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A CALL TO FARMS: DIVERSIFY THE FUEL SUPPLY

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> *All the world is waiting for a substitute to gasoline. When that is gone, there will be no more gasoline, and long before that time, the price of gasoline will have risen to a point where it will be too expensive to burn as a motor fuel. The day is not far distant when, for every one of those barrels of gasoline, a barrel of alcohol must be substituted.*[1]

I. INTRODUCTION

Using corn as the primary ingredient for biofuels has several unintended consequences on the agricultural industry as a whole, and the resulting shortage of corn for food and livestock purposes has negatively influenced market prices for both. The regional nature of corn ethanol production also serves to logistically and seasonally restrict a reliable and robust nationwide ethanol industry. These facts necessitate a long-term plan to shift away from corn as the exclusive crop for ethanol and move toward a broader base of raw materials for not merely ethanol production, but bioenergy production in general. Technology is the key to making the biofuel industry work for America, and ownership of such technology will be a threshold issue. Indeed, the owners of pioneering technology will dictate the way in which bioenergy ultimately develops over the next decade.

The technological advancements required for biofuel diversification have three key components. First, there is the development or identification of new crops high in organic mass for energy production. Second, there is the creation of novel methods of processing crops and other biomass to efficiently refine an expansive array of biofuels including biodiesel and cellulosic ethanol. Third, there is the ability to reward plant researchers, process engineers, and chemists through the time-honored process of intellectual property protection, which could alleviate the high costs of pioneering research and plot a course toward the eventual reduction in large federal subsidies to the biofuel industry.[2]

This article will begin by identifying economic and ecologic problems of using corn as the primary feedstock in ethanol production and will argue that

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1. Ashok Goyal, Director, Ford Asia Pacific, Address at International Motor Show (Mar. 29, 2005) (quoting Henry Ford), http://www.theautochannel.com/news/2005/03/29/023736.html.

2. *See Making Energy, Making Money*, WIRED, Jan. 4, 2002, http://www.wired.com/science/discoveries/news/2002/01/49494.

diversity in bioenergy production is essential to reduce the adverse market consequences of relying upon corn as the primary biomass source. The article will next reveal that inventions of the past concern both the petroleum industry and corn ethanol industry. Therefore, a fundamental technology shift must occur if America is to move away from a dependence upon petroleum or upon corn as the dominant biofuel feedstock. The authors will then identify promising alternative biofuel sources such as cellulosic ethanol, currently under study, including the use of multiple-purpose crops that can be used to graze livestock, attract wildlife, and generate biofuel. The authors then provide an overview of the subsidies and tax incentives the government has used to encourage ethanol production as well as policies designed to encourage the growth of bioenergy at a local, regional, and national level.

Next, the article discusses the relevance of intellectual property to this complex industry, where public and private entities vie against one another to discover new ways for solving the United States petroleum and foreign oil dependence. Furthermore, because public funding is a primary component of biofuel technology, the authors clarify public misconceptions about whether patents should protect inventions that are the fruit of taxpayer funding. Thereafter, the authors compare between federal, state, and local involvement in supporting biofuel research and funding over the last decade. Finally, to illustrate creative ways to find local support for biofuel, the article will introduce the reader to a small company's effort to vertically integrate its soybean seed breeding operation by increasing the demand for its soybean genetics and lowering the cost of biodiesel for local farmers.

II. THE PROBLEM OF CORN AS THE EXCLUSIVE SOURCE FOR BIOFUEL

While corn traditionally served primarily as a food source and export product,[3] the trend over the past thirty years has been to take advantage of overproduction by devoting more and more corn to ethanol distillation.[4] As a result, corn is the dominant crop from which ethanol is produced in the United States.[5] Indeed, the existing infrastructure for farming and harvesting corn for human and animal consumption has made high-energy corn a suitable choice for alternative energy through use of ethanol distillation processes similar to those established for alcoholic beverages. The plans of using corn as a readily available alternative for fuel were well-intentioned and economically feasible during the early implementation of ethanol production. However, the recent spike in demand for corn as an ethanol source has fundamentally altered the food versus fuel equation. The 2005 amendments to the Clean Air Act set a target of

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3. Corn: Trade, ECON. RESEARCH SERV., U.S. DEP'T OF AGRIC. (July 20, 2006), http://www.ers.usda.gov/briefing/Corn/trade.htm.

4. HOSEIN SHAPOURI, JAMES A. DUFFIELD & MICHAEL WANG, U.S. DEP'T OF AGRIC., THE ENERGY BALANCE OF CORN ETHANOL: AN UPDATE 1 (2002), http://www.usda.gov/oce/reports/energy/aer-814.pdf.

5. *See id.*

7.5 billion gallons of renewable fuel by 2012.[6] If such policy goals are to be met using our present infrastructure, approximately twenty-nine percent of current domestic corn production would have to be used to meet 2012 ethanol production targets.[7] Moreover, President George W. Bush, in his 2007 State of the Union Address, set a national goal of producing thirty-five billion gallons of alternative fuels by 2017–nearly five times the currently mandated target.[8] By some estimates, however, this would require 108 percent of the current corn crop to be dedicated exclusively to fuel ethanol.[9] The unrealistic goals for ethanol production and the technological, political, and ecological consequences involved in using a primary food source for ethanol production suggest that better sources of biofuels are necessary. These sources, which are in high demand, are in some instances already available.

A. HISTORICAL USE OF CORN–FOOD, FEED, AND GOODWILL

Indigenous peoples in the Americas cultivated corn well before recorded history.[10] Explorers returning from the New World introduced corn to Europe as a staple commodity.[11] Since that time corn has grown into America's largest food crop.[12] For instance, the United States produced over eleven billion bushels of corn in 2005, which accounted for the majority of U.S. cereal production.[13] Since the 1930s, the United States has subsidized corn production in order to stabilize production and prices.[14] For many decades during the twentieth century, subsidies encouraged excess production that was justified as necessary for political reasons, such as "exporting our way to prosperity."[15] For example, the United States exported millions of bushels of corn to encourage trading with countries such as the former Soviet Union, Japan, South Korea, and Mexico.[16] Corn was also exported to developing countries for humanitarian

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6. 42 U.S.C. § 7545(o)(2)(B)(i) (2000).

7. These calculations are derived from figures discussed in Part II.C. *See infra* Part II.C.

8. President George W. Bush, State of the Union Address (Jan. 23, 2007), http://www.whitehouse.gov/news/releases/2007/01/20070123-2.html.

9. C. Ford Runge, a professor at the University of Minnesota, stated, "That means no corn for pigs, no corn for chickens, no corn for cattle and no corn for our corn flakes . . . . Plus, we would have to import 8 percent of our corn." Matt Bewley, *An Unreachable Target?*, AGWEEK, Dec. 10, 2007.

10. Mark B. Bush, Dolores R. Piperno & Paul A. Colinvaux, *A 6,000 Year History of Amazonian Maize Cultivation*, NATURE, July 1989, http://www.nature.com/nature/journal/v340/n6231/abs/340303a0.html.

11. Jules Janick & Giulia Caneva, The First Images of Maize in Europe 1 (unpublished manuscript, on file with the Purdue University Center for New Crops and Plant Products), *available at* http://www.hort.purdue.edu/newcrop/maize/images_of_maize.pdf.

12. NAT'L AGRIC. STATISTICS SERV., U.S. DEP'T OF AGRIC., CROP PRODUCTION: 2005 SUMMARY 77 (2006), http://usda.mannlib.cornell.edu/usda/nass/CropProdSu//2000s/2006/CropProdSu-01-12-2006.pdf.

13. *Id.*

14. HEATHER SCHOONOVER, INST. FOR AGRIC. & TRADE POL'Y, A FAIR FARM BILL FOR TAXPAYERS 1 (2007), http://www.iatp.org/iatp/publications.cfm?refid=100758.

15. *Id.* at 2.

16. *See* Corn: Trade, *supra* note 3.

reasons.[17]

Regardless of the end consumer, corn was traditionally used for food or animal feed. As such, the retail price of staple foodstuffs, including cereals, milk, and tortillas, is directly related to the seasonal availability of corn.[18] The relation between availability and price of corn also extends indirectly to feedstock for animals such as beef, poultry, and pork, as well as to processed food products that include corn-based sweeteners. The reliance upon high fructose corn syrup as a staple sweetener in the United States has sharply escalated since 1970, when the average person consumed less than half a pound of high fructose corn syrup in one year.[19] In contrast, the average personal consumption had increased to more than fifty-nine pounds annually by 2005.[20] The availability and price of corn is inextricably linked to our nation's multidimensional food supply.

B. NEW USE–CORN AS ETHANOL FUEL SUPPLY

Despite the historical fact that almost all corn was grown for consumption, corn ethanol has been used for centuries, albeit in a limited capacity. Two forces kept ethanol from becoming the dominant U.S. energy source in the early twentieth century. The first was economic: Large oil reserves were discovered in the United States, and gasoline production became cheaper than making ethanol according to inefficient, historical methods.[21] The second was political: Ethanol producers were lumped together with moonshiners during Prohibition. Prices for petroleum-based fuel remained low enough to keep ethanol production from being a viable energy source for much of the remainder of the twentieth century.

Over the last three decades, investment into alternative energy supplies has risen due to peaking petroleum production, political instability in oil-producing regions such as the Middle East, and environmental concerns over global warming caused by burning fossil fuels. It is unsurprising that ethanol is one of the most touted alternative energy sources due to its known production and use. However, the limited use of ethanol as a fuel source throughout the twentieth century means that the technology used in ethanol production is, for all intents and purposes, centuries old. To illustrate the dearth of research in the advancement of ethanol, only seventy-five U.S. patents were issued before 1970 for technologies dealing with ethanol.[22] In contrast, over the same period almost

17. *See USAID Provides Assistance to Food Insecure Populations in Southern Africa Region*, U.S. AGENCY FOR INT'L DEV. (Feb. 16, 2006), http://www.usaid.gov/press/releases/2006/pr060216_1.html.

18. David Rotman, *The Price of Biofuels*, MIT TECH. REV. (2008), *available at* http://www.technologyreview.com/read_article.aspx?id=19842&ch=energy&pg=1.

19. *High Fructose Corn Syrup: Estimated U.S. Per Capita Calories Consumed Daily*, CORN REF. ASS'N (May 18, 2006), http://www.corn.org/percaphfcs.htm.

20. *Id.*

21. NEB. SUSTAINABLE ENERGY ASS'N, FUEL FACT SHEETS: ETHANOL 73-74, http://www.nesea.org/greencarclub/factsheets_ethanol.pdf (last visited Mar. 30, 2008).

22. Free Patents Online Home Page, http://www.freepatentsonline.com (search "TTL/ethanol AND ISD/1/1/1700->12/31/1969") (last visited Mar. 31, 2008).

1,700 U.S. patents were issued relating to gasoline.[23] It was only in the 1970s, the decade that saw the OPEC oil embargo, that research and development in the ethanol field first resulted in the granting of a substantial number of U.S. patents.[24] It is clear that the development of ethanol technology in the United States has suffered due to reliance upon readily available, cheaper petroleum.

Corn is the dominant biomass used for ethanol production today due to the ease with which corn kernels–which have high glucose content–are fermented into ethanol.[25] In the ethanol production process, corn kernels are ground and heated to release glucose, and the glucose is metabolized by yeast in the absence of oxygen producing ethanol and carbon dioxide.[26] This is the same basic process that has been used to create alcoholic beverages for thousands of years.

The outdated corn ethanol production process currently in use has several downsides. Only the glucose-containing kernels may be used, while the stalk, cob, and leaves, which contain large amounts of cellulose and hemi-cellulose, are left as an unused byproduct.[27] Furthermore, there is a question as to whether ethanol is an efficient fuel, as it has been argued that ethanol provides less energy than is required to produce it.[28] Even proponents concede that ethanol produced from corn is far less efficient than ethanol produced from other biomass sources.[29] For example, studies reveal that one gallon of petroleum energy is required to produce 1.24 gallons of corn distilled ethanol.[30] The same study pointed out that the energy-related farm inputs for producing ethanol from corn are especially sensitive to the region where the corn is grown.[31] For example, corn raised in Nebraska had nearly double the energy input cost compared to other Midwestern states such as Minnesota, Iowa, and Ohio.[32] One should openly question the propriety of using corn for ethanol production in areas where the high cost of production drives the net energy value for corn ethanol into a negative position.

C. SUBSTANTIAL SUBSIDIES ON CORN PRODUCTION HAVE QUESTIONABLE VALUE IN THE CURRENT PETROLEUM MARKETPLACE

In addition to the inefficiencies that result from using an ancient ethanol production method, there are other economic, political, and environmental costs

23. *Id.* (search "TTL/gasoline AND ISD/1/1/1700->12/31/1969") (last visited Mar. 31, 2008).

24. *Id.* (search "TTL/ethanol AND ISD/ 1/1/1970->12/31/1979") (last visited Mar. 31, 2008).

25. L. Leon Geyer, Phillip Chong & Bill Hxue, *Ethanol, Biomass, Biofuels and Energy: A Profile and Overview*, 12 DRAKE J. AGRIC. L. 61, 69 (2007).

26. *Id.*

27. *Id.* at 74.

28. *See* David Pimentel, *Ethanol Fuels: Energy Balance, Economics, and Environmental Impacts Are Negative*, 12 NAT. RES. RESEARCH 127, 131 (2003), *available at* http://www.ethanol-gec.org/netenergy/neypimentel.pdf.

29. Geyer et al., *supra* note 25, at 71-72.

30. HOSEIN SHAPOURI, JAMES A. DUFFIELD & MICHAEL S. GRABOSKI, ESTIMATING THE NET ENERGY BALANCE OF CORN ETHANOL, U.S. DEP'T OF AGRIC. 12 (1995), http://www.ers.usda.gov/publications/aer721/aer721.pdf.

31. *Id.* at 8.

32. *Id.*

to the use of corn in ethanol production. Such costs are not typically borne by corn farmers or ethanol producers, and as such must be considered externalities in the ethanol production cycle. For decades, the U.S. government has offered substantial subsidies to corn farmers to assist in the development of stable markets and to preserve farming as a way of life. Between 1995 and 2005, the average yearly subsidy for corn was $4.66 billion[33] on an average of 71.3 million acres of corn,[34] which is around $65.40 per acre. The average yield of corn for the same period was 135.5 bushels/acre.[35] A bushel of corn can produce an estimated 2.7 gallons of ethanol.[36] Therefore, an average acre of corn is capable of producing 366 gallons of ethanol, and government programs that provide subsidies to corn farmers indirectly subsidize ethanol production at the rate of approximately $0.18 per gallon. Other federal programs provide subsidies (in the form of tax credits) directly to ethanol producers at up to $0.60 per gallon.[37] Therefore, each gallon of ethanol produced in the U.S. may have received an estimated $0.78 per gallon in total subsidies. While the wholesale price of pure ethanol in the U.S. averages $2.22 per gallon,[38] the total wholesale cost is really closer to $3.00 per gallon when indirect subsidies to farmers and producers are considered.[39] Confounding this calculation, however, is the fact that a gallon of ethanol contains only about 84,000 BTUs, meaning that a gallon of ethanol has less than two-thirds as much energy as a gallon of gasoline.[40] Accordingly, one could argue that the true energy output comparison of ethanol to the same quantity of gasoline brings the price of ethanol to about $4.00 per gallon.

This comparative pricing between gasoline and ethanol appears at first to argue in favor of our continued reliance on petroleum, that is, until you examine other countries' petroleum fuel costs. For example, if you were to compare the cost of ethanol against the current price of gasoline in New Zealand, at $8.58 per gallon,[41] it would make perfect sense to switch to ethanol. Of course, the price

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33. Env't Working Group, Farm Subsidy Database (2006), http://farm.ewg.org/sites/farm/progdetail.php?fips=00000&progcode=corn.

34. *See* NAT'L AGRIC. STATISTICS SERV., U.S. DEP'T OF AGRIC., DATA AND STATISTICS, *available at* http://www.nass.usda.gov/Data_and_Statistics/Quick_Stats/ (last visited Mar. 30, 2008). Averages taken from data returned by a query of USDA's National Agricultural Statistics Service for (1) Planted, Harvested, Yield, Production, Price (MYA), Value of Production, (2) Corn for Grain, (3) 1995 to 2005, and (4) United States. *Id.*

35. *Id.*

36. *See* Allen Baker & Steven Zahniser, *Ethanol Reshapes the Corn Market*, AMBER WAVES, Apr. 2006, http://www.ers.usda.gov/AmberWaves/April06/Features/Ethanol.htm.

37. 26 U.S.C. § 40 (2000).

38. *See* Rick Kment, DTN Ethanol Ctr., Ethanol Prices Rise as Supplies Remain Tight, http://www.dtnethanolcenter.com/index.cfm?show=10&mid=32 (last visited Feb. 27, 2008).

39. Coincidentally, the national average retail price of gasoline was $2.998 for the week ending December 17, 2007. *See* U.S. Energy Info. Admin., Gasoline and Fuel Update, http://tonto.eia.doe.gov/oog/info/gdu/gasdiesel.asp (last visited Mar. 30, 2008).

40. AGRICULTURAL-BASED RENEWABLE ENERGY PRODUCTION, CONG. RESEARCH SERV. 1 (2006), *available at* http://fpc.state.gov/documents/organization/68294.pdf.

41. The price of gasoline is calculated in New Zealand as per liter, and as of December 17, 2007, the price was NZ$1.75/L. This conversion of 3.78 L to gallons provides an equivalent NZ price of $6.62; however, the conversion of NZD to USD is NZ$1.2971, so the U.S. customer in New Zealand

of gasoline in New Zealand is higher than the United States due to land size restrictions, lack of substantial oil industry, and lack of arable land to devote to biofuels. The citizens in New Zealand are thus wholly dependent upon the good nature of other countries for the majority of their fuel supply. Fuel pricing is something New Zealand must accept without much debate.

The comparison of ethanol to petroleum does not stop at price. Some experts have opined that the volume of ethanol production in the United States has such a minute impact upon the petroleum industry that simply inflating passenger car tires properly would impact gasoline consumption more than ethanol through the year 2011.[42] For another perspective on volume and capacity in today's gasoline market, one can heed the words of David O'Reilly, CEO of ChevronTexaco: "One ethanol plant makes in a year what a typical refinery will produce in gasoline in two days."[43] Therefore, the market impact of ethanol on the current petroleum market is questionable given the dollar value of the substantial subsidies available to ethanol.

D. THE SOCIAL IMPLICATIONS OF THE FOOD VERSUS FUEL DEBATE

Generally speaking, federal government funding has been traditionally required for rapid advancements in technology. It is therefore unsurprising that federal dollars were needed to spur the ethanol fuel industry into action because the current profitability of corn ethanol without subsidies is questionable at best. As mentioned earlier, the U.S. currently exports a substantial amount of corn for both trade and political purposes. Several studies have analyzed the potential effects of ethanol production on world corn markets, with the common conclusion being that food prices will rise dramatically.[44] As one example, Mexico imports a large amount of U.S. corn, and tortilla prices have tripled or quadrupled since ethanol production recently began in earnest in the U.S.[45] Another example of fallout from the U.S. biofuel subsidies, due to the diversion of cooking oil from food use to biodiesel production, is the record price of palm oil in Panaji, India.[46]

Social implications of increased corn reliance may occur in the context of food supply contamination. More specifically, different types or varieties of corn are bred and developed for different needs and even for different

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would actually be paying US$8.58/gal.

42. Josh Flory, *Will Ethanol Help?*, COLUM. DAILY TRIB., June 4, 2006, *available at* http://archive.columbiatribune.com/2006/jun/20060604pers001.asp.

43. Interview by Tim Russert with David O'Reilly, CEO, ChevronTexaco, on *Meet the Press* (June 18, 2006), *available at* http://video.msn.com/?mkt=en-us&vid=f7ffab92-c64a-44a2-bb1b-edfd83131669&from=rss34.

44. Manuel Roig-Franzia, *Culinary and Cultural Staple in Crisis*, WASH. POST, Jan. 27, 2007, at A01, *available at* http://www.washingtonpost.com/wp-dyn/content/article/2007/01/26/AR2007012601896_pf.html.

45. *Id.*

46. *Palm Prices Seen Falling if U.S. Cuts Biofuel Subsidy*, REUTERS, Sept. 23, 2007, http://www.reuters.com/article/environmentNews/idUSDEL16831220070923.

geographic regions.[47] Instead of research and development dollars going toward improving the quality and abundance of the food supply, it is reasonable to forecast that more money will find its way into plant breeding programs with a singular goal of genetically modifying corn to efficiently produce ethanol. Since corn is a dual-use crop, there is risk of genetic contamination of the food supply with corn engineered for fuel purposes but not approved for food uses. These issues are real, especially to those involved in the StarLink contamination event of the 1990s.[48]

Other societal implications include adverse environmental and economic impacts due to the additional acreage devoted to corn production.[49] Adverse environmental impact derives from the fact that corn requires substantial chemical inputs derived from hydrocarbons [50] Additionally, as a row crop, corn causes more erosion and water pollution than native soil cover.[51] The adverse economic impact occurs because producers grow corn instead of other less profitable crops, leading to an increase in prices of these staple items such as the one that occurred recently in Mexico.[52] Moreover, with so many acres planted in corn, a catastrophic plant disease could bring back images of the potato famine in Ireland during the nineteenth century, which ravaged potato crops for eight years and starved to death nearly a quarter of the Irish population. Reliance upon corn alone for both food and fuel source could have devastating long term effects when, not if, disease and drought damage our nation's corn crops.

III. DIVERSIFICATION OF BIOMASS SOURCES

America must look to other crops and biomass for ethanol production to mitigate each of the criticisms levied at current corn-based U.S. ethanol production and policy.

A. REASONS FOR DIVERSIFICATION

Diversification is a concept borrowed from the world of finance. The purpose of diversification is to reduce risk while not necessarily reducing returns.[53] One of the primary arguments for shifting the U.S. energy supply away from foreign oil is energy security. President Bush acknowledged the need for the U.S. to control its own energy supply rather than relying upon the good nature of other nations for our fuel in each of his State of the Union Addresses

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47. *See* Pioneer Hi-Bred Int'l v. Holden Found. Seeds, 35 F.3d 1226 (8th Cir. 1994) (dealing with proprietary nature of corn traits for disease resistance).

48. *EPA Rejects StarLink for Humans*, WIRED, July 27, 2001, http://www.wired.com/medtech/health/news/2001/07/45636.

49. Julia Olmstead, *What About the Land?*, GRIST, Dec. 5, 2006, http://www.grist.org/news/maindish/2006/12/05/olmstead/index.html.

50. *Id.*

51. *Id.*

52. Roig-Franzia, *supra* note 44.

53. *See* Investopedia.com, Diversification, http://www.investopedia.com/terms/d/diversification.asp (last visited Mar. 31, 2008).

since 2002.[54] This movement away from foreign oil and toward a sustainable ethanol system constitutes the first type of diversification in our energy supply. In 2005, President Bush called for a comprehensive energy strategy that includes "renewable sources such as ethanol."[55] In this sense, biofuel has become a national security issue that has been used as a rally cry to rapidly build an ethanol infrastructure built almost solely upon corn.[56] While this may eliminate one type of security risk, it presents a host of other problems. For this reason, the second tier of diversification, not simply away from foreign petroleum imports but also away from corn as the sole crop in ethanol production, is necessary. This second tier of diversification will help minimize the fundamental ecologic and economic risks discussed above.

Corn is a high input crop. It requires large amounts of water and petroleum-based fertilizers.[57] With the increase in corn prices and subsidies, there is a continued westward trend of corn production into drier climates that may impact water availability. By stimulating domestic biofuel production based only upon corn, one must question whether corn-derived ethanol is truly a renewable fuel as the water being lost may be non-renewable.[58] Likewise, the heavy reliance upon hydrocarbon-based fertilizers means that corn cannot practically be considered a renewable fuel source.[59] For these ecologic reasons, diversification of biomass sources contemplates a truly renewable biofuel source.

Diversification away from corn as the exclusive feedstock for ethanol avoids the problems associated with monoculture corn production. The production of biofuel using native plant species already well adapted to a given region reduces the need for fertilizer and reduces reliance upon a single crop. The most commonly cited alternative biomass source for ethanol production is the widely adapted and climate tolerant switchgrass, which is native to most low moisture prairie land.[60] Using native species that vary from region to region lowers the risk that disease or drought affecting a single crop will destroy an entire year's production of biofuel. The use of native species also reduces the amount of inputs required to produce a crop because local plants are more readily adapted to local soils. Additionally, native species may require less disturbance of topsoil, thereby precipitating less erosion. Local production of raw materials also reduces transportation costs of both raw biomass material and *finished* biofuel products by allowing each geographic region to produce its own

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54. *See* President George W. Bush, State of the Union Address (Jan. 29, 2002), http://www.whitehouse.gov/news/releases/2002/01/print/20020129-11.html.

55. President George W. Bush, State of the Union Address (Feb. 2, 2005), http://www.whitehouse.gov/news/releases/2005/02/print/20050202-11.html.

56. *See* Senator Barack Obama, Remarks at the Governor's Ethanol Coalition: Energy Security Is National Security (Feb. 28, 2006), http://obama.senate.gov/speech/060228-energy_security.

57. *See Farms Waste Much of World's Water*, WIRED, Mar. 19, 2006, http://www.wired.com/techbiz/media/news/2006/03/70445. *See also* Olmstead, *supra* note 49.

58. *See* Olmstead, *supra* note 49.

59. *Id.*

60. John Gartner, *Biomass Adds to Ethanol Debate*, WIRED, June 2, 2005, http://www.wired.com/science/planetearth/news/2005/06/67691.

fuel locally. This is much more efficient than transporting corn-based ethanol from the Corn Belt to all corners of the United States.

Notably, use of non-food plants as biomass for fuel production avoids adverse effects on local and world food markets altogether. Native non-food plants could utilize land unsuitable for food crops, and non-food biofuel sources can be genetically modified for fuel production without the threat of food supply contamination.

B. POTENTIAL BIOFUEL SOURCES

Perhaps the most lauded new biofuel source is switchgrass, which President Bush mentioned in his State of the Union Address in 2006.[61] Switchgrass is native to the prairie regions of the U.S. and was a predominant ground cover in the Great Plains before it was replaced with row crops.[62] Switchgrass is so keenly adapted to the Great Plains that it requires very low water and fertilizer inputs yet it is capable of producing 150 percent more biomass per acre of ground than corn. Switchgrass is also a perennial plant, meaning that it will grow for several years once established rather than having to be replanted each year.[63] It has the added benefit of being a dual-purpose crop, as cattle can graze switchgrass prior to harvest as did buffalo at one time.

In order to produce ethanol from switchgrass, scientists must overcome large technological hurdles. Whereas distillation of ethanol from high-sugar corn is relatively inexpensive and straightforward, the cellulosic consistency of switchgrass requires additional steps in processing. Cellulose is a more structurally complex substrate, and biofuel production requires enzymatic processes to break down these complex molecules into smaller, more useful components. These additional steps represent the largest current obstacle to widespread adoption of widely diversified biomass sources. However, once the technological limitations are addressed, switchgrass could serve as a tremendous opportunity for cellulosic ethanol because it has widespread suitability.

The rapidly growing poplar trees that are adapted across a wide range of northern climes serve as another biomass source. The unparalleled advantage of using cellulosic ethanol, rather than corn ethanol, is that virtually any plant matter can serve as raw materials for biofuel. For example, use of wood chips and grass clippings opens the door to community recycling centers and localized production of cellulosic ethanol. In the future, identifying other potential biomass sources individualized to each region of the country is a critical component to diversification.

61. President George W. Bush, State of the Union Address (Jan. 31, 2006), http://www.whitehouse.gov/stateoftheunion/2006/print/index.html.

62. *See* Gartner, *supra* note 60.

63. MARK DOWNING ET AL., CTR. FOR AGRIC., FOOD & ENV'T, TUFTS UNIVERSITY, PERENNIAL GRASSES FOR ENERGY AND CONSERVATION: EVALUATING SOME ECOLOGICAL, AGRICULTURAL, AND ECONOMIC ISSUES 1 (1995) http://bioenergy.ornl.gov/papers/misc/grass95.html.

IV. TECHNOLOGICAL INNOVATION REQUIRED FOR CELLULOSIC ETHANOL AS COMPARED TO OTHER BIOFUELS

High sugar content plants such as corn, milo, and sugar cane are ideal for fermentation because these plant types are high in glucose content. Switchgrass, however, is low in sugar and high in the structural components cellulose and hemicellulose. These structural components contain hardly digestible structural polysaccharides, making them difficult to transform into simple sugars using current technology.[64]

Only ruminant animals, such as cattle, have specialized bacteria living in their digestive system which can digest cellulose into usable sugar components.[65] Bacteria living in a ruminant's digestive tract have unique enzymes that degrade cellulose polysaccharide chains, and those same enzymes can allow switchgrass to serve as a source of cellulosic ethanol.[66] Due to the vast number of polysaccharide combinations, the race is on to either find or create through genetic modification, suitable strains of bacteria or yeast that can ferment the varying lengths and structures of the polysaccharides to produce ethanol.[67]

Even though patent applications typically face a long delay before receiving approval from the Patent and Trademark Office, recently issued patents serve as a good barometer of advancements in the field of cellulosic ethanol production.[68] One inventor working alongside the Wisconsin Alumni Research Foundation believes the solution is to create genetically engineered yeast cultures using recombinant strains that encode for specific expression of xylose metabolism.[69] The problem the industry is trying to solve, he describes in his patent, is the use of microorganisms as "biocatalysists" to convert cellulosic feedstock to usable ethanol.[70] He claims that "efficient biomass conversion in large-scale industrial applications requires a microorganism that is able to tolerate high concentrations of sugar and ethanol, and which is able to ferment more than one sugar simultaneously."[71]

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64. Rotman, *supra* note 18.

65. *See* Enzyme Additives for Ruminant Feeds, U.S. Patent No. 5,720,971 (filed July 5, 1995) (issued Feb. 24, 1998).

66. Rotman, *supra* note 18.

67. *See* Xylose-Fermenting Recombinant Yeast Strains, U.S. Patent No. 7,226,735 (filed Jan. 21, 2003) (issued June 5, 2007). These polysaccharide combinations include D-xylose, L-arabinose, pentose, and various others. *Id.*

68. The average pendency of patent applications is over two years. *See* U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2003: MANAGEMENT DISCUSSION AND ANALYSIS (2004), http://www.uspto.gov/web/offices/com/annual/2003/040201_patentperform.html.

69. *See* '735 Patent.

70. *Id.*

71. *Id.* Claim No. 1 claims patent protection for: "A recombinant xylose-fermenting respiration deficient *Saccharomyces cerevisiae* yeast strain comprising heterologous polynucleotide sequences encoding xylose reductase, xylitol dehydrogenase, and D-xylulokinase." *Id.*

An alternative biofuel to cellulosic ethanol or corn-based ethanol is biodiesel, which is a combustible fuel similar to petroleum-derived diesel. However, it is made from traditional oil drawn from soybeans or collected from animal fats. Because soybean oil contains a variety of saturated, monounsaturated, and polyunsaturated fatty acids, there are many accepted uses of soybean oil including use as food oils, paints, plastics, fibers, detergents, cosmetics, and lubricants.[72] Once again, the availability and price of a crop is inextricably tied to our nation's multidimensional dependence upon household and industrial products. Therefore, the economic and environmental drawbacks familiar in a debate about corn as ethanol feedstock are likewise present in using soybeans to make biodiesel because soybeans are the world's leading source of vegetable oil and protein meal.[73] Soybean-derived biodiesel is not the entire answer but is a valuable component to this bioenergy problem.

Unlike cellulosic ethanol, one benefit of biodiesel is the simplicity of the technology to make it. The process of making biodiesel is relatively straightforward and may be done on a small scale or an industrial level. Biodiesel is comprised of varying purities of fatty acid alkyl esters and can be created from any number of vegetable oils or animal fats. Creating biodiesel involves the process of transesterification.[74] This process includes mixing the fats or drawn oils with an alcohol and a catalyst, usually sodium hydroxide, to prompt a chemical reaction that produces fatty acid methyl esters (biodiesel) and a glycerol byproduct.[75] Once the glycerol byproduct is removed, the resulting biodiesel may be purified to meet federal motor vehicle standards or it can be mixed with petroleum-derived diesel. The advantages of biodiesel over petroleum-derived diesel have been listed as: (1) burning cleaner than petroleum fuel; (2) having exceptional lubricating properties; (3) being biodegradable and nontoxic when used in its pure form; and (4) being friendly to marine environments such as wetlands, marshes, rivers, and oceans when used as a marine fuel.[76]

V. INTELLECTUAL PROPERTY PROTECTION

It is reasonable to believe that private companies that devote substantial resources toward improving the technology in biofuels should receive protection on inventions and discoveries. However, where there is substantial federal funding of both infrastructure and production of biofuels, the question becomes who owns this federally-funded intellectual property? It is arguable that the

72. IOWA SOYBEAN PROMOTION BD. AND AM. SOYBEAN ASS'N, ECONOMIC IMPLICATIONS OF MODIFIED SOYBEAN TRAITS SUMMARY REPORT 92S (1990).

73. *Id.*

74. Soybean Extension & Research Program, Iowa State Univ., Soybean Uses (Apr. 24, 2007), http://extension.agron.iastate.edu/soybean/uses_biodiesel.html.

75. *Id.*

76. *Id.* There are several Internet sources for home-based biodiesel kits for easily transforming used vegetable oil from local restaurants into biodiesel, and some websites even advertise home kits for producing biodiesel for less than 70 cents for each gallon. *See* Home BioDiesel, http://www.homebiodiesel.com (last visited Mar. 30, 2008).

citizens should own the technology since their tax dollars are being allocated to fund a solution to this energy problem. Likewise, a related question is whether public universities that develop biofuel technology subject to federal grants should receive royalties in addition to the grant money as the technology matures?

These questions, as well as our nation's stated goal of advancing technology in biofuel, necessitate some understanding of how researchers and investors will be able to recapture their investment in technology using the U.S. patent system. This system has already motivated tremendous advances in medicine, agriculture, computers, and many other industries.

A. PATENTS

The United States Constitution states that the purpose of federal patent law is to promote the progress of science.[77] Patents encourage innovation by protecting state-of-the-art innovations for twenty years.[78] The patent is, in effect, a grant of a limited private right of exclusion.[79] "The patent is a privilege. But it is a privilege which is conditioned by a public purpose. It results from invention and is limited to the invention which it defines."[80]

This privilege is a grant of a transferable right to the inventor "to exclude others from making, using, offering for sale, or selling the invention throughout the United States or importing the invention into the United States . . . ."[81] In exchange for this right of exclusion, an inventor is required to fully disclose all material elements to her patentable invention. When the patent expires, anyone is able to take advantage of and build on the technology encompassed in the patent.[82] Patent law is founded upon the public policy of encouraging self-motivated entrepreneurial investment into the advancement of useful sciences.

Patents may be granted on a vast array of subject matters, including protection for inventions in the biological sciences. For example, soybean, wheat, and corn cultivars that are the product of conventional breeding as well as those that have been genetically modified can be protected. Patent protection may also be extended to novel biofuel production methods, processes, and machinery useful in the biofuel production systems. Therefore, patents will control ownership of the oncoming flood of technology in this field, and both inventors and investors should understand the rules of the patent process.

Private ownership of pioneering technology is not a new concept to agriculture, as patents have revolutionized the farming industry at virtually every

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77. U.S. CONST. art. 1, § 8, cl. 8.

78. 35 U.S.C. §§ 101, 154 (2000).

79. Graham v. John Deere Co., 383 U.S. 1, 9 (1966).

80. Blonder-Tongue Lab. Inc. v. Univ. of Ill. Found., 402 U.S. 313, 344 (1971) (quoting Mercoid v. Mid-Continent Inv. Co., 320 U.S. 661, 666 (1944)).

81. 35 U.S.C. § 154 (2000).

82. The procedures of the Patent Office ensure that a patent may not be maintained as a trade secret upon expiration, since all applications (save those with nuclear or national security implications) are published 18 months after the filing date. 35 U.S.C. § 122 (2000).

level in the agricultural supply chain. Farming implements were the subject matter of the very first patents granted by the United States Patent Office. Today patented seeds and traits allow farmers to use less erosive farming techniques. Patented crop protection chemicals such as insecticides allow higher crop yields while at the same time giving a return on investment for private agribusiness owners. While private companies and individuals have long recognized the benefit of using patent rights to recapture investments in science, today many more people are recognizing the income stream potential of royalty payments.

In addition to traditional corporate and individual inventors, public and private universities and other publicly-funded institutions are now added to the list of patent owners. Many public institutions apply for patents on inventions and license their intellectual property to private companies for a royalty. This is a way to both recognize the academic achievement of their professors and fund additional research. This publicly-funded patent presence has altered the face of university-developed intellectual property by making ownership of intellectual property the threshold issue for any collaboration.

Under our current patent system, innovators are rewarded for their research which they can then profit from in one of several ways: (1) utilizing the innovation to the exclusion of competitors; (2) selling the patent; or (3) licensing the patent. The rapid technological advancement in the field of semiconductors over the past thirty years illustrates the effectiveness of the U.S. patent system. In fact, most technological innovations in this country are prompted, or at least strongly encouraged, by the opportunity to ultimately obtain a patent. Venture capitalists demand intellectual property protection.

The intersection where public funding and private interests arguably collide occurs in situations involving public institutions receiving patents for inventions funded by the federal government.[83] While the federal government grants exclusionary rights to entrepreneurs for their sweat equity and ingenuity, both public and private universities comprise one of the largest blocks of patent holders in the United States due to substantial federal and state funding. Proponents of patenting university-developed technology suggest it is a way to offset the need for additional public funding or to recapture a return on the taxpayers' investment. Private equity companies investing their own capital argue that universities gain an unfair advantage by utilizing federal funds without any requirement to repay the investment required to advance technology. The patent laws have no clear "research exemption." Therefore anyone who makes or uses patented biofuel technology, such as novel enzymes, bacteria, or production methods, in order to advance the industry may be liable for patent infringement.[84]

Thus, to address the situation where an inventor uses federal funding to

83. A search for the term "University" as the assignee of a U.S. Patent in the U.S. Patent Collection database revealed 49,849 records. *See* USPTO Patent Full-Text and Image Database, http://patft.uspto.gov/netahtml/PTO/search-bool.html (last visited Mar. 30, 2008).

84. *See* Xylose-Fermenting Recombinant Yeast Strains, U.S. Patent No. 7,226,735 (filed Jan. 21, 2003) (issued June 5, 2007). *See also* 35 U.S.C. § 271 (2000).

secure a patent and then refuses to license the technology, the federal government has a policy of retaining certain rights in inventions made with federal assistance:

> It is the policy and objective of the Congress to use the patent system to promote the utilization of inventions arising from federally supported research or development; to encourage maximum participation of small business firms in federally supported research and development efforts; to promote collaboration between commercial concerns and nonprofit organizations, including universities; to ensure that inventions made by nonprofit organizations and small business firms are used in a manner to promote free competition and enterprise without unduly encumbering future research and discovery; to promote the commercialization and public availability of inventions made in the United States by United States industry and labor; to ensure that the Government obtains sufficient rights in federally supported inventions to meet the needs of the Government and protect the public against nonuse or unreasonable use of inventions; and to minimize the costs of administering policies in this area.[85]

The Bayh-Dole Act[86] granted universities and small business firms the right to apply for patents on innovations developed with federal assistance, but the Act retained government rights in the intellectual property.[87] Under this Act, federal agencies may utilize the intellectual property free of charge and have "march-in rights" for situations in which an inventor receiving federal funds makes less than full use of an invention.[88] The federal agency can also require the inventor to license the invention to a responsible, non-government applicant upon reasonable terms if necessary to promote the invention's utilization by the public.[89] It is uncertain whether this Act will have any measurable impact on the development of biofuels in the future. One reason for this uncertainty is that the authors expect only private companies will produce biofuel on a large scale.

At the very least, however, the authors believe that the provisions of this Act, if aggressively pursued, give a pathway around the obstinate inventor who received substantial funding for core research but now refuses to license the invention. In other words, patents relating to biofuels in which the federal government has an interest could be cross-licensed for research and development purposes under a liberal interpretation of the Bayh-Dole Act. In order to maintain an adequate incentive level for publicly-funded inventors, however, the research licenses would have to provide for an appropriate balance between remuneration to original inventors and government licensees for commercial uses of incremental improvements based on licensed patented technology.

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85. 35 U.S.C. § 200 (2000).

86. Bayh-Dole Act of 1980, Pub. L. No. 96-517, 94 Stat. 3015 (codified as amended at 35 U.S.C. §§ 200-12 (2000)).

87. 35 U.S.C. § 202 (2000).

88. 35 U.S.C. §§ 202-03 (2000).

89. 35 U.S.C. § 209 (2000).

B. PLANT VARIETY PROTECTION ACT

Noting the absence of patent-type incentives for the production of sexually reproduced plants more than thirty years ago, Congress passed the Plant Variety Protection Act (PVPA) in 1970.[90] The PVPA was intended to "provide developers of novel plant varieties with 'adequate encouragement for research, and for marketing when appropriate, to yield for the public the benefits of new varieties[.]'"[91] Like patents, the PVPA can serve as an incentive to spur investment into new varieties of robust yielding crops, but only in a narrower sense. This is because rights under the PVPA can only affect one stage of biofuel production, the planting and harvesting of a biofuel crop. Historically, state-funded institutions of higher learning relied upon substantial federal and state investment into crop specific variety research. As priority for state and federal funding for new varieties disappears, these university systems are fast recognizing the importance of securing and enforcing PVPA rights to create a royalty income stream to fund future research efforts. While the university systems offered their crop varieties royalty free in the past, they now find themselves competing for market share with private labels whose development budgets are repaid from a steady royalty stream. State-funded universities such as Texas A&M are now licensing their varieties to private companies for a royalty.[92]

The market trends for PVPA protected varieties is decidedly in favor of procuring and enforcing intellectual property rights irrespective of the funding source. This is no different than a corporation's goal of providing a return on the stockholder's monetary investment. However, the stockholders in the publicly funded scenario are the respective state legislatures and federal agencies responsible for the underlying grants for the technology.

VI. COMPARATIVE GOVERNMENT INVOLVEMENT FOR BIOFUELS

A. FEDERAL LEVEL

1. The agricultural policy of the U.S. government encourages production of corn but fails to stimulate innovation.

Our nation's first farm bill, the Agricultural Adjustment Act of 1933, was passed as part of the New Deal and established a mix of commodity-specific price supports and supply controls.[93] Its purpose was to keep America's distressed farmers from falling deeper into insolvency. As an example of the government's focus on providing financial assistance to farmers, its new role

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90. Asgrow Seed Co. v. Winterboer, 513 U.S. 179, 181 (1995).

91. *Id. See also* 7 U.S.C. §§ 2321-2582 (2000).

92. Tex. Found. Seed Serv., Variety Release Procedures: Standard Procedure Management and Release of New Plant Materials (Nov. 6, 2003), http://tfss.tamu.edu/fshandbook.htm.

93. CAROLYN DIMITRI ET AL., U.S. DEP'T OF AGRIC., 20TH CENTURY TRANSFORMATION OF U.S. AGRICULTURE AND FARM POLICY 1 (2005), http://www.ers.usda.gov/publications/eib3/eib3.pdf.

under the 1933 Act included paying farmers for idling land when necessary to control production of certain crops and avoid surpluses that might weaken market prices.

Beginning in 1996, the Federal Agriculture Improvement and Reform Act replaced the long-standing price support and supply control program with a program of direct payments based on historical production.[94] The 1996 program introduced nearly complete planting flexibility and is credited with reducing the economic inefficiencies of resource misallocation and price distortions associated with the prior farm programs.[95] Today, government commodity programs remain focused on income support for farmers,[96] although farmers receive direct payments without regard to the type of crop, the amount of production, or the price of the crop.[97] While such direct payments may serve the legitimate political purpose of stabilizing a fluid agricultural market, they offer no incentive for innovation.

Likewise, the federal government's current energy program for encouraging biofuel research and development is focused on providing cash subsidies directly to corn growers. In form, most federal statutes do not favor corn specifically, but in practice, corn is the almost-exclusive crop receiving government incentives under bioenergy legislation. For instance, in 2004 under the Bioenergy Program, a program funded in the 2002 Farm Act, ninety-six percent of ethanol program payments went to corn-based ethanol producers.[98]

While these bioenergy program payments may be effective in stimulating the production of raw corn product, they do little to encourage innovation in alternative fuel sources or processing methods. Additionally, the narrow focus of farm subsidies on certain crops discourages crop diversification. To take advantage of the financial incentives for ethanol production, many farmers who historically grew a range of crops have begun growing corn exclusively.[99] This convergence of agricultural resources into a single crop is dangerous to our food and energy supplies, yet governmental spending to date has produced this monoculture.[100]

94. *Id.*

95. *Id.*

96. *Id.*

97. Econ. Research Serv., U.S. Dep't of Agric., ERS Analysis: Direct Payments (July 23, 2002), http://www.ers.usda.gov/Features/Farmbill/analysis/directpayments2002act.htm.

98. LINWOOD HOFFMAN, ET AL., ECON. RESEARCH SERV., U.S. DEP'T OF AGRIC., FEED GRAINS BACKGROUNDER 1 (2007), http://www.ers.usda.gov/Publications/FDS/2007/03Mar/FDS07C01/fds07c01.pdf.

99. For example, a recent Washington Post article describes Iowa farmer Jim Handsaker's abandonment of soybean production to take advantage of ethanol subsidies. According to Handsaker, "[n]ow we're 100 percent corn." Dan Morgan, *Corn Farms Prosper, but Subsidies Still Flow*, WASH. POST, Sept. 28, 2007, at A01, *available at* http://www.washingtonpost.com/wp-dyn/content/article/2007/09/27/AR2007092702054.html.

100. *See supra* Part II.D.

2. Now that agriculture is subsidized for fuel in addition to food, a new agricultural energy policy is required.

Recent changes to U.S. energy policy have drawn it together with agricultural policy and necessitate a strong relationship between the two respective executive departments.[101] Both the new Energy Bill and new Farm Bill require the Secretaries of Agriculture and Energy to cooperate and coordinate policies and procedures that promote research and development leading to the production of biobased fuels and industrial products.[102] Because the future of our energy program appears linked to the introduction of agricultural based feedstocks, it makes sense for the Department of Agriculture to be invited to the energy policy table. However, it is important that, in the process of bringing agriculture into the energy discussion, the farm sector's historic policy objectives do not become entangled with modern energy objectives. When it comes to overhauling our nation's energy structure, it is imperative that our energy policy be based on promoting innovation rather than shackled to the other objectives.

Nearly eight years ago, the government acknowledged the need for biomass diversification away from corn with the passage of the Biomass Research and Development Act of 2000 and President Clinton's issuance of Executive Order No. 13,134, wherein Congress and the President approved funding for research and development in the production of cellulosic ethanol from non-food biomass.[103] In February 2007, the Department of Energy announced a grant of $375 million to six biorefinery projects across the country.[104] All six proposed plants would use non-food based biomass. In a related announcement, the Department of Energy stated, "Corn-based ethanol is already playing a key part in reducing our dependence on fossil fuels, and mitigating the growth of greenhouse gasses but we cannot increase our use of corn grain indefinitely."[105]

The 2007 Energy Bill, signed into law by President Bush on December 19, 2007, goes several steps further by mandating thirty-six billion gallons of renewable fuel production by 2022 with sixteen billion gallons coming from cellulosic ethanol.[106] The bill includes: $500 million for years 2008-2015 allocated to a grant program to encourage the production of advanced biofuels;[107] $25 million each year of 2008-2010 allocated to grants for research,

101. Perhaps the most prominent illustration of this merger is the inclusion of "Energy" in the new Farm Bill's title.

102. *See* Food and Energy Security Act of 2007, S. 2302, 110th Cong. §§ 9002-03, 9005, 9007-08, 9014, 9017, 9019, 9021 (2007); Energy Independence and Security Act of 2007, H.R. 6, 110th Cong. §§ 202-04, 229 (2007).

103. Biomass Research and Development Act of 2000, Pub. L. No. 106-224, 114 Stat. 358 (codified at 7 U.S.C. §§ 8601-8609 (2007)); Exec. Order No. 13,134, 64 Fed. Reg. 21,392 (Aug. 16, 1999).

104. Press Release, U.S. Dep't of Energy, DOE Selects Six Cellulosic Ethanol Plants for Up to $385 Million in Federal Funding (Feb. 28, 2007), http://www.energy.gov/news/4827.htm.

105. Press Release, U.S. Dep't of Energy, Biorefinery Grant Announcement (Feb. 28, 2007), http://www.energy.gov/news/4828.htm.

106. The Energy Independence and Security Act of 2007, H.R. 6, 110th Cong. § 202 (2007).

107. The energy bill defines "advanced biofuels" as "renewable fuel, *other than ethanol derived*

development, demonstration, and commercial application of biofuel production technology in states with low rates of ethanol production;[108] the establishment of a program for research, development, demonstration, and commercial application on technologies and processes to retrofit biorefineries to accept a range of biomass, including lignocellulosic feedstocks;[109] $50 million in grants in 2008 to institutions of higher education for research and development into cellulosic ethanol and biofuels;[110] and continuation of funding originally provided by the Energy Policy Act of 2005 for research and development in renewable energy, including the addition of $963 million for fiscal year 2010.[111]

During the week prior to the enactment of the 2007 Energy Bill, the Senate passed the 2007 Farm Bill which included its own set of legislation relating to biofuel technology.[112] The House of Representatives, which passed its own version of the Farm Bill in July 2007, must still come to a compromise with the Senate on a bill that will be acceptable to the President. However, the Senate bill is expected to eventually be enacted without wholesale revision.

The proposed Farm Bill greatly expands farm legislation's role in energy policy compared to the prior 2002 Farm Bill. This is evidenced in part by the number of sections in Title IX of the Farm Bill, the title devoted to energy legislation, which has doubled from only ten sections in 2002 to over twenty sections in the 2007 bill. Title IX of the Senate Farm Bill makes several noteworthy amendments to the 2002 Farm Bill relating to biofuel. The new bill places added emphasis on developing "coproducts" in the production of biofuels as well as enzymes capable of degrading cellulosic biomass.[113] The bill includes allocations of $110 million for cellulosic biofuel research for each of fiscal years 2008-2012.[114] There is an additional $110 million allocated for development of smaller scale biorefineries and biofuel plants for each of fiscal years 2008-2012.[115]

A stated objective of the Biomass Research and Development Initiative, originally authorized in section 9008 of the 2002 Farm Bill, is development of "a diversity of sustainable domestic sources of biomass for conversion to biobased fuels and biobased products."[116] However, in application, the focus has been on finding a single, miracle source of biomass. It is a popular belief today that this source is corn. In spite of the federal government's realization of the need for diverse biomass sources in the production of ethanol, starch from corn still accounts for an overwhelming ninety-eight percent of U.S. ethanol

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from cornstarch . . . ." *Id.* at § 201 (emphasis added).

108. *Id.* at § 223.

109. *Id.* at § 224.

110. *Id.* at § 230.

111. *Id.* at § 231. The Energy Policy Act of 2005 already provided funding of $632 million in 2007, $743 million in 2008, and $852 million in 2009, which remains unchanged.

112. Food and Energy Security Act of 2007, S. 2302, 110th Cong. (2007).

113. *Id.* at § 9008.

114. *Id.* at § 9021.

115. *Id.*

116. 7 U.S.C. § 8606(b)(3) (2000).

production.[117]

B. STATE LEVEL

California is well-known for leading the nation in environmental consciousness and restrictions on fuel emissions for automobiles.[118] The area of biofuel appears to be an exception. Nearly ten years ago, the California Energy Commission (CEC) chided the current federal and state incentives because they do not "appear to provide any significant inducement, financial or otherwise, for commercializing biomass-to-ethanol production technology."[119] While California has been considering how to incentivize cellulosic ethanol production since at least 1999,[120] there has been little tangible evidence that California is marching in line with a 2001 CEC issued report which had the following recommendations:

> Because technologies for ethanol production from cellulose have not been commercially proven, the state should co-fund activities to advance this technology towards market readiness on an accelerated schedule. The state should provide technical and financial support for one or more biomass-to-ethanol production projects to verify technical and economic performance of commercial scale demonstration facilities.
>
> The cost and availability of cellulose feedstocks in California for ethanol production remains problematic. The state should fund activities to enhance the availability and quality of cellulose resources for ethanol production.
>
> The form and duration of state financial support for emerging biomass-to-ethanol markets is crucial to the development of an industry capable of competing with conventional ethanol production. The legislature should direct an appropriate state agency to develop and implement a market incentives program to increase the certainty of markets for California produced ethanol.
>
> . . .
>
> Facilitate the communication among stakeholders on harvesting of forest materials for ethanol feedstock.
>
> Develop appropriate revisions to state laws affecting use of agricultural and municipal waste and residues for ethanol feedstocks.

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117. HOFFMAN, *supra* note 98.

118. *California Legislation to Establish a Biodiesel/CO2 Label Moves One Step Closer to Becoming Law*, BUSINESS WIRE, Apr. 28, 2004, http://findarticles.com/p/articles/mi_m0EIN/is_2004_April_28/ai_n6002309.

119. CA. ENERGY COMM'N, ETHANOL FULE INCENTIVES APPLIED IN THE U.S.: REVIEWED FROM CALIFORNIA'S PERSPECTIVE 1 (2004), http://www.energy.ca.gov/reports/2004-02-03_600-04-001.PDF.

120. Cal. Exec. Order No. D-5-99 (Mar. 25, 1999).

Provide siting, permitting and environmental impact assessment assistance to prospective biomass ethanol projects.[121]

Again, little appears to have been done to implement any such incentive program for cellulosic biofuels.[122]

California's track record on biodiesel is somewhat better, as last year the California Senate passed a bill with biodiesel adoption targets of five percent of all diesel by 2010.[123] In 2007, the California Department of Transportation conducted a study on the feasibility of using biodiesel blends in the state's fleets, but no transition has occurred to date.[124] This may be because California is a large state with widely-varying geography and climates.[125] Therefore, any statewide cellulosic ethanol policy must consider a large number of variables.[126]

Biofuel production from diverse cellulosic sources will inherently rely upon local and regional biomass sources, so states will be better able to respond to the individual needs presented by each state's unique fuel requirements and biomass availability. As demonstrated by California's articulated goals, states can and should take the lead on important environmental and energy-related issues because the federal government may be slower to adopt changes in such areas due to diverse political viewpoints across the country.[127]

C. Local Level

As discussed above, the consequences associated with the use of a single crop to feed the nation's appetite for biofuel include problems relating to transportation of raw and finished materials and the suitability of corn in localized climates. These problems can be partially solved on a local level by integrating biofuel production into traditional recycling practices.[128]

For example, the authors' hometown already has a robust recycling program and is transitioning to the use of biodiesel for the city's truck fleet.[129] It

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121. CAL. ENERGY COMM'N STATE REPORT, COSTS AND BENEFITS OF A BIOMASS-TO-ETHANOL PRODUCTION INDUSTRY IN CALIFORNIA XII-XIII (2001), http://www.energy.ca.gov/reports/2001-04-03_500-01-002+002A.PDF.

122. ROSA MARIA MOLLER, CAL. RESEARCH BUREAU, BRIEF ON BIOMASS AND CELLULOSIC ETHANOL 27-30 (2005), http://www.library.ca.gov/crb/05/10/05-010.pdf. A December 20, 2007, search for the term "cellulosic" within the California Code revealed no results.

123. *California Biodiesel Mandate Passes Senate*, BIODIESEL, July 2006, http://biodieselmagazine.com/article.jsp?article_id=967.

124. Susanne Retka Schill, *CalTrans Conducts B20 Pilot Project*, BIODIESEL, Aug. 2007, http://biodieselmagazine.com/article.jsp?article_id=1729&q=california&category_id=16.

125. COSTS AND BENEFITS OF A BIOMASS-TO-ETHANOL PRODUCTION INDUSTRY IN CALIFORNIA, *supra* note 121.

126. *Id.*

127. *See* Margot Roosevelt, *Air Board Sets Path to Reduce Emissions*, L.A. TIMES, Dec. 7, 2007, at 1, *available at* 2007 WLNR 24158077.

128. This local solution also includes saving money on fuel transportation costs by spreading more plants among different locations.

129. Marsha L. Melnichak, *City Fleet Prepares for Transfer to Cleaner Fuel*, NORTHWEST ARK. TIMES, Jan. 29, 2007, *available at* http://www.nwarktimes.com/story.php?paper=nwat&section=News&storyid=49586.

is easy to imagine an agreement between a local biofuel producer and the city whereby the city or private company supplies grass clippings or other sources of biomass for cellulosic ethanol. Local restaurants could provide waste vegetable oil for use in localized biodiesel facilities. Biomass sources need not be shipped from the Middle East to be refined into fuel and then hauled inland and across the country to various fueling depots. Therefore, bioenergy provides for flexible solutions for localities willing to entertain them.

VII. LOCAL LEVEL CASE STUDY

Government intervention at any level is helpful, but as hydrocarbon fuel becomes increasingly costly, the adoption of bioenergy will ultimately rely on market forces. One company in rural Arkansas recognized that the substantial cost of transporting petroleum-based diesel to its destination was cutting into its bottom line. The company is Hornbeck Seed Company (Hornbeck) in DeWitt, Arkansas, the heart of the Delta where soybeans are plentiful. However, DeWitt is landlocked with no main travel routes for fuel transportation.[130]

The purpose of the Hornbeck business model is to give local farmers a reason to both market their soybean crop and buy their biodiesel, locally. To make its vertically-integrated corporate plan work, the company begins by developing and marketing its own soybean varieties.[131] Hornbeck generates additional revenue by offering crop monitoring and farm management services. It then buys the harvested soybeans from its clients to crush and turn into biodiesel that will only be sold locally.[132] The federal and state tax incentives and subsidies for the creation of biodiesel and related facilities, as well as the expected cost savings from eliminating transportation of the fuel, may give this vertically-integrated business model a chance to be competitive with petroleum-based diesel at current pricing levels.[133]

The owners of the company describe the benefit to the local community as allowing local farmers to make more money on their crops while saving input costs by purchasing the B100 (pure biodiesel) from Hornbeck at a discounted price. The company is in the process of experimenting with canola as a potential biodiesel crop because canola's oil content is described as double that of soybeans and Hornbeck "sees [canola] as a good supplement to soybeans to supply the plant."[134] Local solutions like Hornbeck demonstrate early signs of private parties working to solve a national problem.

VIII. CONCLUSION

Bioenergy has been plagued for over a century by fits and starts because

130. Susanne Retka Schill, *From the Ground Up*, BIODIESEL, Sept. 2007, http://biodieselmagazine.com/article.jsp?article_id=1800&q=&page=all.

131. *Id.*

132. *Id.*

133. *Id.*

134. *Id.*

petroleum is affordable. Our nation's infrastructure is not yet ready for bioenergy. Nevertheless, important to bioenergy's success is the realization that a monoculture ethanol industry based on corn can only serve as a mere stepping stone to the next-generation biofuel technologies that regard soil conservation, water conservation, and long term sustainability as solutions, not obstacles.

All levels of government, and private parties alike, can contribute to the creative advancement toward newer, more efficient bioenergy production methods. All participants should invest with a full understanding of the federal patent system, which is the same system from which virtually all of our agricultural, automotive, industrial, communications, and computer revolutions were born. The biofuel industry offers an exciting opportunity for innovation and agriculture to once again join and draft one of the most important chapters in America's history.