International Scholars Journals

African Journal of Agricultural Marketing ISSN 2375-1061 Vol. 8 (1), pp. 001-006, January, 2020. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Avoiding more biofuel surprises: The fuel, food and forest trade-offs

Clayton W. Ogg

US Environmental Protections Agency, 1200 Pennsylvania Ave. N.W., EPA West 4339T, MC 1809T, Washington, DC 20460. E-mail: ogg.clay@epa.gov. Tel: 202-566-2315. Fax: 202-566-2339.

Accepted 16 September, 2019

Biofuel policies involve a convergence between, policies to protect ecosystems and reduce greenhouse gases and policies to support food security and agricultural income. Beginning in 1985, agricultural programs shifted dramatically from being a major cause of environmental damage to providing a strong leverage which encouraged the most environmentally beneficial practices. Biofuel programs are erasing some of those gains. Careful review of the literature indicates that biofuel incentives considerably increase both food prices and destruction of the world's tropical ecosystems, even though funding organizations have been slow to document the latter. Attempts to frame the policy issues as a pursuit of "biofuel sustainability" apparently understate environmental and food security challenges and could undermine over 2 decades of efforts to make farm programs more equitable, market oriented and environmentally friendly.

Key words: Biofuels, deforestation, water quality, food prices, equity.

INTRODUCTION

Recent, unexpected spikes in oil prices supported equally unexpected rounds of world food price increases, as higher petroleum prices spurred biofuel production. Links between biofuel demands, food prices and destruction of ecosystems are documented by recent studies. Yet, the response by research funding organizations remains dis-appointing on several fronts, especially regarding the im-pacts on tropical ecosystems of a worldwide, conven-tional biofuel expansion. Corn ethanol producers in the U.S. may over comply and produce biofuels far in excess of the mandates (Babcock, 2008b).

It takes a large portion of the world's food to supply a modest increase in liquid fuel, suggesting trade-offs be-tween energy independence, forest preservation and food security. Given the above ambiguity regarding secu-rity, it is most useful to examine biofuel policies in the context of agricultural policy or environmental policy re-forms of the past 2 decades. These reforms include a shift from price support programs, which encourage agri-cultural expansion, to income support programs which are much more equitable and environmentally friendly. Exhorta-tions to pursue "biofuel sustainability" will be reviewed in the light of the above food price and ecosystem pressures that inevitably result from use of food products as fuel.

FUEL VERSUS FORESTS VERSUS FOOD

The petroleum price increases and the related food and forest problems were nearly impossible to predict, even 4 years ago, because the large petroleum price increase was unexpected. Yet, economists know that attempts to support farm commodity prices by reducing the availabi-lity of grain and oil crops for food will lead to land clearing for crop production, including the conversion of forests and savannas to cropland in the tropics. Tropical coun-tries have vast land resources (Valdez, 2006, Hooijer et. al., 2006) and the ability to convert their forests and sava-nnas to take advantage of increased demands for crops (Elobeid et. al., 2006). Cropland expansion is necessary in order for the rapid biofuel expansion to occur.

One recent study of a hypothetical set aside program found that for each acre set aside by U.S. farmers, 3 quarters of an acre would come into production in some country outside the U.S. within 5 years (FAPRI, 2001). Set aside programs were used by the U.S. farm policies for decades to support grain and oilseed prices by idling cropland, to reduce the supply of crops. These programs ended when it became clear that tropical countries could rapidly expand their crop land and take advantage of the supported price.

Moving from price support programs to income support payments for U.S. farmers also opened the way for compliance programs and sodbuster programs that protected ecosystems in the U.S. These more market oriented, income support programs could be crafted to avoid encouraging chemical use (Kuch and Ogg, 1996).

Biofuel programs affect our grain and oil crop exporting competitors in a manner similar to acreage set-asides, reducing U.S. exports of food, raising commodity prices and causing land to be cleared for cropland in Brazil, Argentina, Indonesia, as well as in our own country. A recent study by Nelson and Robertson (2008) found that a 25% increase in the price of maize (at the time of the study) could lead to a doubling in cropped area in Brazil. That area (165.6 million hectares) represents a 19% reduction in land that is suitable for crop production in Latin America that was not cropped in the late 1990's. Another study suggests that a 76 billion liter increase in corn ethanol production in the U.S. would lead to over 10 million ha of land coming into crop production in foreign countries, with Brazil leading the way (Searchinger et al., 2008). Even tropical forest preserves are being removed to supply biofuels for use in Europe's automobiles (Ogg, 2008; Ngunjiri, 2007).

As tropical countries burn down rainforests and drain bogs (Pierce, 2007) to take advantage of the reduced U.S. exports and the resulting higher world prices, substantial green house gases (GHS) releases occur (Searchinger et al., 2007). These releases appear to largely offset any life cycle GHG benefits from burning corn ethanol or biodiesel made from crops like corn, soybeans and rapeseed oil. (The U.S. congress (2008) requires life cycle analyses for each fuel, but those analyses are not completed, yet.)

Destruction of the forest, itself (Nelson and Robertson, 2008), remains as the major environmental impact of biofuel demands. As the result of the above, offsetting effects of the forest destruction, costs per ton of carbon saved by biofuel programs in the U.S., Canada, and Europe, is very high, about $1000 per ton (OECD, 2008).

In Europe, biofuel programs heavily subsidize use of vegetable oil in cars and trucks, which may lead to even more destruction. Since Indonesian palm oil is the World's lowest cost source of vegetable oil (FAPRI, 20-08) , European biofuel subsidies are major drivers causing the loss of rainforests in Indonesia (Ogg, 2008). Studies have documented that a fourth of the land that is conver-ted to crop production in Indonesia is peat bog (Hooijer, et. al., 2006). When the peat bogs are drained to pro-duce palm oil, 10 cm of peat disappears into the atmos-phere each year (Pearce, 2007). Greenhouse gas relea-ses from forest destruction in Indonesia therefore, are in an order of magnitude higher than estimates for many other countries (Fargione et. al., 2008). European subsi-dies and mandates supporting oil crops for biodiesel are linked to these very large releases of greenhouse gases, which far exceed the estimated releases linked to burning ethanol.

The response by economists to reports of food scarcity was relatively prolific compared to the above studies that have quantified certain biofuel impacts on ecosystems or biofuel impacts regarding greenhouse gases. Abbott et al. (2008) find that a fourth of an increase in corn prices from about $2.00 to $4.00 is due to biofuel subsidies and that the other $3.00 is due to the higher price of oil, which causes most of the expansion in corn ethanol production. However, higher oil prices also directly affect the cost of producing corn through its effects on the cost of fertilizer and tractor fuel, so not all of the above $3.00 increase is due to expanded ethanol production. The International food policy research institute (IFPRI) (2008) estimated that the impact on food prices due to biofuel expansion from 2000 to 2007 accounted for 30% of weighted cereal prices increases over the "long term". More recently, a World Bank (2008) report suggested that 70 to 75% of the commodity price increases from 2002 to 2008 were caused by biofuels "and the related consequences of low grain stocks, large land use shifts, speculative activity and export bans".

POTENTIAL OVER COMPLIANCE FOR CORN ETHANOL

Expanded biofuel mandates will contribute to even greater, future demand for grains and oil crops as we go forward. Demand for conventional biofuels from these expanded mandates in the U.S., the E. U., Brazil and in other countries will continue to draw down grain stocks and support crop prices, as biofuel production continues to expand (FAPRI, 2008) . Biofuel policies and biofuel subsidies play a supporting role in this future biofuel expansion by providing direct incentives to produce ethanol (through the $0.45 tax subsidy, itself) and by supporting the sale of flex fuel vehicles and ultimately, the sale of higher ethanol blends, such as E85 (Tokgoz et al., 2007; Eobeid et al., 2006).

Congress (2008) apparently hopes new incentives favoring the sale of flex fuel vehicles will encourage use of more environmentally friendly, cellulosic ethanol made from waste materials. Although economists do not find that existing incentives will accomplish this shift to cellulosic ethanol production (Tokgoz et al., 2007), oil prices that are sufficiently high relative to ethanol prices will encourage the spread of E- 85 stations or stations offering 20 – 30% ethanol blends. Once built, these stations with higher ethanol blends could then facilitate even further expansion of corn ethanol markets to supply a domestic automobile fleet with increasing numbers of flex-fuel vehicles.

Corn ethanol production is currently limited to well below the 15 billion gallons mandate for corn ethanol specified in the energy Independence and SECURITY Act (EISA) (U.S. Congress, 2008) because of the potential for ethanol to corrode fuel lines in automobiles. The above 15 billion gallons would constitute about 10% of the U.S. fuel supply. The limit for mixing ethanol with gasoline also is 10%, but only until consumers buy flex-fuel vehi-cles (with fuel lines that allow safe use of higher ethanol blends) and until stations begin to supply them. Once E-85 stations or stations with greater than 10% ethanol blends become available, the price of food will be linked much more completely to the price of petroleum, as ethanol use in the U.S. may expand far beyond 15 billion gallons (Babcock, 2008b).

FUTURE BIOFUEL EXPANSION WORLDWIDE

In just a few years, petroleum prices tripled and then returned to $40 per barrel. According to estimates by Tyner and Taheripour (2008), corn prices may vary from about $2.00 per bushel to over $6.00 per bushel in response to oil prices varying from $40 per barrel to $160 per barrel. As noted above, petroleum prices remain volatile, are far above historic levels and can encourage more biofuel production whenever oil prices are high.

The international food policy research Institute (Rosegrant et. al., 2008) analyzed the combined, food price effects of the worldwide, conventional biofuel expansion in the major producing countries, including scenarios with "drastic biofuel expansion" of conventional biofuels in all the major producing countries. The analysis found that world prices at the time of the study would be 72% higher for maize, 44% higher for oilseeds, 27% higher for cassava and sugar and 20% higher for wheat when compared with a baseline that did not include worldwide biofuel expansion. This analysis of biofuel effects on food prices is most relevant for policy analysis because it isolates the effects of biofuel production from the other forces, such as income growth in developing countries that potentially drive up food prices and it addresses the effects of the large worldwide, future expansion in biofuel production planned in producing countries.

Unfortunately, we have no detailed analysis addressing trade-offs between a potential worldwide, future expansion of conventional biofuel production and loss of the world's tropical forest ecosystems. Rough estimates by Gallager (2008) suggest that meeting biofuel production targets in all of the biofuel producing countries would require 56 to 166 million ha, respectively, depending on whether advanced technologies are used or conventional technologies that rely on conventional crops. As biofuel producing countries convert land to biofuel production, tropical countries expand crop acreage to meet food demands previously met by the biofuel producing countries.

When world leaders met in Bali to address global warming, preservation of rainforests was identified, at that time, as 1 of the most promising opportunities to address global warming (Ogg, 2008). In Indonesia, worldwide growth in biofuel demands contributes to a projected increase in palm oil acreage of 35% over the next 10 years (FAPRI, 2008). However, the trade-offs between countries' forest preservation aspirations versus their biofuel production programs have never been adequately documented.

The above fuel, forest and food trade-offs need to be documented in an integrated manner. For example, if world leaders decide to advance conventional biofuel production from corn and oil crops, while also avoiding any adverse impacts on forest ecosystems, as proposed in the British renewal fuels agency report by Gallager (2008), the consequences in causing food price increases would be even more severe than the effects of biofuel expansion alone. World leaders are intensely interested in all 3 objectives, including biofuel expansion, forest preservation and food security. It is especially important, then, to document the above, 3 way trade-offs and in an efficient, timely manner.

Ideally, we analyze major policy choices affecting food security and the environment in advance of policy makers' decisions, rather than waiting until several tens of billions of dollars are invested in a heavily subsidized industry. But there is still time to contribute to decisions affecting continued biofuel expansion.

FOOD PRICES AND INFLATION

The recent run-up in petroleum and food prices added to inflationary pressures at a time when inflation was already becoming a concern in many countries. In developed countries, where agricultural commodity prices are a much smaller part of total food costs and a smaller part of the economy, petroleum prices are by far the most important player in adding to inflation (IMF, 2008). However, in developing countries, rising food prices contribute much more to the inflationary pressures because food ac-counts for over a third of consumer expenditures in the developing countries. The recent run-up in crop prices happened at a time when inflation in developing countries already was occurring and was adversely affecting economies of individual developing countries and the world economy.

Food price increases can be especially harmful to poor people in developing countries who spend a very large portion of their incomes on food (IMF, 2008; Bradsher, 2008). The world bank (2008) estimates that food price increases at the time of the study set back poor countries' efforts to reduce poverty by 5 to 10 years.

CROP PRICES AND FERTILIZER USE

Higher crop prices are believed to have a large effect in encouraging farmers to apply more fertilizer (Abler and Shortle, 1992; Herten et al., 1990). During years with good weather conditions, this additional fertilizer enhances yields, thereby allowing farmers to gain more benefit from the higher crop prices. More research is needed to better quantify fertilizer's responsiveness to the higher crop prices, but the past research suggests that farmers substantially increase their fertilizer use per acre when crop prices are high.

Fertilizer nutrients are a major source of pollution in our streams and contribute nitrous oxide to the atmosphere, an important greenhouse gas. When biofuel production raises crop prices and encourages farmers to use more land and fertilizer, exhortations to produce biofuel feedstocks in a "sustainable" manner (U.S. Congress, 2008) may not accomplish very much. Swimmers may try harder when they encounter a swift riptide, but still go backward.

BIOFUEL SUSTAINABILITY: CAN WE CHOOSE THE LAND?

There is a presumption that biofuels can be produced in a "sustainable" manner (Gallager, 2008), if policy makers would choose to do so. Yet, sustainability calls for an integrated approach to solving environmental and a variety of other problems by seeking remedies that benefit the environment, soil, consumers and farmers, themselves (Sustainable Agriculture Research and Education, 2005). Sustainable solutions therefore aim to achieve multi-media benefits. For example, following a nutrient recommendation helps farmers to credit manure nutrients in their soils and other farm produced nutrients (fertilizer carryover), when applying fertilizer, so they apply less fertilizer. The environment benefits from the reduced nutrients available to cause water and air pollution, farmers benefit from reduced fertilizer expenditures and consumers benefit from reduced costs (Kuch and Ogg, 1996).

In the case of conventional biofuels, virtually all of the synergisms unfortunately are negative, suggesting that policies supporting biofuel production undermine 2 decades of efforts to make U.S. farm programs more sustainable. It requires 6.2% of the world's food production to replace 0.8% of global oil production (Elam, 2008). Biofuel demands undermine compliance program incentives while contributing to loss of key prairie ecosystems in wetland regions of the U.S. and the use of more fertilizer which pollutes the land, water and air (Ogg, 2008). Biofuel demands also contribute to higher prices for consumers, to loss of feed and pasture for livestock, to loss of water availability and to worldwide destruction of forests, including the most critical tropical forest ecosystems (Gurgel et al., 2007).

Potentially, the above damage to ecosystems could be minimized by exploiting certain "idle" lands (Gallager, 2008). These idle lands would be used to produce more food, as world demand for crops are driven upward by ever larger larger food needs and by worldwide biofuel expansion. This hypothesis needs to be tested in an integrated way, as described above, by analyzing options which simultaneously expand biofuel production, while protecting forest and savanna ecosystems from conversion to crop production. Although it would be very difficult to implement forest preservation programs in the real world, plausible scenarios can be developed and effects on food prices estimated. Clearly, limiting land use change to avoid damaging valuable ecosystems will add to the food price increases as biofuel production expands, but it is useful to quantify these fuel versus forest versus food trade-offs to inform policy discussions.

Emerging plug-in technologies offer a welcome contrast to the above, liquid biofuels. Plug-in, hybrid vehicles potentially use electricity generated by burning biofuels from waste material, such as corn stalks, dead trees and tree litter, in a sustainable manner without the economically and environmentally costly step of converting these materials to a liquid fuel. New plug- in hybrid technologies will provide fuel at a fraction of the cost of liquid biofuels and less than one fourth the cost of conventional gasoline, while providing large reductions in green house gases (Sandalow, 2007). Cars that plug in may use fuels from a relatively low cost, renewable sources in a truly sustainable manner. For example, plugging in soon may offer an option for commuters to avoid use of liquid fuels during their daily commute.

In the future, biofuels also may be produced efficiently and sustainably from waste materials, including agro-industrial waste. Use of these materials helps in their safe disposal rather than pressuring the natural resources.

THE STRUCTURE OF AGRICULTURE

Agricultural producers and especially land owners, remain as the clear beneficiary the biofuel boom. Consumers benefit from increased fuel supplies, but loose from the large amounts of food sacrificed to produce the fuel. In the U.S., however, farmer benefits from biofuel production are not evenly distributed among farmers. One recent study found biofuel subsidies at the time of the study provided 4.1 billion dollars in benefits to corn growers, but livestock producers and other "nonethanol corn users" lost 3 billion dollars per year (Babcock, 2008a).

Since much of the grain and soybean production occurs on a relatively small % of the farms, programs that sup-port farmers' incomes by raising those crops' prices will primarily benefit the few, largest and most well-off land owners. By 1978, 1% of the land owners owned nearly a third of the farm land and about a third of U.S. farm land was owned by nonfarming landlords (USDA, 1981). By 1998, 9% of U.S. farms accounted for 66% of the value of production (ERS, 2001) and most crop land was owned by someone other than the person farming the land (NASS, 1999). Small farmers here and around the world

(Abbott, et. al., 2008) also benefit, but large land owners receive a larger share of the benefit from higher commodity prices. Recent administrations have supported changes in farm income support programs which spread the benefits of these programs more widely among domestic farmers and use program benefits as an incentive to employ environmentally friendly practices, such as protecting farmed wetlands (USDA, 1995).

Recent farm legislation switched from price support, which relied on annual acreage set-asides, to income payments for supporting farmers' income. Per farmer payment limits then prevented the largest land owners from capturing such a large proportion of the program benefits. Other changes in recent years provided more support for conservation programs whose benefits were spread much more evenly among farmers. Conservation programs included more of the modest sized farms and livestock producers who benefited only marginally from the past programs, or were hurt by them (USDA, 1995; U.S. Congress, 1996). In the end, the largest land owners and the largest producers of the program crops still enjoy a major share of the farm program benefits, but certain program features support a wider group of farmers and reduce the government payments going to the very rich.

In the context of these farm policy reforms, biofuel subsidies represent a return to the old practice of supporting the price of grains and oil crops. Relatively large cropland owners, once again, capture the great majority of the biofuel subsidies' benefits, while livestock producers are the major losers. Environmental compliance programs, conservation compliance, sodbuster, and swamp buster program, loose much of their influence when market prices are very high.

Large land owners became large by purchasing or renting other farms. As a result of this process and of the growth in absentee ownership, the number of actual farmers that benefit from farm programs, as well as from the biofuel boom, has shrunk relative to the rest of the U.S. population. Although rural residents make up 20% of the U.S. population, farmers "who list farming as their main source of income" account for only 2% of these rural residents (Cowan, 2001).

Conclusion

Biofuel programs were implemented without first considering their food and environmental consequences. As the biofuel expansion occurred rapidly, many groups reacted enthusiastically to the obvious benefits to politically influential land owners and to early analyses which over estimated the benefits of conventional biofuels in reducing greenhouse gases.

The biofuel boom clearly benefits the larger cropland owners in the U.S. In achieving this benefit, the boom imposes massive damage on tropical forest ecosystems and creates a risky and painful food scarcity situation which may last for a decade.

Possible over compliance with conventional biofuel mandates, especially for corn, could add greatly to the above problems. Although biofuel programs seem to favor a switch to advanced biofuels, actual incentives favor more production of corn ethanol in the U.S. and vegetable oil (biodiesel) in Europe. Powerful incentives that support sale of flex-fuel vehicles in the U.S. could ultimately support construction of E85 pumps or pumps with 20 – 30% ethanol at gas stations and open up a Pandora's box where the price of food will be tied to the price of oil, at a time when oil prices are volatile and frequently above historic levels. Analysis needs to consider the ecological and food price effects of likely scenarios for worldwide biofuel expansion, in an integrated manner and compare these effects with environmentally friendly alternatives.

REFERENCES

Abler DG, Shortle JS (1992). Environmental and farm commodity policy linkages in the US and the EC. Euro. Rev. of Agric. Econ. 19 (2): 197-217.

Babcock BA (2008a). Distributional implications of U.S. ethanol policy. Rev. of Agric. Econ. 30(3): 533-542.

Babcock BA (2008b). Breaking the link between food and biofuels. Iowa Ag. Review 14 (2).

Banse M, Meijl H and Woltjer G (2008). Consequences of EU biofuel policies on agricultural production and land use. Choices 23(3): 22-27. Available on line at www.choicesmagazine.org.

Bradsher K (2008). A new, global oil quandary: Costly fuel means costly calories. The N.Y. Times, Jan. 19.

Cowan T (2001). The changing structure of agriculture and rural America: Emerging opportunities and challenges. CRS Report for Congress. Washington, DC.

Elam TE (2008). Food or fuel? Choices and conflicts. Choices 23(3): 12-13. Available on line at www.choicesmagazine.org. Access Date: November.

Elobeid A, Tokgoz S, Hayes DJ, Babcock BA, Hart CE (2006). The long-run impact of corn-based ethanol on the grain, oilseed, and livestock sectors: A preliminary assessment. Center for Agriculture and Rural Development, CARD Briefing Paper 06-BP 49, Iowa State University, Ames, IO.

Fargione J, Hill J, Tilman D, Polasky S, Hawthorne P (2008). Land clearing and the biofuel carbon debt. Sciencexpress. www.sciencexpress.org/7February2008/page1/10.1126/science.1152747

Food and Agricultural Policy Research Institute (FAPRI). (2008). U.S. and world agricultural outlook. FAPRI Staff Report 08-FSR 1 ISSN 1534-4533. Iowa State University and University of Missouri-Columbia, Ames, IO.

Food and Agricultural Policy Research Institute (FAPRI) (2001). Impact of a 10 percent decrease in planted acreage of all U.S. program crops. Briefing Paper 01-BP 33. University of Missouri, Columbia, Missouri, Ames, IO.

Gallager E (2008). Gallager review of indirect effects of biofuels. Renewable Fuel Agency. Available at http://www.dft.gov.uk/rfa/reportsandpublicastions/reviewoftheindirecteffectsofbiofuels.cfm. Access date: July 7, 2008.

Gurgel A, Reilly J, Paltsev S (2007). Potential land use implications of a global biofuels industry. J. of Agric. and Food Ind. Org. 5(2): Article 9. Available at http://www.bepress.com/jafio/vol5/iss2art9.

Hertel TW, Tsigas ME, Preckel PV (1990).Unfreezing program payment yields: Consequences and alternatives. Choices (Second Quarter), 32-33.

Hooijer A, Silvious M, Wosten H, Page S (2006). PEAT -CO2, Assessment of CO_2 emissions from drained peatlands in SE Asia. Rotterdam, The Netherlands: Delft Hydraulics Report Q3943.
International Food Policy Research Institute (IFPRI) (2008). Biofuels and grain prices: Impacts and policy responses.
International Monetary Fund (IMF) (2008). Food and fuel prices—Recent developments, macroeconomic impact, and policy responses. Washington, DC.
Kuch PJ, Ogg CW (1996). The 1995 Farm bill and natural resource conservation: major new opportunities. Am. J. of Agric. Econ. 78(4): 1207-1214.
Mitchel D (2008). A note on rising food prices. World Bank, Policy Research Working Paper 4682. Washington, DC.
Nelson GC, Robertson RD (2008). Green gold or green wash: Environmental consequences of biofuels in the developing world. Rev. of Agric. Econ. 30(3): 517-529.
Nfunjiri P (2007). Dishing out the country's forests. The East African, Nairobi.
Ogg CW (2008). Environmental challenges associated with corn ethanol production. Geopolitics of Energy 30(1):13-18.
Organization for Economic Co-Operation and Development (OECD) (2008). Biofuel support policies: An economic assessment. ISBN-97-89-26404922-2, OECD Publishing.
Pearce F (2007). The bog barons: Indonesia's carbon catastrophe. New Scientist, 2632 (December), 50-53.
Rosegrant M, Zhu T, Msangi S, Sulser T. (2008). Global scenarios for biofuels: Impacts and implications. Rev. of Agric. Econ. 30(3):495-505
Sandalow D (2007). Ending oil dependence. The Brookings Institution. Washington, D.C.
Searchinger T, Heimlich R, Houghton RA, Dong F, Elobeid A, Fabiosa J, Tokoz S, Hayes D, Yu TH (2008).Use of U.S. cropland for biofuels increases greenhouse gases through emissions from land use change.Sciencexpress.7February2008/Page1/10.1126/science.1151861. Availability Date: Feb 7.
Sustainable Agriculture Research and Education (SARE) (2005). Exploring Sustainability in Agriculture.U.S. Department of Agriculture, Cooperative Extension Service, Washington, DC.
Tokgoz S, Elobeid A, Fabiosa J, Hayes D, Babcock B, Yu T, Dong F, Hart C, Beghin J (2007). Emerging biofuels: Outlook of effects on U.S. grain, oilseed, and livestock markets. Center for Agricultural and Rural Development, Staff Report 07-SR101, Iowa State University, Ames, IO.
Tyner W, Taheripour F (2008). Biofuels, policy options, and their implications: Analyses using partial and general equilibrium approaches. J. Agric. and Food Ind. Org., 6, Article 9: Available online at www.bepress.com/jafio/vol6/iss2/art9.
U.S. Congress. (1996). Federal Agricultural Improvement and Reform Act of 1996. P.L. 104-127, 4 April, 1996. Washington, D.C.
U.S. Congress. (2008). Energy Independence and Security Act of 2007. H.R. 6, 110 Congress, 1st session. Washington, D.C.
U.S. Department of Agriculture (1995). Farm bill: Guidance of the Administration. Washington DC.
U.S. Department of Agriculture. National Agricultural Statistics Service (NASS) (1999). Agricultural economics and land ownership survey. Volume 3, Special Studies Part IV, Washington, DC.
U.S. Department of Agriculture (2001). Economic Research Service (ERS). America's diverse family farms: Assorted sizes, types, and situations. Agriculture Information Bulleting Number 769, Washington, DC.
U.S. Department of Agriculture (1981). A time to choose: Summary report on the structure of agriculture. Washington, DC.
Valdez C (2006). Brazil's booming agriculture faces obstacles. Amber Waves. U.S. Department of Agriculture, Economic Research Service, Washington, D.C. www.ers.usda.gov/amberwaves.
World Bank (2008). Rising food prices: Policy options and World Bank response. Washington, DC.

Disclaimer: Any views expressed belong to the author only and not the U.S. Environmental Protection Agency