3: Conversion of CRP to 2nd Gen. Biofuel Crops

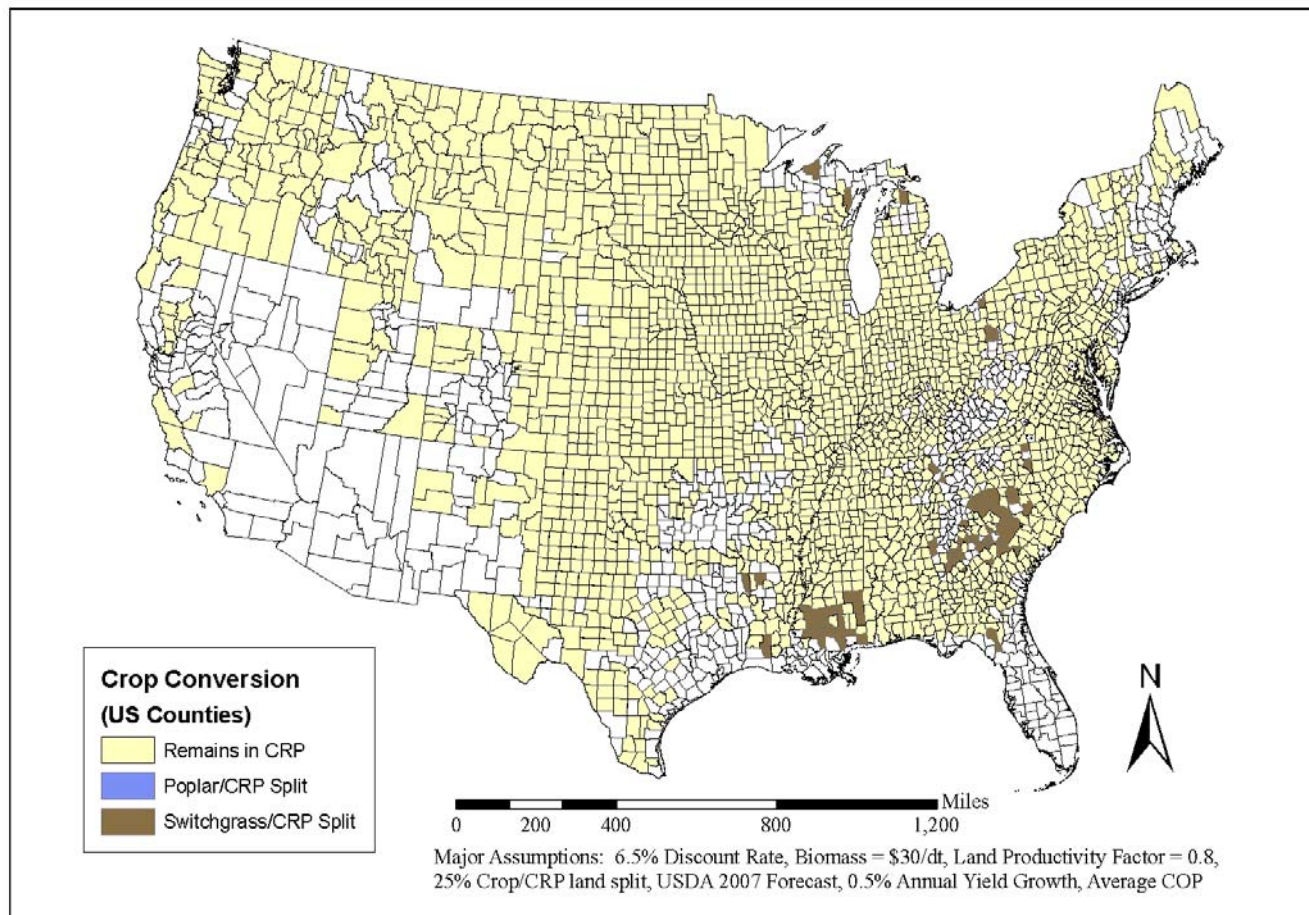


Figure 6-22 Map of Results - Program Scenario #3 - Biomass Yield Growth, 0.5%

### Scenario 3: Conversion of CRP to 2nd Gen. Biofuel Crops

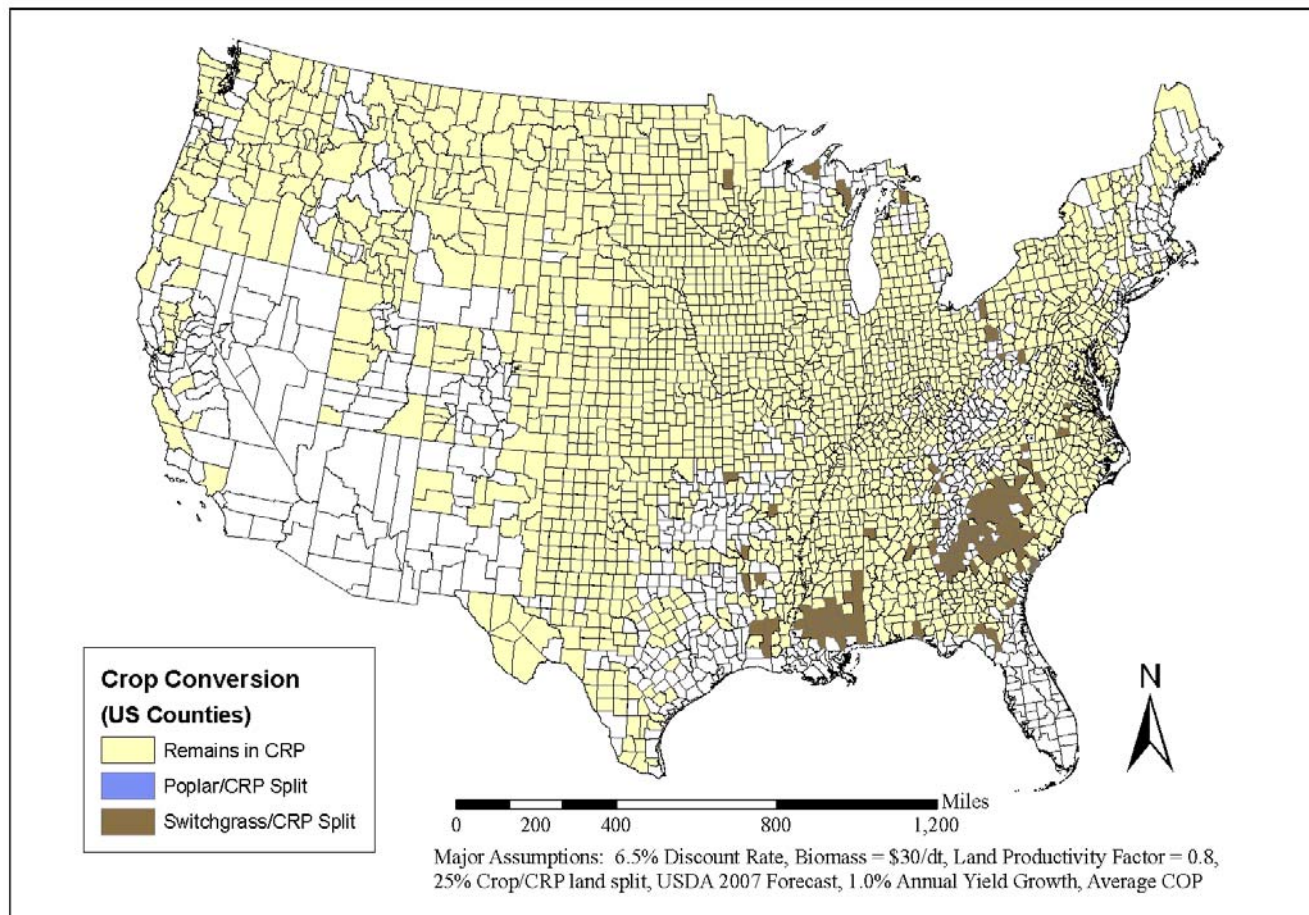


Figure 6-23 Map of Results - Program Scenario #3 - Biomass Yield Growth, 1.0%

### Scenario 3: Conversion of CRP to 2nd Gen. Biofuel Crops

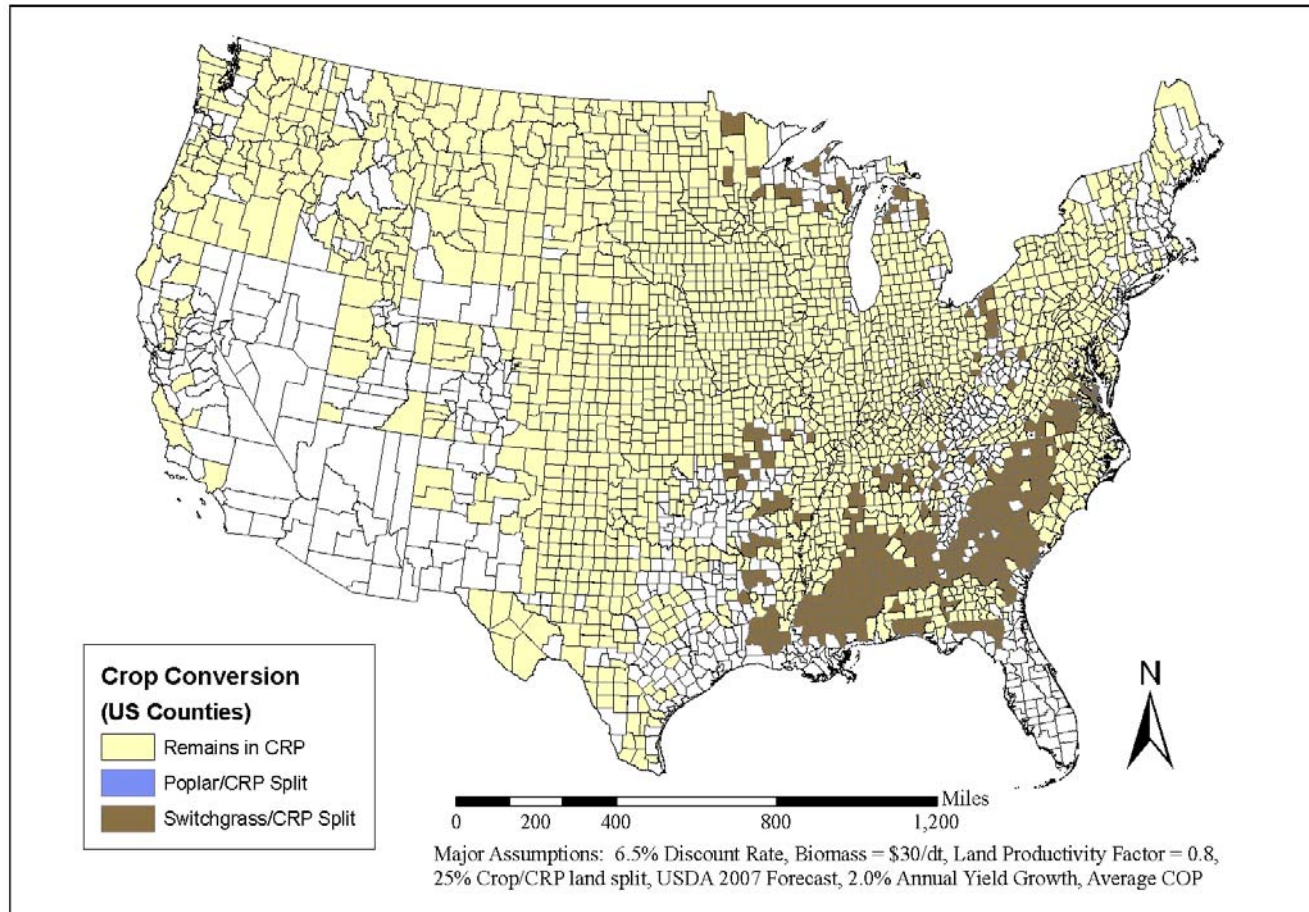


Figure 6-24 Map of Results - Program Scenario #3 - Biomass Yield Growth, 2.0%

## 6.6 Summary of Results

As part of this research, four CRP program scenarios (Section 5.2) were evaluated to determine how each scenario would affect program enrollment, program costs, net farm income, and biofuel supply potential. Brief descriptions of the program structures are summarized in Table 6-21.

**Table 6-21 Brief Program Scenario Descriptions**

<b>Program Scenario</b>	<b>Description</b>
Scenario #1	CRP Reauthorization With No Changes – CRP reauthorized with static annual CRP rental rates and opt-out provision for landowners
Scenario #2	1 <sup>st</sup> Generation Biofuel Feedstock Growth – Farmers may use up to 25% of land to grow corn or soybeans for biofuel feedstocks
Scenario #3	2 <sup>nd</sup> Generation Biofuel Feedstock Growth – Farmers may use up to 25% of land to grow biomass crops for cellulosic ethanol feedstocks
Scenario #4	Working Lands Conservation Program – Farmers may use up to 25% of their land to grow any crop desired

Key results from the analysis are summarized below:

- Program administration scenarios have a stark effect on the number of acres converted and the type of crop grown on the converted acres.
- Regional variations in cropping practices, climate, and CRP rental rates greatly influence the profitability of alternate uses of CRP land.
- Price forecasts for the major seven field crops and biomass are the most significant factor in determining whether alternate uses for CRP contracted acres will be profitable. The relative

uncertainty of USDA and FAPRI price forecasts over the analysis period makes accurate prediction of CRP conversion rates, program costs, and biofuel supply potential difficult.

- In most scenarios, growing corn on a portion or all CRP contracted acres in the Mid-western region of the United States is the most profitable use of those lands (Figure 6-1 through Figure 6-4, Table 6-2).
- Program costs are indirectly proportional to the number of acres enrolled in the CRP. Reduction of the number of acres in regions with higher rental rates (i.e. Heartland, Fruitful Rim, and Northern Crescent) is the most effective way to reduce program costs (Table 6-6 and Table 6-8).
- Net farm income is maximized in scenarios where farmers are permitted to convert contracted CRP acres to alternate, more profitable uses (Table 6-9).
- The biofuel supply potential of land enrolled in the CRP is limited (< 2%) when compared to the forecasted demand for liquid petroleum fuels over the analysis period, 2007-2016 (Table 6-12).
- Sustained farmgate prices for biomass over \$35 per dry ton are required before landowners will consider biomass production a profitable alternate use for CRP contracted acres (Table 6-13 and Table 6-14).
- The predominant biofuel feedstock is and will remain corn until demand and farmgate prices for biomass are high enough to justify converting acres from corn to biomass (Figure 6-11 and Figure 6-12)
- Utilization of native biomass plants (i.e. switchgrass) may be more economically favorable than standard field crops on highly marginal lands (Table 6-16).
- Biomass production becomes more favorable as biomass yields increase (Table 6-20).

Within the framework of a particular CRP program scenario, fluctuations in price, economic conditions, and regional variation of climate and crop type can

greatly influence a landowner's decision to convert CRP contracted acres to alternate uses. Model results have demonstrated that program costs can be reduced and net farm income boosted by allowing landowners to convert CRP acres to more profitable uses. The biofuel supply potential of the CRP depends heavily on the farmgate price for biomass and whether a sustained market for biomass develops. The program structures examined in this analysis demonstrate that the CRP has a large enough enrollment and dispersion of types of land to flexibly respond to changes in program administration or accommodate new policy goals related to development of biofuel feedstocks.

## **Chapter 7**

### **7 THE FUTURE OF THE CRP: RESEARCH CONCLUSIONS AND POLICY PERSPECTIVES**

#### **7.1 Redirecting the Conservation Reserve Program: The Challenge**

Established in 1985, the Conservation Reserve Program remains the dominant agricultural conservation program in the United States almost 25 years later. Nearly 9% (~36 million acres) of arable farmland in the United States is enrolled in the program and administration costs approach \$2 billion per year (US-USDA, FY2006 CRP Summary Report). Despite the continued support for conservation programs at the local, state and national level, high prices for agricultural commodities, coupled with increasing demand for arable cropland, has prompted stakeholders to reassess whether the Conservation Reserve Program is the most efficient and cost-effective use of contracted acres.

The rapid growth of the corn ethanol industry in the United States in the last ten years has dramatically altered the agriculture sector. The surging demand for ethanol has resulted in nearly 12% more acres planted with corn in 2009 than in 1999, despite the fact that the amount of arable cropland in the United States continues to decrease at an average rate of 750,000 acres per year (US-USDA, “2002 Agriculture Census” Table 5). As acreage has shifted into corn, fewer acres have been available for other commodities resulting in reduced supplies and higher prices.

Congressional mandates for production of biofuels, first established as a Renewable Fuel Standard (RFS) in the *Energy Policy Act of 2005* and later broadened in the *Energy and Independence Security Act of 2007*, underscore the growing limitations of the agriculture sector to produce biofuel feedstocks in addition to other agricultural commodities destined for export or domestic consumption.

The 36 million acres of land enrolled in the Conservation Reserve Program is the largest bloc of potentially arable cropland available to relieve land resource constraints without converting virgin forests or grasslands. However, allowing contracted acres to revert to productive cropland could reverse or eliminate the environmental benefits gained by participating in the CRP. The challenge confronting Conservation Reserve Program administrators in the next ten years will be to design a program that secures the environmental benefits on contracted acres while providing suitable land resources for the burgeoning demands of the biofuel sector.

Research conducted in this thesis explored how the CRP would be affected by administrative changes that allowed contracted acres to be utilized for growing biofuel feedstocks. In this chapter, an optimum program design that balances the conservation mandate of the CRP with the growing demands for land to grow biofuel feedstocks is recommended, and the ramifications of that program design are explored within the Energy-Economy-Environment framework.

## **7.2 Criteria for Evaluating Changes to the CRP**

An optimum program design for the Conservation Reserve Program must balance the sometimes-conflicting goals of energy production and environmental preservation while allowing for economic gain and cost-effective program

administration. To assess the value of any changes to the program design, each scenario was judged according to the following criteria:

- Economic benefits must be achieved, either in the form of increased net farm income or reduced administrative costs,
- The environmental integrity of contracted acres must be preserved or enhanced, and
- Usage of contracted acres for production must generate biofuel feedstocks and cannot be used to produce other agricultural commodities.

Any proposal failing to meet the three criteria outlined above would preferentially favor either energy, economic, or environmental goals at the expense of the other two and is not recommended for implementation.

### **7.3 Assessment of Proposals for Redirecting the CRP**

A comprehensive review of existing research pertaining to the CRP (Chapter 3) and stakeholder proposals for altering the CRP (Chapter 4) was conducted to develop and analyze four proposals for modifying the CRP to accommodate productive use of contracted acres (Chapters 5). Using the analytical model results summarized in Chapter 6, each proposal can be judged against the criteria listed in Section 7.2 to determine the optimum program design for balancing the conservation mandate of the CRP with the capacity of contracted acres to produce biofuel feedstocks.

### **7.3.1 Evaluating Scenario 1: CRP Reauthorized With No Changes**

In this scenario, the structure of the Conservation Reserve Program remains effectively unchanged following passage of the 2008 Farm Bill, but participants are allowed one opportunity to renegotiate their enrollment and opt out of the CRP if desired.

Model results show that the number of participants that opt-out of the CRP is highly dependent on the anticipated prices for agricultural commodities, with higher prices resulting in more contracted acres converted to alternate uses. Depending on the price forecast utilized, the number of converted acres will range between 895,000 (4%) and 5.7 million acres (24%). Additionally, the majority of acres will be converted to growing corn (41- 88%), with a negligible amount converted to dedicated biomass feedstocks.

#### **7.3.1.1 Economic Benefits of Scenario #1**

The economic benefits related to Scenario #1 are proportional to the number of acres converted to alternate uses. Depending on the price forecast selected, the 10-year Net Farm Income will range between \$7.65 billion and \$10.28 billion, representing an increase over the baseline of existing annual CRP rental rates of between 1.62% and 36.65%, respectively. CRP program savings range between \$35 million and \$284 million per year, depending on the price forecast selected.

While this scenario results in an increase of Net Farm Income and reduction of CRP program costs, the economic benefits are heavily reliant on the prices of agricultural commodities. A shift in commodity prices may result in reductions of Net Farm Income below that achieved by keeping all contracted acres in the CRP during the 2007 – 2106 period. Program savings will be achieved regardless

of swings in commodity prices since acres removed from the program no longer receive a rental payment.

#### **7.3.1.2 Environmental Benefits of Scenario #1**

Significant environmental benefits have been attributed to the CRP. Removing land from active farming has been attributed to improving wildlife habitat, reducing soil erosion and nutrient runoff, improving air/water quality and sequestering carbon (Section 3.5.1). In contrast, annual tillage of farmland has been demonstrated to increase erosion and reduce soil organic matter content (Burke et al. 793). High rates of conversion of contracted acres to production of traditional field crops forecasted by the model (approx. 99% of converted acres) will reverse many of the environmental benefits achieved by enrollment in the CRP and contribute to further erosion and nutrient runoff.

#### **7.3.1.3 Energy Benefits of Scenario #1**

Utilization of contracted CRP acres to grow corn, soybeans or biomass will improve the availability of biofuel feedstocks. Implicitly assumed in this analysis, all corn, soybeans or biomass grown on CRP acres will be converted into biofuels. Based on the price forecasts utilized in this analysis, the majority of converted acres (41 – 88%) will be used to grow corn. Biomass is not profitable to grow relative to other field crops at a farmgate price of \$30/dt and negligible amounts are grown in this scenario. As a result, the majority of converted acres are utilized to grow enough corn on CRP acres to produce approximately 2.5 billion gallons of corn-ethanol per year, which is nearly 40% of the ethanol produced in the entire United States in 2007.

#### **7.3.1.4 Policy Recommendation for Scenario #1**

Despite the high likelihood that altering the administration of the CRP in accordance with Scenario #1 recommendations will result in an increase in Net Farm Income, decrease in program costs and a significant amount of corn produced as a biofuel feedstock, Scenario #1 is not recommended as a suitable program design for the CRP. The high degree of uncertainty regarding future commodity prices casts doubt on the magnitude of projected gains in Net Farm Income. In addition, high conversion rates to traditional field crops will reverse many of the environmental gains achieved by enrollment in the CRP.

#### **7.3.2 Scenario 2: First-Generation Biofuel Feedstock Growth**

The structure of the Conservation Reserve Program is altered to allow farmers to use up to 25% of their contracted CRP land to grow corn or soybeans that can be used to produce ethanol or biodiesel.

Model results show that the number of landowners that participate in the program allowing production of 1<sup>st</sup> generation biofuel feedstocks on a portion of contracted CRP acres is again highly dependent on the anticipated prices for agricultural commodities, with higher prices resulting in more contracted acres converted. Due to the acreage conversion caps incorporated into Scenario #2, overall conversion rates are significantly lower than Scenario #1. Depending on the price forecast utilized, the number of converted acres will range between 93,000 (0.4%) and 1.4 million acres (5.8%). The vast majority of acres will be converted to growing corn (95 - 99%), with a negligible amount utilized to grow soybeans.

### **7.3.2.1 Economic Benefits of Scenario #2**

The economic benefits related to Scenario #2 are again proportional to the number of acres converted to alternate uses. Depending on the price forecast selected, the 10-year Net Farm Income will range between \$7.54 billion and \$8.21 billion, representing an increase over the baseline of existing annual CRP rental rates of between 0.17% and 9.05%, respectively. CRP program savings range between \$4.3 million and \$35 million per year, depending on the price forecast selected.

With nearly 95% of acres converted to growing corn, 10-year Net Farm Income is highly dependent on the farmgate price of corn. However, the change in 10-year Net Farm Income relative to the baseline of existing CRP rental payments (either positive or negative) will be proportionately smaller than Scenario #1 due to the acreage conversion restrictions. Scenario #2 presents many of the same economic benefits as Scenario #1, but at a smaller scale with considerably less overall risk.

### **7.3.2.2 Environmental Benefits of Scenario #2**

Similar to Scenario #1, high rates of conversion of contracted acres to production of corn forecasted by the model (approx. 99% of converted acres) will reverse many of the environmental benefits achieved by enrollment in the CRP and contribute to further erosion and nutrient runoff. Due to the acreage conversion caps, the reduction in environmental benefits may be proportionally less based on the number of acres converted relative to Scenario #1. However, the reduction of environmental benefits may be limited if converted acres are isolated and surrounded by acres enrolled in the CRP to help mitigate the increased erosion and nutrient runoff of traditional farming practices.

### **7.3.2.3 Energy Benefits of Scenario #2**

Based on the price forecasts utilized in this analysis, the vast majority of converted acres (~95 - 99%) will be used to grow corn. Biomass is not profitable to grow relative to other field crops at a farmgate price of \$30/dt and negligible amounts are grown in this scenario. As a result, the majority of converted acres are utilized to grow enough corn on CRP acres to produce approximately 0.66 billion gallons of corn-ethanol per year, which is about 10% of the ethanol produced in the entire United States in 2007.

### **7.3.2.4 Policy Recommendation for Scenario #2**

By limiting the amount of program acreage that can be converted and restricting converted acres to production of either corn or soybeans, Scenario #2 presents a measured and conservative program design for the Conservation Reserve Program. Conversion of contracted acres is still highly dependent on the forecasted commodity prices for corn and soybeans, but acreage caps limit the magnitude of the effect on Net Farm Income resulting from swings in commodity prices. Imposing selective conversion criteria may also allow program administrators to restrict conversion of acres to the least environmentally sensitive areas and more easily preserve the environmental mandate of the CRP. However, the biofuel potential of Scenario #2 is necessarily limited by the small number of acres converted. Due to the limited environmental and economic risk, Scenario #2 is recommended as a valid program option for transitioning a portion of CRP lands to produce biofuel feedstocks.

### **7.3.3 Scenario 3: Second-Generation Biofuel/Biomass Feedstock Growth**

The structure of the Conservation Reserve Program is altered to allow farmers to use up to 25% of their contracted CRP land to grow switchgrass or hybrid

poplar trees that can be used as biomass feedstock for electricity generation or cellulosic ethanol production.

Model results indicate that the number of landowners that participate in the program allowing production of 2<sup>nd</sup> generation biofuel feedstocks on a portion of contracted CRP acres is severely limited at a farmgate biomass price of \$30/dt, resulting in only 1,973 acres converted nationwide. However, relative increases in either the biomass yield or the farmgate price for biomass would rapidly improve the attractiveness of growing biomass on CRP contracted acres. Improving the annual yield for biomass by 2.0% increases the number of converted acres from 1,973 to 47,235. Figure 6-11 and Figure 6-12 shows that increasing the farmgate price by 25% to \$40/dt results in biomass becoming the most profitable use of CRP lands and nearly 50% of contracted acres in the CRP converted to biomass production.

#### **7.3.3.1 Economic Benefits of Scenario #3**

The economic benefits related to Scenario #3 are proportional to the number of acres converted to growing biomass. Assuming a farmgate price of \$30/dt, the increase in 10-year Net Farm Income is negligible relative to the baseline of existing annual CRP rental payments due to the small number of acres converted. CRP program savings is only \$43,601 per year.

However, the economic benefits of growing biomass are highly dependent on the forecasted farmgate price for biomass. Model results indicate that an increase of the farmgate price for biomass of 15-25% can make biomass production even more financially attractive than growing corn, assuming either the USDA 2007 or FAPRI commodity price forecasts. In such a circumstance, a CRP program dedicated to

biomass production would be unnecessary since biomass production would compete directly with traditional field crops for acres outside the CRP.

#### **7.3.3.2 Environmental Benefits of Scenario #3**

Numerous researchers have documented the environmental advantages of growing native perennial crops as compared to traditional row crops (Downing et al.; Walsh et al.; US-USDA, “2007 Farm Bill Theme Paper”; Graham et al., “Environmental Benefits”). Native perennial plants do not require irrigation, pest/weed management or annual tillage of the soil (McLaughlin et al.) and replenish soil organic carbon (Gebhart et al. 492), reduce wind and water erosion and provide wildlife habitat. Unfortunately, the extremely limited number of acres converted to biomass assuming a farmgate price of \$30/dt results in small to negligible environmental benefits. While biomass production on converted CRP acres has the most environmental benefits per acre of any program design considered, the small number of acres expected to be converted severely limits the magnitude of environmental benefits associated with Scenario #3.

#### **7.3.3.3 Energy Benefits of Scenario #3**

Any energy benefits associated with Scenario #3 are predicated on the establishment of a cost-effective cellulosic ethanol production facility or biomass-based industrial heat/electricity generation facility close to the acres growing biomass. Given the very limited number and wide dispersion of acres converted to biomass production at a farmgate price of \$30/dt, close proximity to a conversion facility is unlikely. In the best case, Scenario #3 would result in 1 million gallons of cellulosic

ethanol per year, or less than 1/10<sup>th</sup> of 1% of the ethanol produced in the entire United States in 2007.

#### **7.3.3.4 Policy Recommendation for Scenario #3**

Due to the continued high cost of producing ethanol from biomass and limited market for biomass in industrial heat or electricity generation facilities, demand for biomass is expected to remain slack and prices low. As a result, Scenario #3 has limited potential for either preserving or enhancing the environmental mandate of the CRP, boosting farm income, reducing program expenses, or significantly contributing to the production of biofuel feedstocks and is not recommended.

Energy and economic benefits associated with utilizing CRP contracted acres to grow biomass are contingent upon a viable, local market for biomass and reasonable farmgate prices. It should be noted that the CRP presents an opportunity for program administrators to incentivize pilot biomass production systems, perhaps by subsidizing biomass production on CRP acres near biomass conversion facilities (Walsh et al.). Co-locating biomass conversion facilities nearby CRP acres contracted to grow biomass could result in a viable, small-scale system that boosts farm income, produces biofuels, and preserves the environmental benefits of CRP acres.

#### **7.3.4 Scenario 4: Working-Lands Conservation Program**

The structure of the Conservation Reserve Program is altered to allow farmers to use up to 25% of their contracted CRP land to grow any of the major field crops – corn, soybeans, wheat, oats, barley, sorghum, rice, cotton – or biomass crops.

Scenario #4 is identical to Scenario #1, with the exception that landowners are only permitted to convert up to 25% (rather than the full 100%) of CRP contracted

acres to alternate uses. As would be expected, the number of acres converted is approximately 25% of those converted in Scenario #1. Once again, the conversion rate is highly dependent upon the anticipated prices of agricultural commodities, with higher prices resulting in more acres converted to alternate uses. Depending on the price forecast utilized, the number of converted acres will range between 224,000 acres (0.9%) and 1.4 million acres (6%). Similar to Scenario #1, the vast majority of converted acres are dedicated to growing corn (41-88%), with a negligible amount converted to dedicated biomass feedstocks.

#### **7.3.4.1 Economic Benefits of Scenario #4**

The economic benefits related to Scenario #4 are proportional to the number of acres converted to alternate uses. Depending on the price forecast selected, the 10-year Net Farm Income will range between \$7.56 billion and \$8.21 billion, representing an increase over the baseline of existing annual CRP rental rates of between 0.41% and 9.16% respectively. CRP program savings range between \$8.6 million and \$71 million per year, depending on the price forecast selected.

This scenario results in an increase of Net Farm Income and reduction of CRP program costs, but the economic benefits remain heavily reliant on the prices of agricultural commodities. However, the magnitude of the benefits (or losses) is proportionally less than Scenario #1 due to the acreage conversion caps and landowners reduce the risk of incurring losses in Net Farm Income by keeping the majority of acres enrolled in the CRP and continuing to receive annual rental payments.

#### **7.3.4.2 Environmental Benefits of Scenario #4**

Annual tillage of farmland has been demonstrated to increase erosion and reduced soil organic matter (Burke et al. 793). High rates of conversion of contracted acres to production of traditional field crops forecasted by the model (approx. 99% of converted acres) will reverse many of the environmental benefits achieved by enrollment in the CRP and contribute to further erosion and nutrient runoff. However, due to the acreage conversion caps, the reduction in environmental benefits may be proportionally less, based on the number of acres converted relative to Scenario #1. The reduction of environmental benefits may be lessened if converted acres are isolated and surrounded by acres enrolled in the CRP to help mitigate the increased erosion and nutrient runoff of traditional farming practices.

#### **7.3.4.3 Energy Benefits of Scenario #4**

Based on the price forecasts used in this analysis, the majority of converted acres (41-88%) will be used to grow corn. Biomass is not profitable to grow relative to other field crops at a farmgate price of \$30/dt and negligible amounts are grown in this scenario. Due to the acreage caps, the number of converted acres is proportionally less than Scenario #1 and the amount of biofuel feedstocks produced is also proportionally less. As a result, the majority of converted acres are utilized to grow enough corn on CRP acres to produce approximately 0.64 billion gallons of corn-ethanol per year, which is about 10% of the ethanol produced in the entire United States in 2007.

#### **7.3.4.4 Policy Recommendation for Scenario #4**

Similar to Scenario #1, altering the administration of the CRP in accordance with Scenario #4 recommendations will result in an increase in Net Farm

Income, decrease in program costs and a significant amount of corn produced as a biofuel feedstock. Imposition of acreage conversion caps, coupled with program administrator oversight of which acres are converted, can significantly lessen the environmental effects of converting CRP acres to traditional row crops. Imposing acreage caps also lessens the effect that swings in future commodity prices may have on Net Farm Income. As such, a program that allows landowners to convert an approved portion of their contracted acres to alternate uses to boost farm income and produce additional biofuel feedstocks with minimum reversal of environmental gains is recommended.

#### **7.4 Optimum Policy Proposal for the Conservation Reserve Program**

Based on the research conducted as part of this thesis (Chapter 6), and combined with an analysis of various program design proposals for the CRP (Chapter 4), an optimum program design that balances the conservation mandate of the CRP with the growing demands for land to grow biofuel feedstocks is proposed. The program design seeks to keep the most environmentally sensitive acres enrolled in the CRP, boost farm income by allowing landowners to keep profits from growing bioenergy feedstocks on converted acres, and reduce CRP administration costs.

The recommendation is broken into two parts: (1) program design changes and (2) administrative changes. Suggested program design changes fundamentally alter the goals or intent of the CRP and would require approval by Congress, while administrative changes are independently implemented by the Farm Service Agency to satisfy the stated objectives of the Conservation Reserve Program.

#### **7.4.1 Program Design Changes for the CRP**

The focus of the Conservation Reserve Program should be revised to “assist owners and operators in conserving and improving soil, water and wildlife resources on their farms and ranches” (US-USDA, “2007 Farm Bill Theme Paper” 13) by means other than land-retirement and planting of long-term conservation cover crops. Landowners would be permitted to submit applications to the FSA to convert *up to* 25% of contracted acres to alternate uses, ideally to sustainably grow and harvest corn, soybeans or biomass intended for use as feedstocks for biofuel or energy production.

As part of the application review, the FSA reserves the right to determine whether acres are suitable for conversion to alternate uses based on the Environmental Benefits Index (EBI) score, proximity of the acres relative to wildlife habitat or adjacent watersheds, or involvement in regional conservation initiatives (i.e. CREP projects). Acres will not be converted if conservation priorities are compromised. Additionally, landowners would be required to implement an approved conservation plan on converted acres to limit nutrient runoff associated with production of corn, soybeans or biomass.

CRP rental rates would be reduced in proportion to the fraction of acreage converted to corn, soybeans or biomass production. Landowners are required to report the crop grown on the converted acres and any associated profits annually to the FSA. Landowners may revert converted acres back to CRP contracted acres during a competitive annual general sign-up, but are restricted from converting any additional acres to alternate uses for a period of 5 years.

The FSA should also establish a Biomass Reserve Program (BRP) within the CRP or CREP and incentivize existing CRP participants in localities nearby

existing or planned biorefineries to convert a portion (*up to 25%*) of contracted acres to grow biomass. The FSA would provide technical assistance and funding to establish and manage a biomass crop and guarantee a fixed price for biomass at harvest at least equivalent to the forfeited rental rate for a specified number of years. The Biomass Reserve Program would be limited to existing CRP contract owners in select areas identified by the FSA.

#### **7.4.2 Administrative Design Changes for the CRP**

To accommodate the program design changes to the CRP that allow landowners to convert a portion of contracted acres to alternate uses, the FSA should institute a number of administrative changes:

- The FSA should move to a recurring (annual or biannual) competitive sign-up process for CRP enrollments and landowner elections to convert contracted acres to alternate uses.
- An annual survey of dry land and irrigated cash rents should be used to update CRP rental rates on a periodic basis and insure rental rates are competitive with other economic uses of the land.
- Incorporate selection criteria into the CRP enrollment process that result in acreage selections that contribute to specific program goals: (1) retirement of the most environmentally sensitive acres, (2) preservation of wildlife habitat, (3) erosion control, and (4) growth of bioenergy feedstocks.
- A comprehensive program for tracking and verifying the environmental gains associated with conservation initiatives should be implemented.

Administrative changes are aimed at insuring that the conservation programs provide consistent conditions and expectations and verifiable results. Such

a framework is integral to evaluating the success of the CRP, particularly with regards to contracted acres converted to alternate uses.

## **7.5 Assessment of the Optimum Policy Proposal**

The optimum policy proposal was generated from the variety of suggestions examined as part of the 2008 Farm Bill policy process and informed by results from the land-usage model developed for this research. Similar to model scenarios examined earlier, the optimum policy proposal was judged against the criteria outlined in Section 7.2.

### **7.5.1 Economic Benefits of the Optimum Policy Proposal**

The economic benefits related to the Optimum Policy Proposal are two fold: (1) profitable, productive use of converted acres results in increases in Net Farm Income, and (2) converting contracted acres to alternate uses reduces annual rental payments and Conservation Reserve Program costs. As results from Scenario #2 (the modeled scenario most similar to the optimum policy proposal) show, 10-year Net Farm Income increase between 0.17% and 9.05% over the baseline of existing annual CRP rental payments while CRP program savings range between \$4.3 million and \$35 million per year.

Net Farm Income is highly dependent upon commodity prices of corn, soybeans or biomass. Price forecasts utilized in this analysis predict an increase in Net Farm Income for landowners who convert a portion of contracted acres to production. However, swings in commodity prices could either magnify or erase predicted gains and leave a farmer in a position where leaving acres in the CRP was more desirable.

The optimum policy proposal sets acreage caps for the amount of contracted CRP acres a landowner can convert to other uses, effectively providing a hedge against wide fluctuations in commodity prices and mitigating a landowner's risk. The landowner has the potential to earn greater profits by converting acreage to corn, soybean or biomass production, but risks only 25% of the annual CRP rental payment. Economic benefits will always accrue to the Conservation Reserve Program since rental payment savings accrue regardless of prevailing commodity prices. On a 10-year basis, the optimum policy proposal is expected to achieve positive net economic benefits in all but extreme circumstances.

#### **7.5.2 Environmental Benefits of the Optimum Policy Proposal**

Retiring land from production and planting long-term cover crops results in number of environmental benefits, including: limiting erosion and nutrient runoff, improving wildlife habitat, reducing application of fertilizer and pesticides, and replenishing soil organic carbon (Gebbert et al. 492). Reversion to traditional row cropping will reverse many of these environmental benefits and may erase any gains achieved by leaving the land enrolled in the CRP.

The optimum policy proposal preserves the environmental integrity of acres enrolled in the CRP while still allowing for productive use of the land. Program guidelines will prevent landowners from returning the most environmentally sensitive acres to production. Annual updates of CRP rental payments also insure there is limited economic incentive to return contracted acres to production. The proposal also caps the number of acres that can be converted, effectively limiting the nationwide potential to reverse the environmental benefits achieved while acres were enrolled in the CRP. Finally, landowners are required to implement an approved conservation

program to limit nutrient runoff and the FSA will evaluate the results of conservation efforts over time.

Incorporating a Biomass Reserve Program into the CRP also contributes to preserving the environmental integrity of previously contracted acres. Planting native perennial plants have few of the disadvantages of traditional row crops and achieve many of the same benefits as a long-term conservation cover crop (Downing et al.; Graham et al., “Environmental Benefits”). Providing technical assistance and funding to landowners to grow biomass on contracted acres is one of the most practical methods to insure environmental gains achieved during enrollment in the CRP are not lost.

### **7.5.3 Energy Benefits of the Optimum Policy Proposal**

Energy benefits are highly dependent on the number of acres converted to bioenergy feedstock production and the relative demand for biomass to produce cellulosic ethanol or power industrial heat/electricity generation facilities. Results from Scenario #2 (the modeled scenario most similar to the optimum policy proposal) show the vast majority of converted acres (~95-99%) will be used to grow enough corn to produce approximately 0.66 billion gallons of corn-ethanol per year (10% of ethanol production in the U.S. in 2007).

The optimum policy proposal limits the number of acres that can be converted to alternate uses and essentially caps the potential energy benefits derived from converted acres. In addition, biomass is not profitable to grow relative to other field crops at a farmgate price of \$30/dt and negligible amounts will be grown unless influenced by other factors, further limiting the bioenergy potential of the CRP.

However, the optimum policy proposal enables landowners to utilize converted acres to grow 1<sup>st</sup> generation biofuel feedstocks (i.e. corn and soybeans) while simultaneously providing a structured framework (the Biomass Reserve Program) to develop viable biomass production systems in targeted areas throughout the CRP. As demand develops for biomass and farming practices improve, landowners may transition away from traditional row crops to biomass production, resulting in increases in net farm income and environmental benefits. Given a dedicated market for biomass, the Biomass Reserve Program offers the opportunity for contracted acres to be used to sustainably produce enough bioenergy feedstocks to significantly influence the biofuel supply in the United States.

#### **7.5.4 Optimum Policy Proposal Summary**

The optimum policy proposal effectively balances the conservation mandate of the CRP with the growing demands for land to grow biofuel feedstocks. Landowners that participate in the program are likely to boost farm income while simultaneously reducing the cost to administer the CRP. Acreage caps and administrator oversight, combined with implementation of approved conservation plans, protect the environmental gains achieved by enrolling in the CRP. Finally, CRP lands are managed more efficiently to provide additional capacity to produce biofuel feedstocks and supplement the domestic production of liquid transportation fuels.

#### **7.6 Judging the 2008 Farm Bill**

Evaluation of stakeholder proposals, coupled with thorough research of how CRP program changes would affect net farm income, bioenergy production,

program enrollment and government program payments influenced the development of the optimum policy proposal for modifying the CRP. However, the protracted policy process surrounding the creation of the 2008 Farm Bill offered ample opportunities for critics of conservation programs to constrain program funding or seek concessions to accommodate other programs included in the 2008 Farm Bill. Enacted legislation in the 2008 Farm Bill is evaluated relative to the optimum policy proposal to determine the extent that program design changes balance the capacity of acreage enrolled in the CRP to produce bioenergy with the continued need for conservation.

#### **7.6.1 Evaluating the Conservation Title of the 2008 Farm Bill**

The Conservation Title of the 2008 Farm Bill reauthorizes and funds the Conservation Reserve Program through FY 2012, but reduces the permitted acreage cap by nearly 20% to 32 million acres. In contrast, the Conservation Stewardship Program was authorized to replace the existing Conservation Security Program and funding was expanded to refocus conservation efforts towards “working-lands” conservation practices on productive cropland.

These changes are consistent with a shift in the administration of conservation programs away from more the more expensive “land-retirement” approach towards a cheaper “working-lands” approach that emphasizes conservation assistance on productive cropland to reduce environmental degradation associated with traditional row cropping. This approach offers landowners a portfolio of conservation programs to choose from and provides the flexibility to the FSA to direct conservation dollars more efficiently to targeted applications with the greatest environmental benefit.

The 2008 Farm Bill does not explicitly direct the FSA to incorporate bioenergy feedstock production as a goal of the program as suggested in the optimum policy proposal and effectively limits the potential to convert CRP acres to alternate uses. However, the conservation framework approved in the Farm Bill acknowledges that CRP contract holders are less likely to re-enroll in the program when commodity prices are high and provides adequate funding for “working-lands” conservation programs like the CSP that can help protect the environmental gains achieved while acres were enrolled in the CRP. Reducing the acreage allotment of the CRP also limits funding to those acres deemed most environmentally sensitive and necessary to prevent from returning to production.

While the 2008 Farm Bill did not alter the fundamental design of the CRP consistent with the suggestions in the optimum policy proposal, Congress enacted portions of other measures set forth in the proposal. In particular, the 2008 Farm Bill directs the Department of Agriculture to conduct annual survey of average market dry land and irrigated cash rental rates for cropland and pastureland and to develop technical guidelines to measure, verify and report environmental services benefits from conservation programs. However, the legislation does not require that the annual survey of cash rental rates be used to periodically update CRP rental rates, or that the technical guidelines developed to measure environmental benefits actually be used to measure and report the benefits. Essentially, the Conservation Title in the 2008 Farm Bill emulates the intent of the optimum policy proposal, but stops short of implementing binding provisions that would improve tracking of conservation benefits, encourage sustainable bioenergy production on CRP lands, or update CRP rental rates periodically over the contract term.

### **7.6.2 Evaluating the Energy Title of the 2008 Farm Bill**

The Energy Title of the 2008 Farm Bill creates a framework to provide funding and support to farmers and biorefineries who produce advanced biofuels from renewable biomass while limiting support for production of biofuels from traditional row crops like corn and soybeans. In contrast to the optimum policy proposal, legislation enacted as part of the 2008 Farm Bill makes no attempt to encourage land enrolled in the Conservation Reserve Program or other conservation programs to be used for biofuel feedstock production.

The Energy Title does establish two new programs aimed at encouraging production of advanced biofuels from renewable biomass; the Bioenergy Program for Advanced Biofuels aimed at biofuel producers and the Biomass Crop Assistance Program aimed at producers of renewable biomass. The Bioenergy Program for Advanced Biofuels provides \$300 million in funding from FY 2009 – 2012 for incentive payments to eligible producers. The Biomass Crop Assistance Program contracts with landowners located near biorefineries to grow biomass and provides funding for the collection, harvest, storage and transport of biomass to the conversion facility. The combination of these two programs achieves much the same effect as the Biomass Reserve Program recommended in the optimum policy proposal, but focuses on traditional cropland rather than land enrolled in the CRP.

In response to mounting criticism about government support for the production of ethanol from corn, especially in light of the size and maturity of the industry, the 2008 Farm Bill extends additional incentives to producers of advanced biofuels that utilize renewable biomass and reduces incentives for continued production of ethanol from corn. A production tax credit of \$1.01 per gallon of cellulosic ethanol produced was enacted while the alcohol blender's tax credit for

corn-ethanol was reduced in years where U.S. production exceeds 7.5 million gallons per year. The 2008 Farm Bill also enacted a limited “Sod Saver” provision to prevent conversion of native lands to bioenergy feedstock production. Additionally, the 2008 Farm Bill commissions a National Academy of Sciences study to explore the effects of increased domestic production of biofuels and directs the Departments of Energy, Agriculture, Transportation and the Environmental Protection Agency to assess the infrastructure requirements associated with expanding domestic production of biofuels.

While 2008 Farm Bill legislation does not address using land enrolled in the Conservation Reserve Program to grow biofuel feedstocks, energy provisions enacted by the 2008 Farm Bill will achieve much the same effect as recommendations included in the optimum policy proposal. Encouraging biomass production is accomplished through a combination of the Biomass Crop Assistance Program and the Bioenergy Program for Advanced Fuels rather than a single Biomass Reserve Program. Incentives have been realigned to encourage production of advanced biofuels based on renewable biomass rather than 1<sup>st</sup> generation biofuels based on corn or soybeans. The 2008 Farm Bill provides substantial support for the development of sustainable 2<sup>nd</sup> generation domestic biofuel production systems, but fails to capitalize on the available land resources contained in the Conservation Reserve Program.

## 7.7 Policy Conclusions

The expiration of the *Farm Security and Rural Investment Act* of 2002 (2002 Farm Bill) provided an opportunity to specifically address the role of agriculture as a bioenergy producer in the newly enacted 2008 Farm Bill. The reauthorization process sought to address the growing need for energy resources, the potential of agriculture to supply bioenergy and biofuels, and whether idle and retired land can and should be reallocated to bioenergy production. Proposals suggested targeting part of the large amount of land enrolled in the Conservation Reserve Program (CRP) – a land-retirement program that contains over 36 million acres of land – and transforming it into a biomass reserve program that meets the multiple objectives of conservation, energy security, and agricultural growth (Collins, “New World of Biofuels”).

This research utilized the E3 Framework (Energy-Environment-Economy) to evaluate various proposals for modifying the CRP to allow contracted acres to be used for bioenergy feedstock production. A land utilization model based on profit maximization was developed to analyze if CRP participants would convert contracted acres to alternate uses and model how farmer income, program cost, biofuel feedstock potential, and cropland usage were affected by four possible CRP program structures between 2007 and 2016. A multi-perspective analysis was employed to judge the results based on environmental and energy implications as well as economic efficiency and recommend an optimum policy solution that balances the conservation mandate of the CRP with the growing demands for land to grow biofuel feedstocks.

The optimum policy proposal recommends incorporating sustainable bioenergy production on contracted acres as a primary goal of the Conservation

Reserve Program. Landowners would be permitted to submit applications to the FSA to convert *up to 25%* of contracted acres to sustainably grow and harvest bioenergy feedstocks. Implementation of an approved conservation plan would be required on converted acres and acres could not be converted if conservation priorities are compromised (i.e. wildlife habitat, erosion control). The CRP rental rate would be reduced in proportion to the amount of land converted to bioenergy production.

Model results indicate that the optimum policy proposal increases net farm income over a 10-year period, reduces program administration costs, preserves the environmental integrity of the CRP, and expands the availability of biofuel feedstocks. The optimum policy proposal effectively balances the capacity of acreage enrolled in the CRP to produce bioenergy with the continued need for conservation. In addition, the optimum policy proposal contributes towards achieving broader national policy goals to improve energy security by expanding domestic energy supplies, offsetting petroleum imports, reducing oil price volatility, and reducing emissions of carbon dioxide (Collins, “Emerging Bioeconomy”; Cook and Beyea 442; Sims 95-97).

Actual legislation enacted as part of the *Food, Conservation and Energy Act of 2008* seeks to streamline conservation programs, encourage sustainable bioenergy production, and increase domestic bioenergy usage, but employs alternate policy methods than suggested as part of the optimum policy proposal. The 2008 Farm Bill reduces the acreage cap on the CRP by nearly 20% to 32 million acres, effectively limiting funding to those acres deemed most environmentally sensitive, but expands funding for alternate “working-lands” conservation programs like the CSP in order to enroll acres leaving the CRP upon contract expiration. Sustainable bioenergy

production is incentivized through two separate programs, the Biomass Crop Assistance Program and the Bioenergy Program for Advanced Biofuels, but the 2008 Farm Bill does not encourage bioenergy development on acres enrolled in the CRP. The 2008 Farm Bill provides substantial support for the development of sustainable 2<sup>nd</sup> generation domestic biofuel production systems on existing cropland, but fails to capitalize on the available land resources contained within the Conservation Reserve Program as recommended as part of the optimum policy proposal.

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## LIST OF ACRONYMS

AEO 2007	Annual Energy Outlook 2007
AEO 2008	Annual Energy Outlook 2008
AER 2008	Annual Energy Review 2008
AFT	American Farmland Trust
APAC	Agricultural Policy Analysis Center at the University of Tennessee
ARMS	Agricultural Resource Management Survey
ASD	Agricultural Supply District
ASTM	American Society for Testing and Materials
B5	A 5% blend of biodiesel with ordinary No. 2 Diesel
B10	A 10% blend of biodiesel with ordinary No. 2 Diesel
B20	A 20% blend of biodiesel with ordinary No. 2 Diesel
B100	100% biodiesel, not blended with ordinary No. 2 Diesel
BFDP	Bioenergy Feedstock Development Program
BRP	Biomass Reserve Program
BTU	British Thermal Unit
CAA	Clean Air Act
CBP	County Business Patterns
CCC	Commodity Credit Corporation
CI	Confidence Interval
CO	Carbon Monoxide
CO <sub>2</sub>	Carbon Dioxide
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CSP	Conservation Security Program
DDGS	Dried Distiller's Grains and Solubles
DOE	Department of Energy
E10	A 10% blend of ethanol with motor gasoline
E85	A 85% blend of ethanol with motor gasoline
EBB	European Biodiesel Board
EBI	Environmental Benefits Index
ECP	Emergency Conservation Program
EI	Erodibility Index
EISA 2007	Energy Independence and Security Act of 2007
EPACT 1992	Energy Policy Act of 1992

EPACT 2005	Energy Policy Act of 2005
EQIP	Environmental Quality Incentive Program
ERS	Economic Research Service (a division of the United States Department of Agriculture)
EtOH	Abbreviation for Ethanol
EWP	Emergency Watershed Program
FAPRI	Food and Agricultural Policy Research Institute
FSA	Farm Service Agency (a division of the United States Department of Agriculture)
FFV	Flex-Fuel Vehicle – vehicles designed to run on any blend of 85% or less ethanol with gasoline
FWP	Farmable Wetlands Program
FY	Fiscal Year
GHG	Greenhouse Gas Emissions
GIS	Geographic Information System
GRP	Grasslands Reserve Program
IATP	Institute for Agriculture and Trade Policy
LDV	Light Duty Vehicle
MTBE	Methyl-Tertiary-Butyl-Ether, an oxygenate fuel additive
NASS	National Agriculture Statistics Service
NBB	National Biodiesel Board
NFU	National Farmer's Union
NPV	Net Present Value
NRCS	National Resource Conservation Service
ORNL	Oak Ridge National Laboratory
PPR	Prairie Pothole Region
POLYSYS	Agricultural Policy Simulation Model
REX	Re-enrollment and Extension Initiative
RFA	Renewable Fuels Association
RFS	Renewable Fuel Standard
RFG	Reformulated Gasoline
SOC	Soil Organic Carbon
SOM	Soil Organic Matter
TRCP	Theodore Roosevelt Conservation Partnership
TRCG-AAWG	Theodore Roosevelt Conservation Partnership – Agriculture and Wildlife Working Group
USDA	United States Department of Agriculture
US-DOE	United States Department of Energy
US-EIA	United States Energy Information Administration (a division of the Department of Energy)
US-EPA	United States Environmental Protection Agency

US-NREL	United States National Renewable Energy Laboratory (a division of the Department of Energy)
VOC	Volatile Organic Compound
WHIP	Wildlife Habitat Incentive Program
WTO	World Trade Organization
WRP	Wetland Reserve Program