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Biofuels: Political/Economic Boondoggle* or Energy Salvation for Western States?

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Editor's Introduction. *This paper is updated from the Keynote Address delivered by Professor Young at the Annual Meetings of the Western Agricultural Economics Association held in Kauai, Hawaii, June 24–26, 2009. Professor Young was honored at the meetings for his many contributions throughout his career by the pre-conference, "Microeconomics in Service of Humanity: A Symposium in Honor of Doug Young's Career." Professor Young's influence during his active career was evident in the papers presented by former colleagues and graduate students at the Symposium. Dr. Young served as President of the Western Agricultural Economics Association during 1993–94, and was editor of the Western Journal of Agricultural Economics from 1989 to 1991.*

Nearly all western states lack comparative advantages for producing corn for ethanol and oilseeds for biodiesel. Despite this disadvantage, most western states have legislated incentives for production of biofuels. Unfavorable changes in price relationships, high transportation costs for imported feedstocks, and tight credit markets in 2008 and 2009 led to bankruptcies and plant closures at a disproportionate rate in the western biofuel industry. Policy makers in western states are advised to fund research and development for bioenergy and biofuel feedstocks in which they have a comparative advantage. These include forestry by-products, food processing and crop residues, and livestock wastes.

Key words: biodiesel, bioenergy research, biofuels, biofuel bankruptcies, biofuel feedstocks, biofuel incentives, corn ethanol, western United States

Introduction

Despite the fact that little corn for ethanol or soybeans and canola for biodiesel is produced in the western United States, all but Alaska, Nevada, and Wyoming of the 16 western states have enacted significant incentives for in-state production of these biofuels (U.S. Department of Energy, 2009a).[1] The emphasis on *in-state* feedstocks ignores the fact that all American states comprise an open national economy and a partially open economy with the rest of the world.

These realities notwithstanding, promoting greater self-sufficiency in biofuels possesses great political appeal. For example, the governor of my own state of Washington, the Honorable Christine Gregoire, proclaimed in March 2006, "Today we move away from our dependence on foreign oil . . . .Washington must compete in global markets. The quality of our

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Note: Taylor and Van Doren (2007) are acknowledged for first using the term "boondoggle" with respect to biofuels promotion.

[1]Although the Western Agricultural Economics Association includes 19 states west of the Dakotas to the Texas line, the states of South Dakota, Nebraska, and Kansas are among the top 10 corn states in the nation and are placed in the Corn Belt for purposes of this study.

products is second to none.... This bill [encouraging biofuels] won't just help individual farmers. It will help rural communities" (Gregoire, 2006). Other politicians and business leaders have offered similar appeals. Biofuel support was genuinely nonpartisan. Only a handful of frequently ignored economists and scientists raised early cautions (Crutzen et al., 2007; de Gorter and Just, 2007; Klein and LeRoy, 2007; Taylor and Van Doren, 2007). Later, as the biofuels industry began encountering difficulty, journalists and others piled on criticism (e.g., Grunwald, 2009).

My objectives in this paper are to (*a*) review the unpromising comparative advantage of western states for crop biofuel feedstocks; (*b*) provide a brief overview of western states' cellulosic feedstocks which might become an affordable source of biofuels with further technological development; (*c*) describe selected federal and state legislative incentives for biofuels; (*d*) describe the rise and decline of the ethanol and biodiesel industries in western states over 2006–2009, and provide an evaluation of primary economic causes of the decline; (*e*) suggest a more comprehensive set of energy policies which may have been by-passed by the narrow focus on biofuels; and (*f*) offer recommendations for future economic and scientific research to provide a sound basis for future biofuels and energy policy in western states. The organization of the paper will follow the sequence of the preceding objectives.

The paper purposefully avoids popular topics which have been covered at length by others. These topics include optimal biofuels policy design to maximize social welfare (de Gorter and Just, 2007, 2009a, b), the projected multi-market impacts of alternative biofuel policies [Food and Agricultural Policy Research Institute (FAPRI), 2009], the debate on the energy efficiency of different fuels (Pimental and Patzek, 2005; Shapouri, Duffield, and Wang, 2002), the greenhouse gas contribution of different fuels considering full life cycle effects (Searchinger et al., 2008), and the impact of biofuels policies on world food prices (Grunwald, 2009; Klapper, 2008; Meyers and Meyer, 2008).

Crop Feedstocks

It is useful to provide an overview of world and North American production of the primary crop feedstocks for ethanol and biodiesel. Table 1 shows that the U.S. and Brazil dominate production of the primary ethanol feedstocks, corn and sugar cane, respectively. Other large corn and/or sugar cane producers, notably China and India, consume these crops as feed or food, leaving less available for biofuels. The U.S. is a major producer of sugar beets which are processed into food sugar. The U.S. uses little or no sugar beets for ethanol, but France does (Yoder et al., 2009). The U.S. is the world's leading producer of soybeans, and soy oil is the largest biodiesel feedstock in the country. There are several limitations of soy oil as a biodiesel feedstock. Soybeans yield about half the amount of oil as canola and other oilseeds, though this is partially offset by higher yields. More importantly, food uses of soybeans compete strongly with biofuel production. Soybean acreage and prices fluctuate considerably in world markets as soybean competitiveness with grains varies. As shown in table 1, Indonesia and Malaysia dominate in world production of palm oil. Use of palm oil for biodiesel has met criticism due to clearing of rain forests in response to increased demand. Also, biodiesel from palm oil provides a lower quality motor fuel. Producing countries have also attempted to protect their palm oil for domestic cooking oil or for their own biodiesel refining industries.

Table 2 shows that the U.S. dominates in North American corn and soybean production, while Canada dominates in oilseeds. Canada has historically been a large exporter of canola,

Table 1. World Crop Sources of Ethanol and Biodiesel, 2007

Ethanol			Biodiesel		
Crop	Country	Metric Tonnes (millions)	Crop	Country	Metric Tonnes (millions)
Maize (Corn)	USA	332	Soybeans	USA	71
	China	152		Brazil	58
	Brazil	52		Argentina	46
	Mexico	23		China	16
Sugar Cane	Brazil	514	Palm Oil	Indonesia	78
	India	355		Malaysia	78
	China	106		Nigeria	9
	Thailand	64		Thailand	8
Sugar Beets	France	32	Rapeseed/Canola	China	10
	USA	32		Canada	9
	Russian Fed.	29		India	7
	Germany	26		Germany	5

Source: United Nations, Food and Agriculture Organization (2009).

Table 2. North American Crop Feedstock Production Shares, 2007

	% North America			% of World		
Country	Canola and Mustard	Soybeans	Corn	Canola and Mustard	Soybeans	Corn
Canada	93	4	3	18	1	1
United States	7	96	97	1	33	42

Source: United Nations, Food and Agriculture Organization (2009).

and the U.S. an exporter of corn. In recent years, each of the three prairie provinces of Canada exceeded the total U.S. canola production by three to six times.

As reported in table 3, Iowa leads the nation in corn production and ethanol capacity, while Nebraska ranks third in corn production and second in ethanol capacity. Of the 16 western states considered in this study, most produce considerably less than 0.1% of the nation's corn. The largest western corn-growing states of Texas, North Dakota, and Colorado produce only 2.5%, 2.2%, and 1.1% of the nation's total, respectively.

North Dakota dominates in canola production, accounting for over 90% of the nation's total [USDA/National Agricultural Statistics Service (NASS), 2008]. Very little canola is produced in the remaining western states. Mustard, safflower. and flax seed are minor oilseeds in the U.S. and have important food and/or fiber applications. They have received little use as biodiesel feedstocks. Camelina, touted as an oilseed suited for arid regions, has failed to live up to production expectations in Montana and elsewhere (USDA/NASS, 2009a; Durlin, 2009).

Recycled cooking oils and surplus fats constitute a small profitable niche in the biodiesel industry. For example, the populous Puget Sound area of Washington surrounding Seattle produces an estimated 65 million pounds/year of edible and inedible animal tallow plus 13 million pounds/year of recycled yellow grease (Western Governors' Association, 2006). This is sufficient to support at least three small biodiesel refineries in the area (Domby and Young, 2008).

Table 3. Top 10 Corn-Producing States and Ethanol Capacity

State	Corn (% USA, 2008)	Nameplate Ethanol Capacity (% USA, 2009)
Iowa	18.1	25.8
Illinois	17.6	9.3
Nebraska	11.5	12.0
Minnesota	9.8	8.5
Indiana	7.2	7.1
South Dakota	4.8	8.0
Kansas	4.0	3.8
Ohio	3.5	3.7
Wisconsin	3.3	3.9
Missouri	3.2	2.1
Total	82.9	84.2

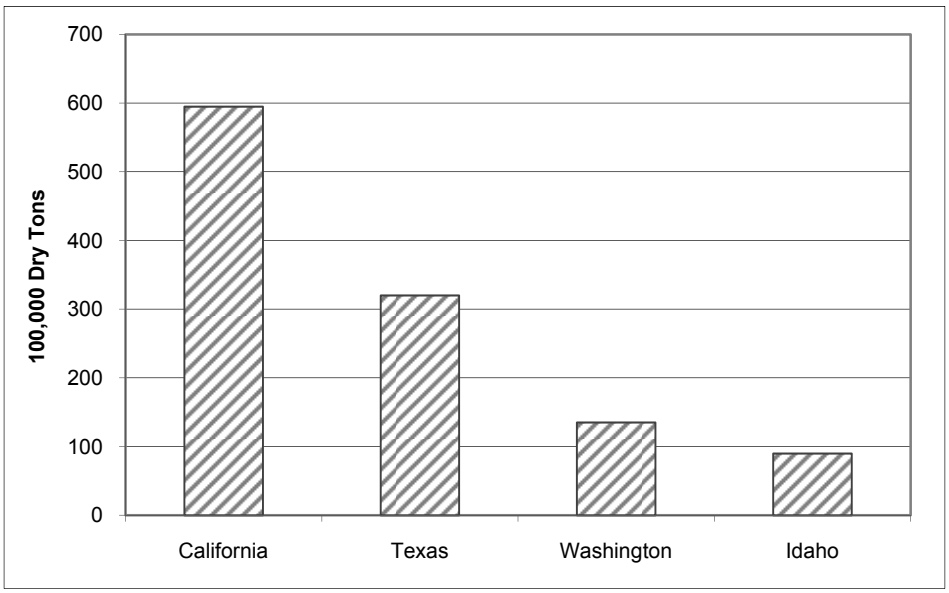
Sources: % USA corn (USDA/NASS, 2009b); ethanol capacity (Nebraska State Government, 2009).

Forward projections have also shown little growth for most crop biofuel feedstocks in western states. A linear programming projection of crop feedstocks centered in 2010 for five subregions in Washington state revealed canola and sugarbeets never entered the basis for any subregion. Potatoes, apples, grapes, hay, sweet corn, hops, and other high-value hops dominated in irrigated areas, and wheat, barley, and edible legumes dominated in dryland areas (Yoder et al., 2008). Projected field corn production was very low by national standards.

In summary, western states lack a comparative advantage in corn and oilseed production. Most of the West lacks the summer rainfall and warm 24-hour temperatures that favor corn and soybeans. The American West, with the apparent exception of North Dakota, also does not resemble the Canadian Prairies where cooler summer temperatures and less competitive grains favor oilseeds. This is not to say that agriculture is impoverished in the American West. The West is justly famous for its high-quality wheat, cotton, vegetables, tree fruit, wine grapes, specialty crops, alfalfa hay, livestock, and livestock products. California has long been the leading agricultural state, accounting for 11.4 % of the nation's agricultural value in 2007 (USDA/NASS, 2008).

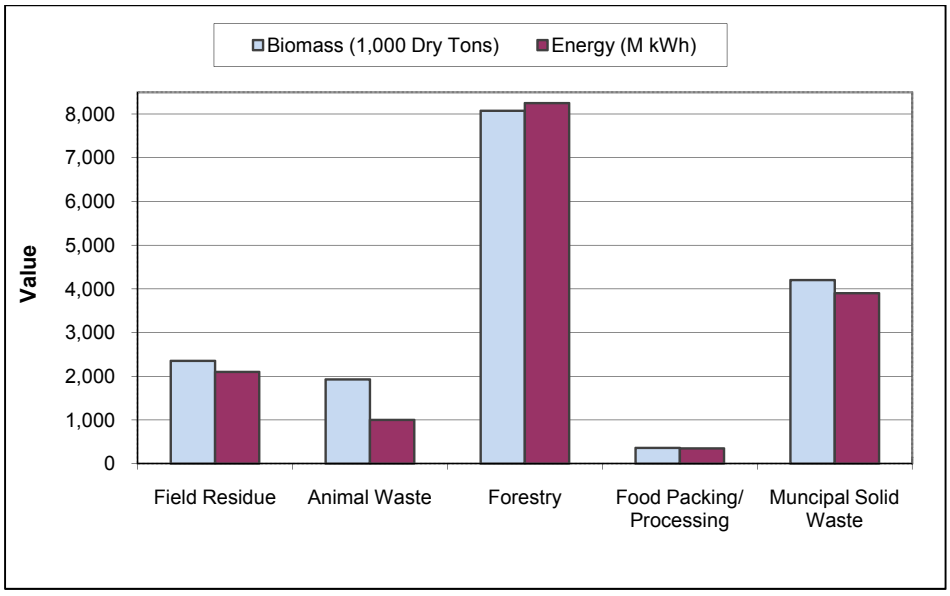
Cellulosic Feedstocks

Figure 1 ranks the top four western states for potential cellulosic ethanol feedstocks from agricultural, forestry, and municipal waste sources (Western Governors' Association, 2006). California, with the region's largest population and agriculture, has two to six times the cellulosic biomass of the other states. Municipal waste is a large contributor in California. Crop, animal, food processing, and forestry residues are also large contributors. Likewise, agricultural sources are important for Texas, where municipal waste contributes substantially, but less than in California. Using Washington as an example, forestry residues provide the leading source of biomass and potential bioenergy in the Pacific Northwest (figure 2).



Source: Modified from Western Governors' Association (2006) to provide comparable units as Frear et al. (2006).

Figure 1. Top 4 of 16 western states in biomass resources (agricultural, forestry, and municipal waste)



Source: Frear et al. (2006).

Figure 2. Washington State biomass and bioenergy by category

There are several strong caveats regarding the near-term promise of cellulosic inventories for biofuels. First, while there is a large amount of ongoing research and experimental facilities for converting biomass to ethanol, the technology is not sufficiently developed for profitable commercial production. In contrast, commercial generation of electricity from burning forestry and other waste has existed for decades. Potential biofuel production from these "waste" inventories will be sharply reduced by economically competitive current uses of these by-products such as electricity generation, fiberboard sheeting from forestry residues, animal feed from field and food processing residues, soil quality maintenance from field residues, recycling municipal waste paper, aluminum, glass, plastic, and composting organic matter (Frear, 2008). High collection costs for small diameter timber from rugged remote regions in the West could also make many forestry thinning sources unaffordable.

There has been considerable interest in new dedicated crops such as switchgrass and hybrid poplar trees as ethanol sources (Yoder et al., 2008). Again, these sources face technological and economic hurdles at present. Poplar confronts competing demands for paper and cardboard manufacturing. Switchgrass, most successfully grown under irrigation, will face land competition from hay and other crops. A review of articles published in the *Biofuels Business E-News* following July 2007 provides one indicator of research attention focused on different cellulosic feedstocks. During 2007–2008, algae accounted for about one-fifth of the articles on cellulosics followed by Jatropha, waste, and grasses (including switchgrass). During 2008–2009, algae, waste, and Jatropha were again the top three sources mentioned. By mid-August to early November 2009, algae alone accounted for 38% of the cellulosic references, outranking other top sources by a four-to-one margin.

Federal and State Biofuel Incentives

With the passage of the 2008 Farm Bill, corn ethanol, cellulosic ethanol, and biodiesel blenders qualify for federal tax credits of $0.45, $1.01, and $1.00/gallon, respectively, of biofuel blended (U.S. Department of Energy, 2009a). Small producers of ethanol and biodiesel receive a federal tax credit of $0.10/gallon for up to 15 million gallons per year (MGY) for plants producing no more than 60 MGY. In addition to subsidies, federal renewable fuel standards (RFS) mandated use of 9 billion gallons/year (BGY) of biofuels in 2008, rising to 36 BGY by 2022. The 2008 and 2022 mandates would account for about 8% and 24% ethanol content in gasoline, respectively. Corn ethanol for the 2022 mandate is capped at 15 BGY, with the remaining 22 BGY to be derived from advanced biofuel feedstocks. The U.S. ethanol industry is also protected by tariffs on foreign ethanol. Proponents of repealing the ethanol tariff argue that the tariff gives petroleum imports an unfair advantage.

As noted above, most U.S. states and all but three of the 16 western states provide significant incentives for in-state biofuel production. Readers are referred to a U.S. Department of Energy (2009a) website [http://www.afdc.energy.gov/afdc/incentives_laws.html] for an up-to-date review of the diverse and sometimes complex incentives for all western states. Among these states, Oregon's biofuel incentives and mandates are the most generous (U.S. Department of Energy, 2009a; Yoder et al., 2008). Oregon provides biofuel refiners a state investment tax credit of 50% up to $200 million per facility. The state requires biofuel blends of 2% for diesel and 10% for gasoline. Oregonians qualify for a state income tax credit of $0.50/gallon of transport biofuels purchased up to $200/year for each registered vehicle. Oregon growers and collectors of in-state biofuel or bioenergy feedstocks receive state income tax credits based on energy content.

California adopted the nation's first low carbon fuel standard (LCFS) in April 2009 (U.S. Department of Energy, 2009a). The state has set deadlines to reduce greenhouse gas emissions from transport fuels. Major fuel users can trade and bank LCFS credits consistent with a "cap and trade" policy. California has also established a generous program of grants and low-interest loans for alternative fuel and energy research and development.

Washington has instituted a portfolio of incentives somewhat less generous than Oregon's (U.S. Department of Energy, 2009a; Yoder et al., 2008). It set a 2% unenforced fuel blend goal that had been exceeded by mid-2009 for ethanol, but was far from being met for biodiesel. State legislation encouraged use of in-state feedstocks, but by mid-2009, virtually all ethanol and biodiesel consumed in the state was generated from feedstocks produced in other states or countries. Washington has no state income tax, but it has legislated several exemptions to business, property, and sales taxes for biofuel refiners and blenders. The state has targeted reducing greenhouse gases 15% by 2020. Like most states, Washington has funded grants and low-interest loans for alternative fuel and energy research and development.

Evaluation of the Western U.S. Biofuels Industry: 2006–2009 [2]

Despite generous government support for the biofuel industry in the western states, the industry has been plagued by bankruptcies, plant closures, and postponed building plans during 2008 and 2009. Although it is difficult to track the status of biofuel plants by region, one source reported 33% of ethanol plants in the 16 western states were idle in October 2009, whereas only 5% were idle in the top 10 Corn Belt states (*Ethanol Producer Magazine*, 2009).

There are several prominent examples of biofuel plant failures in the West. Pacific Ethanol built six 40-million-gallon/year, $100 million plants at Madera, Stockton, and Calipatria, California; Boardman, Oregon; Burley, Idaho; and Windsor, Colorado. Pacific Ethanol's stock fell from $44.50/share in 2006 to $0.20/share in 2009, and it filed for bankruptcy on May 18, 2009. Panda Energy and White Energy, ethanol firms headquartered in Dallas, Texas, declared bankruptcy in 2009. The bankruptcies of Pacific Ethanol, Panda Energy, and White Energy, all in the West, accounted for 50% of ethanol plant bankruptcies by August 2009, but the West accounted for only 15% of the nation's ethanol plants at that time (Reidy, 2009; *Ethanol Producer Magazine*, 2009). Imperium Renewables (IP) in Gray's Harbor, Washington, the nation's largest biodiesel plant, shut down in 2009. IP imported canola from Canada and exported biodiesel to Europe, thereby providing little support for U.S. energy independence. Biodiesel exports were terminated by international trade rulings on January 1, 2009, which was the final blow for IP's operation.

Not surprisingly, the U.S. ethanol industry is centered in the Corn Belt, which is favored by transportation cost advantages for the primary feedstock. However, there have been plant failures in this region as well. Perhaps the most notable is VeraSun of Sioux Falls, South Dakota, one of the nation's largest ethanol producers. VeraSun filed for bankruptcy on October 31, 2008, following an initial public stock offering in 2006. Its stock price fell from a high of about $18/share to $0.48/share.

With beneficial hindsight, what does an evaluation of the rise and decline of the U.S. biofuels industry over the past few years reveal? Low corn and oilseed prices and generous government subsidies launched a biofuel plant building binge in 2006 and 2007. However, as

[2] This discussion applies only to the 2006–2009 rise and decline of the industry. As always with economics, the health of the biofuels industry could change sharply in the future with changing technology, differing policies, and shifting demand and supply conditions in petroleum, biofuels, and feedstock markets.

shown in figure 3, corn prices rose sharply in 2008. Corn prices are expressed in figure 3 per 0.36 bushel, an average amount required to produce a gallon of ethanol. Furthermore, excess supply drove ethanol prices down after mid-2008. These trends decreased ethanol plant profit margins. Plummeting gasoline prices after mid-2008 put additional competitive pressure on ethanol.

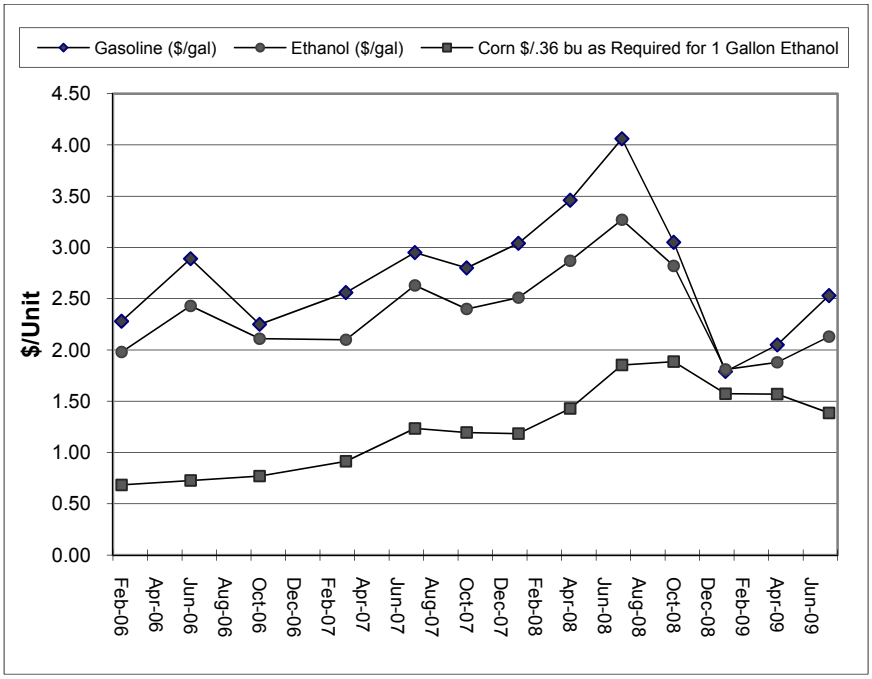
A serious feedstock transportation cost disadvantage magnified these problems for western biofuel plants. Transportation costs per bushel of grain from the Corn Belt to the West Coast range from $1.25 to $1.75 (USDA/Agricultural Marketing Service, as summarized in Yoder et al., 2008). Figure 4 compares ethanol price to the cost of purchasing and transporting 0.36 bushel of corn to the West Coast, assuming the conservative transport cost of $1.25/bushel. This comparison shows that delivered feedstock cost alone could erase net returns in California and other West Coast plants in late 2008 and early 2009. Plants were still required to pay variable costs for labor, energy, water, and maintenance plus fixed costs on a high debt load for fixed facilities. A high debt/asset ratio for biofuel plants and tight credit markets during the 2008–2009 recession was the *coup de grace* for many struggling western biofuel firms. Overly optimistic linear projections by entrepreneurs of low feedstock prices, healthy ethanol prices, and continuing growth in government incentives contributed strongly to the industry's difficulties. Based on my observations, developers of plants in the West also over-estimated the extent to which local growers would alter long established cropping patterns to satisfy their feedstock needs.

Other factors dampened public enthusiasm for biofuels nationwide. Reductions in miles per gallon and alleged engine damage discouraged many automobile drivers, boaters, and others (Galbraith, 2008; *BioFuels Business* staff, 2009). Journalists, some scientists, and other spokespersons increasingly argued that shifting crops to biofuel feedstocks was raising food prices everywhere and increasing hunger in developing countries (Grunwald, 2009; Klapper, 2008). Use of palm oil from Indonesia and Malaysia for biodiesel, and intensifying feedstock production elsewhere, heightened criticism that biofuels were degrading the environment. More complete "life cycle" studies of greenhouse gas production, including "indirect land use effects" in developing countries, cast doubt as to whether global greenhouse gases were reduced by crop-based biofuels (Searchinger et al., 2008; Crutzen et al., 2007). California and federal low carbon fuel standards penalized corn ethanol when full life cycle greenhouse gas production was considered.

The prognosis for the biofuels industry by autumn 2009 shows some modest signs of improvement. As corn prices have declined relative to ethanol and petroleum prices, corn ethanol profit margins have improved (Berry, 2009). However, political support and research priorities have shifted to "second generation" cellulosic feedstocks (Wyman and Yang, 2009). Nonetheless, a strong lobbying effort continues from groups including the National Corn Growers Association, biofuel trade organizations, and midwestern politicians to retain corn ethanol subsidies, to retain tariffs on Brazilian ethanol, to increase ethanol blends to 15%, and to waive consideration of life cycle greenhouse gas emissions for crop-based biofuels.

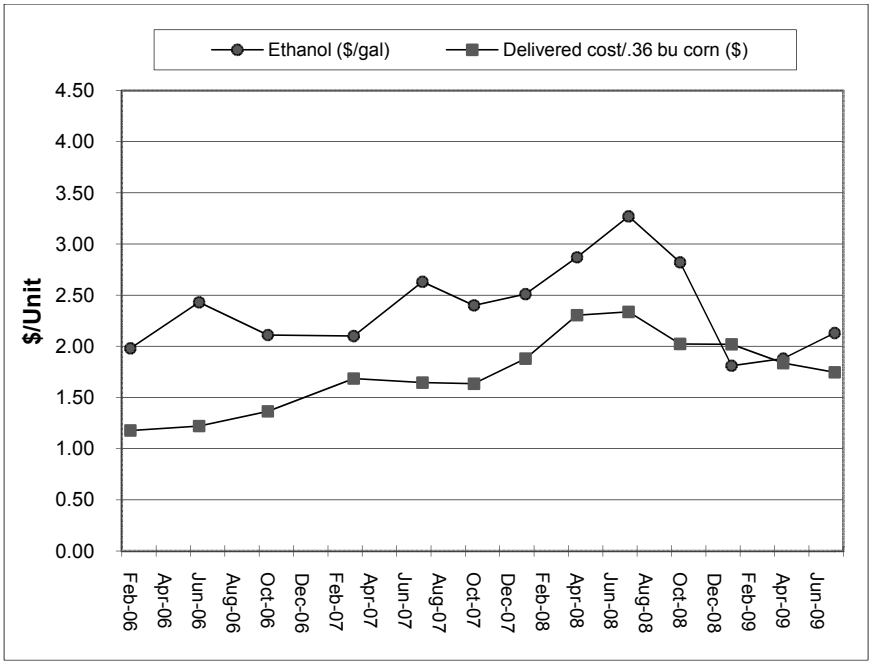
By-passed Bioenergy Policies

Have the politically popular biofuel mandates and subsidies by-passed more socially beneficial bioenergy policies? Most states and the federal government have legislated a broad portfolio of energy conservation and promotion policies. However, it is fair to say that most of these policies have enjoyed less political support from agricultural states than corn ethanol.



Sources: Corn price (Farm Doc, 2009); ethanol price (U.S. Department of Energy, 2009b); gasoline price (U.S. Department of Energy, 2009c).

Figure 3. U.S. average prices for gasoline, ethanol, and corn, 2006–2009



Sources: Corn price (Farm Doc, 2009); ethanol price (U.S. Department of Energy, 2009b).

Figure 4. U.S. average ethanol price and cost of corn input delivered from Midwest to West Coast

Among alternative policies that merit benefit/cost comparisons with biofuel incentives are: (*a*) promotion of energy conservation and education as in the early 1970s; (*b*) promotion of general energy- and fuel-saving technology; (*c*) promotion of more efficient and environmentally sound extraction and use of fossil fuels; (*d*) promotion of carefully regulated nuclear energy; (*e*) promotion of clean energy such as hydro, solar, wind, tidal, methane, and others; (*f*) taxing carbon or general greenhouse gas emissions—as in British Columbia; (*g*) enforcing strict energy and fuel efficiency standards; (*h*) removing trade barriers in biofuels; and (*i*) permitting markets to dictate fuel and energy production and consumption, thereby trusting that market efficiencies will outweigh nonmarket externalities.

Research Agenda

In order to provide a sound basis for future biofuel and bioenergy policies, there are several priorities for engineering, biochemistry, agriculture, and economics research. The technical research agenda should comprise a broad menu of energy-saving technology, including electric automobiles, more efficient power grids, more affordable cellulosic feedstock conversion, and improved transportation infrastructure. Energy resources are often substitutable; for example, efficiency gains in natural gas used for electricity generation could be used for transportation or household heating or cooling. Agricultural scientists should develop plant varieties and management practices which improve the life cycle energy efficiency and greenhouse emissions of algae, miscanthus, switchgrass, sugar cane, corn, oilseeds, and other feedstocks.

Economists should identify a spatial network of energy and fuels from petroleum, coal, hydro, wind, solar, and other sources that meet environmental targets at minimum social cost (Sexton et al., 2009). Economists should include *worldwide* effects on the environment, on food and energy consumers, on food and fuel producers, and on taxpayers of a broad spectrum of energy and fuel policies. Economists should address the optimal location, scale, and technology of bioenergy and biofuel plants. For example, would smaller forestry residue bioenergy plants located closer to the source offset high collection and transportation costs? Studies should compare the net benefits of organic municipal waste converted to compost versus ethanol production. Policies promoting multiple benefits from forest thinning for wildfire suppression, timber quality improvement, and feedstocks for electricity or fuels should be evaluated. Economists should measure the effects on energy security and on net social benefits of international trade and commodity policies (e.g., Gardner, 2007).

Conclusions

The politics of biofuels, both nationally and in western states, outpaced the engineering, scientific, and economic analysis necessary for sound public decisions. The period 2006–2007 represented a political boondoggle that was followed by an economic collapse in 2008 through mid-2009, especially in western states that lacked comparative advantages in crop feedstocks. What lessons can western states learn from this experience? Use of taxpayer money to subsidize in-state production of feedstocks without a regional comparative advantage is wasteful. Western corn ethanol or oilseed biodiesel plant developers should calculate their transportation cost disadvantages compared to plants closer to these feedstocks. It is doubtful that western ethanol plants relying on corn imported from the Midwest could supply

more than a small fraction of their states' transportation fuel requirements. Research and development funding in western states should attempt to complement federal funding in areas where these states have a comparative advantage such as forestry residues, food processing residues, livestock waste, and, in states with large urban populations, municipal waste.

If western entrepreneurs and politicians cannot refrain from appeals for start-up funds and subsidies for crop-based biofuels, economists and other analysts should remind them of the 2006–2009 experience. Policy analysts should consider the relative social efficiency of a much broader menu of bioenergy options.

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