Working Paper Number 151
August 2008

Biofuels and the Food Price Crisis: A Survey of the Issues

By Kimberly Elliott

Abstract

While the precise contribution of biofuels to surging food prices is difficult to know, policies promoting production of the current generation of biofuels are not achieving their stated objectives of increased energy independence or reduced greenhouse gas emissions. Reaching the congressionally mandated goal of blending 15 billion gallons of renewable fuels in gasoline by 2015 would consume roughly 40 percent of the corn crop (based on recent production levels) while replacing just 7 percent of current gasoline consumption. Moreover, while it has long been known that the net energy and greenhouse gas emission benefits of corn-based ethanol are relatively small because its production is energy-intensive, recent scientific studies suggest that the current generation of biofuels, including biodiesel made from palm oil, soybeans, and rapeseed, as well as corn-based ethanol, actually add to greenhouse gas emissions relative to petroleum-based fuels when land use changes are taken into account. That is, greenhouse gases are released when forests are cut down or grasslands cleared to plant biofuels, or food is planted on new acreage to replace crops diverted to fuel elsewhere. In sum, the food crisis adds urgency to the need to change these policies but does not change the basic fact that there is little justification for the current set of policies.

The Center for Global Development is an independent, nonprofit policy research organization that is dedicated to reducing global poverty and inequality and to making globalization work for the poor. This paper was made possible in part by financial support from the William and Flora Hewlett Foundation and the John D. and Catherine T. MacArthur Foundation.

www.cgdev.org

Biofuels and the Food Price Crisis: A Survey of the Issues

Kimberly Ann Elliott*

* Senior Fellow, Center for Global Development and Peterson Institute for International Economics. I would like to thank Peter Timmer and David Orden for helpful comments and Selvin Akkus for research assistance. The views expressed here do not necessarily reflect those of the staff or boards of directors of either the Center or Peterson Institute.

"The RFS [renewable fuel standard] remains an important tool in our ongoing efforts to reduce America's greenhouse gas emissions and lessen our dependence on foreign oil, in aggressive yet practical ways."

Environmental Protection Agency Administrator Stephen L. Johnson announcing his decision to deny a waiver of the mandated minimum level of ethanol in gasoline, August 7, 2008[1]

Just months before riots spurred by high food prices broke out in developing countries around the world, the US Congress passed, and President George W. Bush signed, legislation aimed at promoting energy independence, including via a sharply increased minimum level of "renewable fuels" that refiners must blend with gasoline. With current technologies, "renewable" means mainly corn- (in the United States) or sugar-based (Brazil) ethanol or oilseed- or palm oil-based biodiesel (in the European Union). At the same that the energy bill was being finalized, Congress was also debating farm legislation that included an extension of the $0.54 per gallon tariff on imported ethanol and modestly reduced the tax credit for refiners using ethanol, from $0.51 to $0.46 per gallon.

Eight months later, with season-average corn prices projected to be more than 50 percent higher than a year earlier, EPA Administrator Johnson made the announcement affirming the Bush administration's support for biofuel subsidies. The European Union also has similar tax and regulatory policies promoting the use of biofuels. With food prices surging, however, these policies are under increasing scrutiny. Biofuel advocates usually cite one or more of the same rationales as Johnson—improving energy security by reducing dependence on foreign sources of oil, reducing greenhouse gas emissions, or boosting rural livelihoods.

Skepticism regarding the security and environmental benefits of the current generation of food-based biofuels is not new. But the critiques have become sharper and louder since the acceleration of food price increases that threatens to push 100 million people back into hunger, malnutrition, and poverty. Moreover, while past research raised serious questions about the significance of potential climate change benefits from corn-based ethanol, new research that takes into account deforestation and other land use changes concludes that the current generation of food-based biofuels is more likely to contribute to than mitigate global warming. Climate change, in turn, is expected to threaten agricultural sustainability in tropical areas, especially sub-Saharan Africa, making food insecurity an even more serious problem in the future (Cline 2007).

This paper briefly surveys the array of factors behind recent food price spikes, but the focus is on the role that biofuels, especially corn-based ethanol, and policies promoting them, might be playing.[2] To summarize the conclusions:

- Demand for ethanol is the major factor in the rise in corn prices (and an important one in increasing oilseed and palm oil prices).

---

[1] http://yosemite.epa.gov/opa/admpress.nsf/6424ac1caa800aab85257359003f5337/871e4716874340fe8525749e005b43be!OpenDocument

[2] Nora Lustig, a member of the Center's Board of Directors, is writing a paper that explores in detail the broader causes and consequences of rapidly rising food prices, especially for the poor.

- The magnitude of any spillovers to other grains and food products is harder to pin down, but biofuels have had some role by diverting production from and consumption to alternative crops.
- Regardless of its contribution to rising food prices, corn ethanol is not making a significant contribution to the energy security and environmental goals set for it and the policies promoting it are costly to taxpayers and the environment.

Even as some proponents concede the limitations, they nevertheless argue that government support for corn ethanol is necessary as a "bridge" to the next generation of potentially more efficient and environmentally effective biofuels, including those made from agricultural waste, grasses or jatropha (a tropical shrub) grown on marginal land not suitable for food crops, or algae. But development of viable alternatives is slowed rather than accelerated by diverting resources to corn ethanol and creating production and distribution infrastructure that may not be transferable or in the right place if the next generation is eventually developed. Moreover, sugar ethanol from Brazil, which has greater net energy and environmental benefits as long as it does not contribute to further deforestation in the Amazon region, is available now, but is discouraged by an import tax.

Finally, while the food price crisis is not the only, or perhaps even primary, reason to review biofuel policies, critics should also not overestimate the degree to which eliminating subsidies would alleviate the food crisis, at least as long as oil prices stay high. High gasoline prices boost the demand for alternatives and make ethanol a more economically competitive alternative. The tax credit and tariff on imported ethanol do support the US ethanol price and particularly now are helping to offset high corn prices that are squeezing producers' profits margins. Thus, changing those policies might provide *some* relief in the short run. Unfortunately, the tax credit and tariff were extended in the recent farm bill and changes would require additional action by Congress. The Environmental Protection Agency has authority to waive all or part of the mandate for up to a year at any time, but declined to do so in response to a request from Texas Governor Rick Perry, who is concerned about the health of his state's livestock industry. But a waiver would provide little more than symbolic relief in the short run, because it is not binding (production is likely to be above the mandated level this year, unless corn prices remain close to $7 per bushel or oil prices drop well below $120 per barrel).[3] In the longer run, however, the mandate level props up production and could encourage the building of additional capacity.

The Magnitude and Timing of Food Price Increases

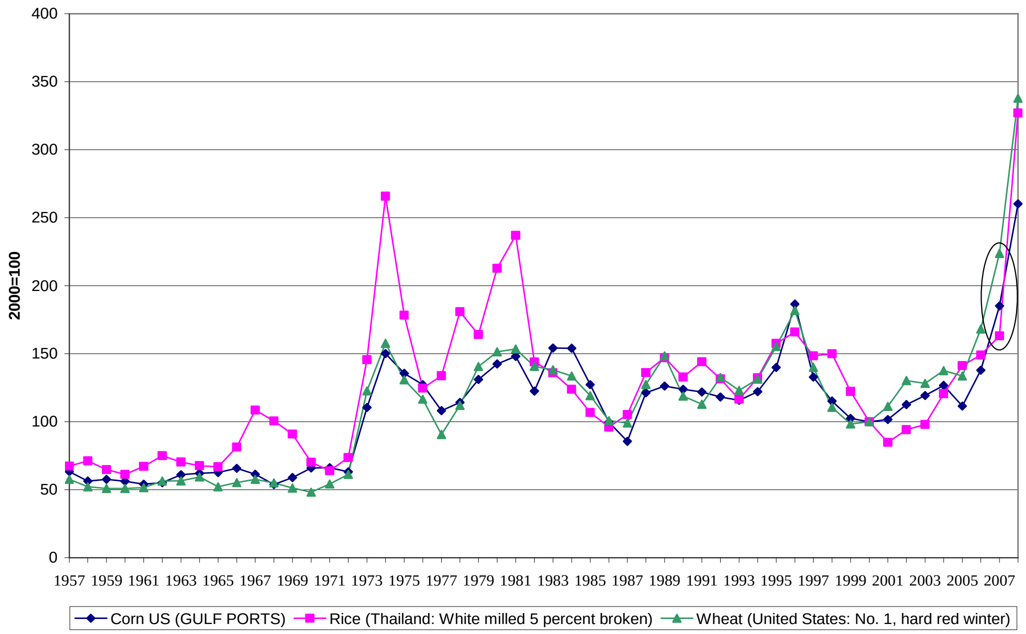
Food prices are notoriously volatile, with average annual changes (up and down) for corn, wheat, and rice of around 13 percent, in nominal terms, over the past 20 years. Figure 1 illustrates these fluctuations over five decades for the major grains and underscores the unprecedented nature of the price spike in the first half of 2008. On average in 2007, only wheat prices were clearly above the level of previous spikes in the mid-1990s or 1970s. But early in 2008 prices for all three grains surged beyond previous peaks. In inflation-adjusted terms, grain and other food prices were up sharply from levels in the late 1990s and early 2000s, but they remain well below the levels reached in the 1970s. Still, there are indications that the long downward trend in real food prices may have reversed in recent years (OECD-FAO 2008; UN FAO-2008). In the past,

[3] Tyner and Taheripour (2008), cited in UN FAO (2008).

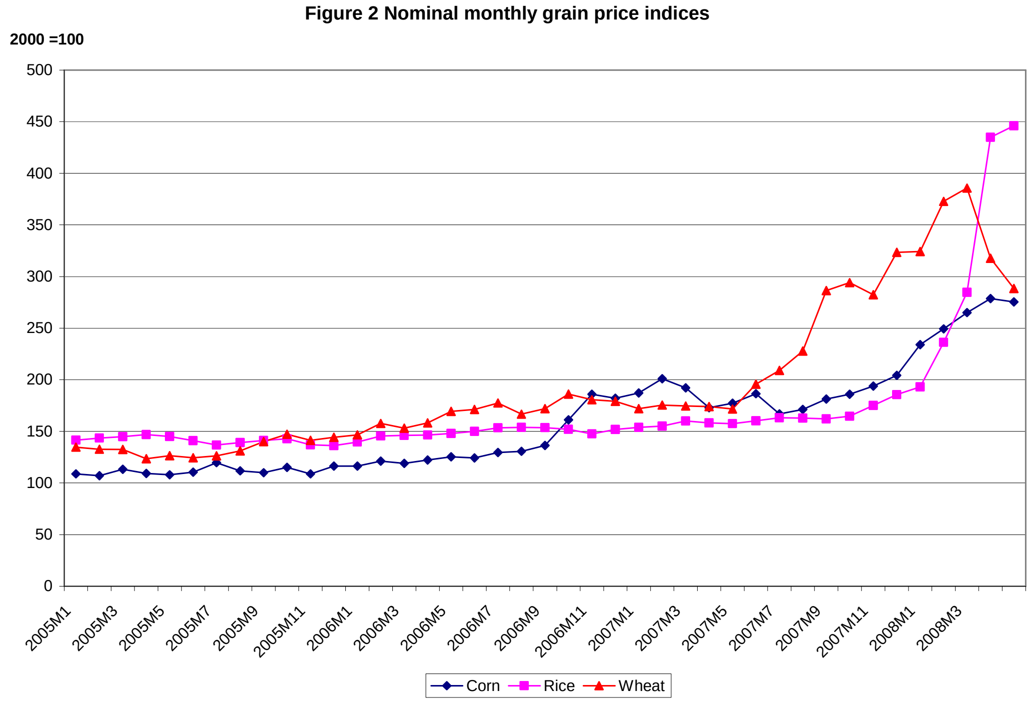
farmers responded to high prices by increasing production. Increasingly, however, the supply response may be constrained by limitations on available land and water.

One of the factors that made the recent price increases so disruptive is the speed with which they occurred. Figure 2 shows monthly price trends since 2005 when the price increases for corn and wheat began to accelerate. It underscores how rapidly prices rose over the past year, especially for wheat, beginning in mid-2007 and again for all three commodities in late 2007 and the first months of 2008. From 2000-07, prices for corn, rice, and wheat by rose 85, 63, and 124 percent, respectively. For corn and wheat, most of the rise has occurred just since 2005, 66 and 67 percentage points, respectively. The rice price, after increasing more rapidly than the other grains early in the 2000s, slowed in 2005-07, but then surged in 2008, as did corn and wheat prices to a lesser degree.

Figure 1 Nominal grain prices



NB: The last data point is for the first half of 2008 only.



Source for Figures 1, 2: International Monetary Fund, *International Finance Statistics (IFS) on CD-ROM*.

Factors behind Food Price Increases

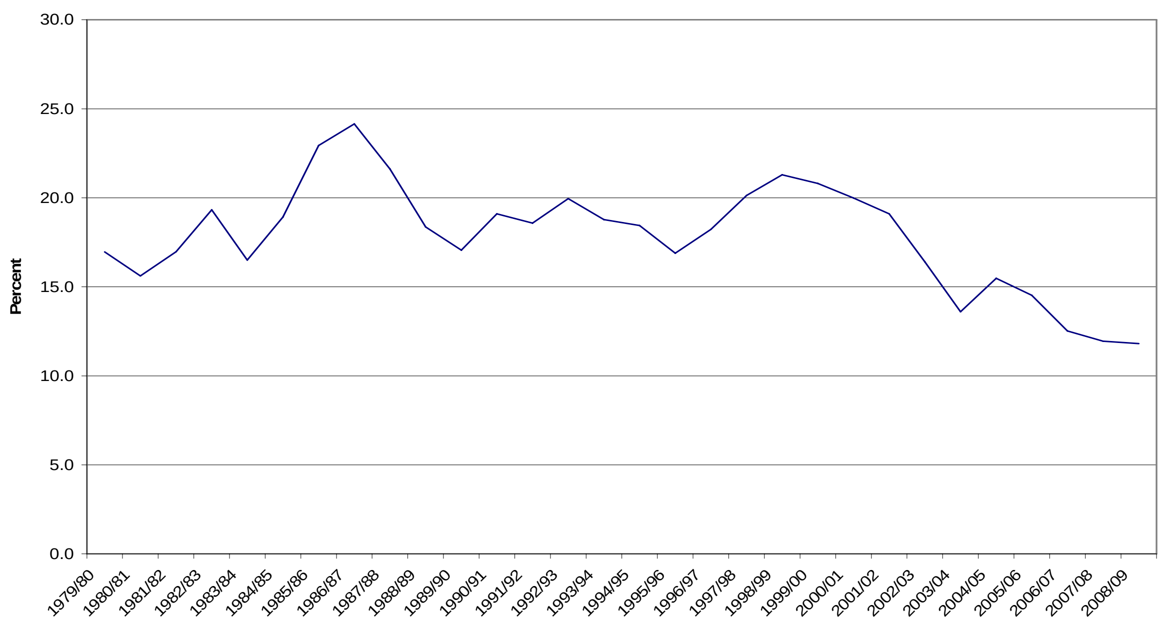
Longer run trends in both food supply and demand contributed to a situation where global grain stocks reached historic lows in recent years. Much of the global adjustment was due to China drawing down stocks that had reached unusually high levels in the late 1990s, but US stocks have also fallen to low levels in recent years (Schnepf 2008, p. 6; Abbott et al. 2008, p. 12). Low stocks were not the trigger for the recent price spikes, but they set the stage for them. Tight supplies meant there was very little cushion to absorb sudden changes in demand, such as for biofuels, and cyclical supply shocks, such as the prolonged drought in Australia, and that, in turn, amplified the price effects. The market effects driving prices up were further exacerbated by macroeconomic trends and shocks outside agriculture, including the declining dollar, which boosted demand for US exports, the popping of the real estate bubble, and inflationary expectations, which drove investors and speculators into commodity futures markets as a hedge (Trostle 2008).[4]

The longer run trends driving stocks down include rising demand in large developing countries, especially for meat and dairy products, which require several pounds of grain for each pound of meat produced.[5] On the supply side, investments in agriculture have been declining for more than two decades, especially in developing countries. While the latter is reversible, albeit limited

[4] The role of financial speculation in recent commodity price increases remains highly disputed. For a detailed analysis concluding that such speculation has not played a major role, see Sanders, Irwin, and Merrin (2008).
[5] The ratio ranges from nearly 3:1 for poultry to around 7:1 for pork and beef (Trostle 2008, p. 12). While China and India have attracted significant attention in this context, Abbott et al. (2008) point out that both countries pursue policies of self sufficiency and trade very little, thus the largest impact from increasing demand is yet to come.

by physical limits on available land and water, the former, a result of growth and rising incomes, is both welcome and here to stay. Also on the supply side, subsidies and trade protection provided by rich countries to their farmers, which averaged a third of gross farm receipts from the mid-1980s to the early 2000s, pushed down world prices and discouraged increased investments and production in developing countries (Elliott 2006). These trends, in turn, contributed to stocks of corn, rice, and wheat that peaked in the late 1990s at over 500 million metric tons and then fell to 300 million metric tons, just over 10 percent of needs (Figure 3).

Figiure 3 World grain stocks to use



Source: USDA, Production, Supply, and Distribution database.

In addition to these long-run trends, sharply rising energy prices both increased the demand for alternative fuels, such as ethanol, and raised production costs. Demand, and prices, for corn and vegetable oils, for example, rose sharply as fuel uses competed for limited supplies. On the cost side, fertilizer prices, which are energy-intensive in production, were two to four times higher in May 2008 than the average for 2006, while the price of phosphate rock had climbed seven-fold.[6] The declining dollar also contributed by dampening price increases in foreign currency terms, which increased demand for US exports and further boosted the US dollar price.[7] Adverse weather events, especially in key wheat-producing areas, also contributed to unusually tight supplies. Over the longer run, climate change is projected to exacerbate drought in some areas, especially sub-Saharan Africa, and floods in others (Cline 2007). Table 1 summarizes the factors contributing to the food price crisis.

---

[6] World Bank, Commodity Price Data (Pink Sheets), various issues.

[7] Abbott et al. (2008) argue that the role of dollar depreciation has been under appreciated in most analyses of the food price story.

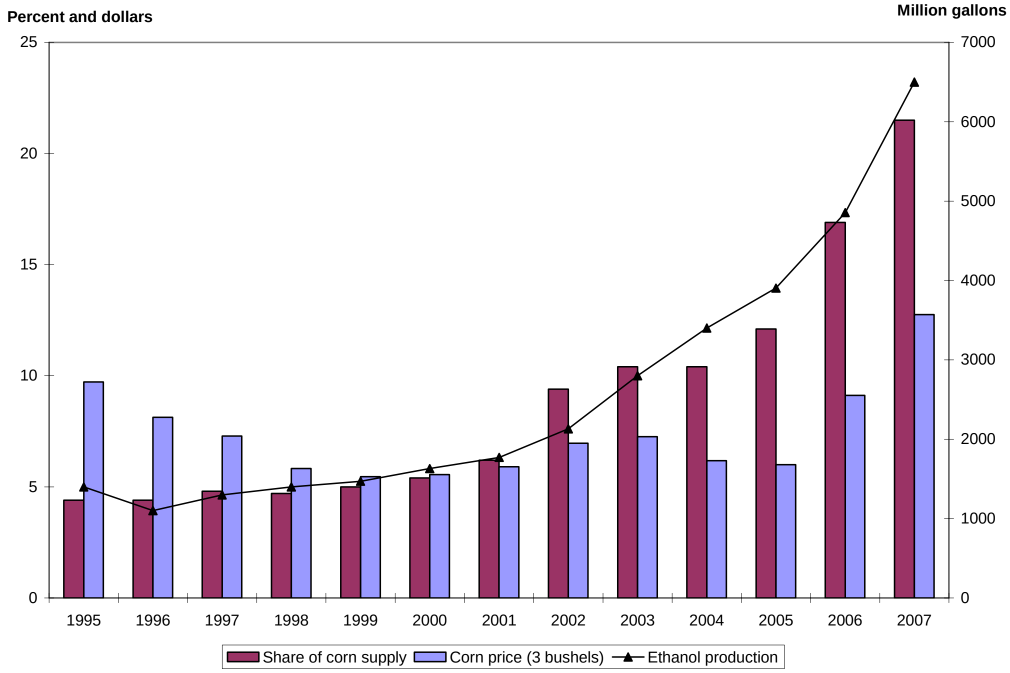
Table 1 An Illustration of Factors in the Food Price Crisis		
	Demand Side	**Supply Side**
Long run	Growth, rising incomes in developing countries leading to increased demand for meat, dairy products and indirect demand for grains	Inadequate investments in research and development, infrastructure, and extension services to increase productivity
Effect of long run trends: Demand growth > Supply growth = Declining stocks		
Recent, emerging	Biofuels demand	Rising energy, other costs
Short-run, cyclical	Financial speculation?	Adverse weather Bad policies, including export restrictions, hoarding and pre-emptive buying, price controls, untargeted subsidies

Biofuels and Food Prices

Figure 4 illustrates the links between feed corn prices and the share of corn production in the United States going into ethanol, as well as production of ethanol. There is not much correlation between the corn price and ethanol production until 2005-06, when ethanol production, the share of US corn production going to ethanol, and corn prices all surged upward.

Most analyses conclude that increased demand for ethanol has been the major factor in rising corn prices (for example, Yacobucci and Schnepf 2007; Collins 2008). But ethanol supporters argue that ethanol demand has little or nothing to do with the recent food price increases because people do not eat feed (yellow) corn. While true, people do indirectly eat feed corn when they eat meat, especially poultry, dairy products, and eggs. Prices of the latter two items are projected to rise roughly 50 percent in the United States this year (Yacobucci and Schnepf 2007). The story around the increased price of staple grains that people eat, including white corn, wheat, and rice, is more complicated.

Figure 4 Corn markets and ethanol production



Source: Renewable Fuels Association, Industry Statistics, online; USDA, Economic Research Service, Feedgrains Database, online.

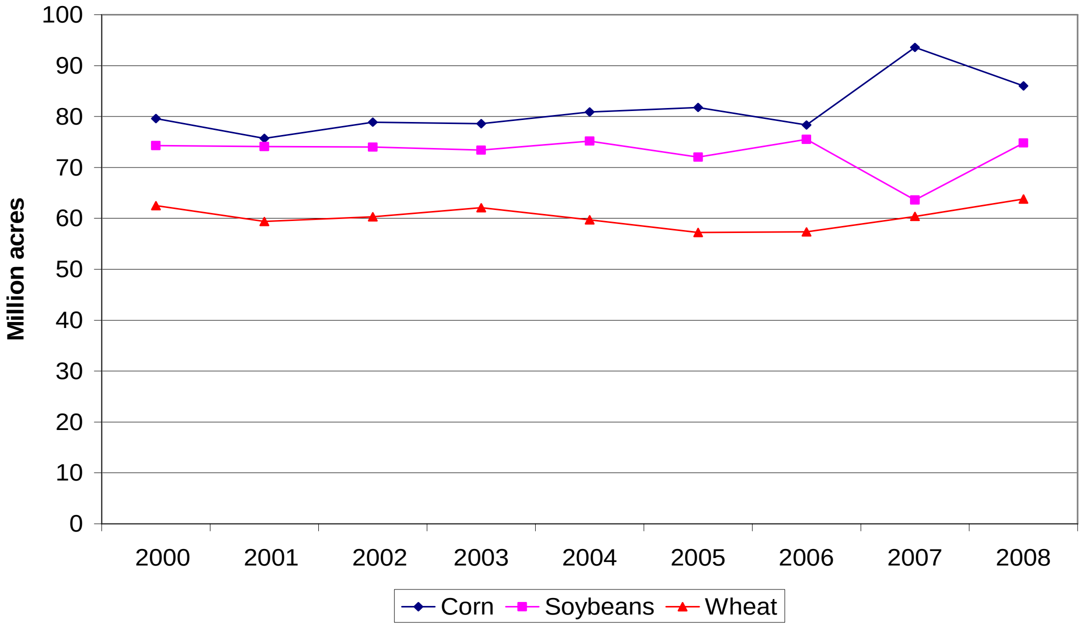
There are two main channels by which increased demand for corn-based ethanol might affect other grain prices:

- By shifting acreage from production of other crops to corn, thereby reducing supplies and raising prices for the competing crops.
- By shifting consumption, by both people and animals, from corn to other staple grains.

In the United States, many farmers rotate land between corn and soybeans to maintain soil quality and yields. Wheat and corn-growing areas overlap only along the fringes and relatively little substitution of corn for wheat in production would be expected. While the number of acres planted in wheat did decline slightly from 2003 to 2005 as corn acreage was increasing a bit, the big surge in acres planted in corn when ethanol demand surged in 2006-07 came out of soybean acres (figure 5). But the sharp rise in soybean prices induced farmers to reverse some of the production shift in the United States.

Biofuels thus contributed to rising oilseed prices through both channels—by diverting acreage from soybeans to corn in the United States, and by increasing demand for oilseeds for biodiesel in Europe. But plantings of wheat are up sharply this year in response to high prices and production is expected to be nearly 10 percent above the average for the past three years (USDA 2008). As shown in figure 2, this contributed to a significant softening in wheat prices.

Figure 5 Acreage planted by commodity



Source: USDA, Economic Research Service, Feedgrains Database, online.

It is more difficult to identify a link between biofuel demand and the surge in rice prices early in 2008. Land and climatological conditions appropriate for growing rice are generally not suitable for the other crops so one would expect relatively little diversion of acres planted in rice to corn. Nor would one expect diversion of consumption from other grains to rice to be a very large part of the rice price story—aside from the Indian subcontinent where both rice and wheat are important (see below). Only about a third of rice consumption occurs outside Asia, where rice accounts for 50 percent of daily calories consumed. In Latin America and Sub-Saharan Africa, however, roughly 15 percent of calories are provided by corn versus 8-9 percent from rice, so some switching in reaction to high corn prices is possible (Table 2). Wheat makes up another 7 to 13 percent of daily calories consumed in Sub-Saharan Africa and Latin America, respectively, and consumption-switching could again be a part of the rice story, but not seemingly a large one.

Moreover, since the wheat price rise was somewhat ahead of that for the other grains, it is not clear that the wheat price story can be explained by consumption switching from corn, and, as shown above, there was relatively little production diversion, at least in the United States, which accounts for roughly 10 percent of global production and a quarter of exports (figures 2, 5, and data from USDA op cit.). There were, however, a number of adverse weather events in key wheat-producing areas, including Australia and Ukraine.

Table 2 Sources of Daily Calories in Developing Countries, 2002

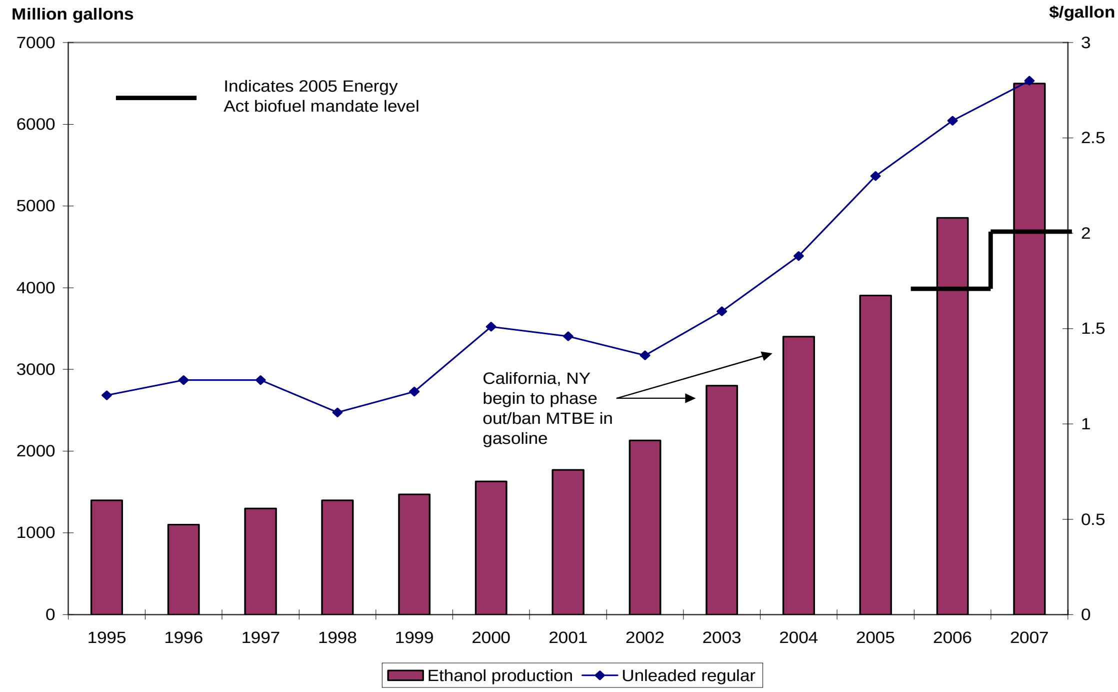
	Sub-Saharan Africa		**Latin America, Caribbean**		**South Asia**		**East, SE Asia**	
	Percent of daily calories:	Import share	Percent of daily calories:	Import share	Percent of daily calories:	Import share	Percent of daily calories:	Import share
Cereals, starchy roots	66	21	40	31	63	2	64	25
Wheat	7	77	13	62	21	3	6	105
Rice	8	42	9	16	35	negl.	49	5
Maize	15	9	14	18	2	2	5	38
Sorghum, millet	14	1	negl.	33	3	negl.	negl.	negl.
Starchy roots	20	negl.	4	2	2	negl.	4	6
Vegetable oils	8	32	10	33	9	52	7	32
Animal products	6	16	20	11	8	1	9	26
Source: FAOSTAT, archived Food Balance Sheets.								

In addition, as Slayton and Timmer explain (2008), weather-related damage to the local wheat crop in 2006 and the desire to avoid expensive wheat imports were behind the Indian decision in late 2007 to ban exports of non-basmati rice in order to ensure adequate domestic food supplies. That, in turn, triggered export bans and hoarding elsewhere in Asia, which was a major factor in the rice price spike in early 2008. Mitchell (2008) attributes the Indian decision to avoid expensive imports to tight supplies and high prices that he argues were caused to a significant degree by increased demand for biofuels. Thus, the rice panic story is related in his view to biofuels production and that sharp price rise (at least as of February this year when his analysis stops) is included in his assessment that “three-quarters of the 140 percent actual [food price] increase was due to biofuels and the related consequences of low grain stocks, large land use shifts, speculative activity, and export bans” (ibid., p. 1).

In sum, most analysts have concluded that the increase in ethanol production is the major cause of rising corn prices since 2005 (Yacobucci and Schnepf 2007; Collins 2008). Along with some shifts in plantings, weather seems to be an important factor in the case of wheat, and speculative hoarding and panic the main cause for price rises in the case of rice in Asia. Mark Rosegrant of the International Food Policy Research Institute estimates that from 2000-2007, biofuels caused 39 percent of the rise in corn prices, 21 percent for rice (keeping in mind that much of the rice price surge occurred just this year), and 22 percent for wheat. He estimates that biofuels account for 30 percent of the overall weighted average increase in grain prices over that period. The OECD similarly blames biofuels for a third of the projected increase in cereal and oilseed prices over the next decade, relative to the average level over the past decade (Boonekamp 2008, p. 17). Mitchell’s estimate that 75 percent of the food price increase is due to biofuels and related supply effects is very much on the high side.

Energy, Food Prices, and US Biofuel Policy
Rising energy prices affect food prices on both the supply and demand sides. Rising oil and natural gas prices raise the costs of producing food and transporting it to markets. Agriculture in rich countries, where commodities are produced using diesel-powered machines and large amounts of fertilizer and pesticides, which in turn are energy-intensive in their production, is particularly affected by rising energy costs. And, on the demand side, rising gasoline prices make ethanol and other biofuels economically attractive. Figure 6 illustrates the correlation between gasoline prices and ethanol production.

Figure 6 Gasoline prices and ethanol production



Source: Renewable Fuels Association, Industry Statistics, online.

The chart also indicates some of the effects of government policies affecting ethanol production. Congress approved subsidies for adding ethanol to gasoline following the first oil price shock (and commodity boom) in the 1970s. Today, there are a plethora of federal and state subsidies for biofuels, but the most important are a credit against the excise tax on gasoline, an import duty designed to offset the benefits of the tax credit for foreign-produced ethanol, and a mandate setting minimum levels of biofuels use in transportation fuels and home heating oil.

The credit against the federal excise tax on gasoline has changed in details but it has fluctuated around $0.50 a gallon over the years. It was reduced to $0.46 a gallon in the 2008 farm bill in years in which ethanol production is above 7.5 billion gallons. In addition, there is a $0.54 per gallon tariff, primarily to discourage imports of sugar-based ethanol from Brazil.[8] In the 1990 Clean Air Amendments Act, the federal government required refiners to seasonally mix oxygenates in gasoline to reduce pollution in certain regions with particularly severe air pollution. Methyl tertiary butyl ether, better known as MTBE, was the favored additive until it was discovered that it was leaking into groundwater and creating a potential health hazard.

Demand for ethanol as an oxygenate jumped in the early 2000's when several large states, including California and New York began phasing out the use of MTBE as an additive. The 2005 energy act, with the intent of reducing dependence on imported oil, added a broader mandate for replacing gasoline with a minimum level of renewable fuels, mostly corn-based ethanol. The Global Subsidies Initiative estimated in Fall 2007 (before recent changes in energy and farm legislation) that the total cost to consumers and taxpayers of the support for biofuels in the United States would be roughly $10 billion per year from 2006 to 2012 (Koplow 2007).

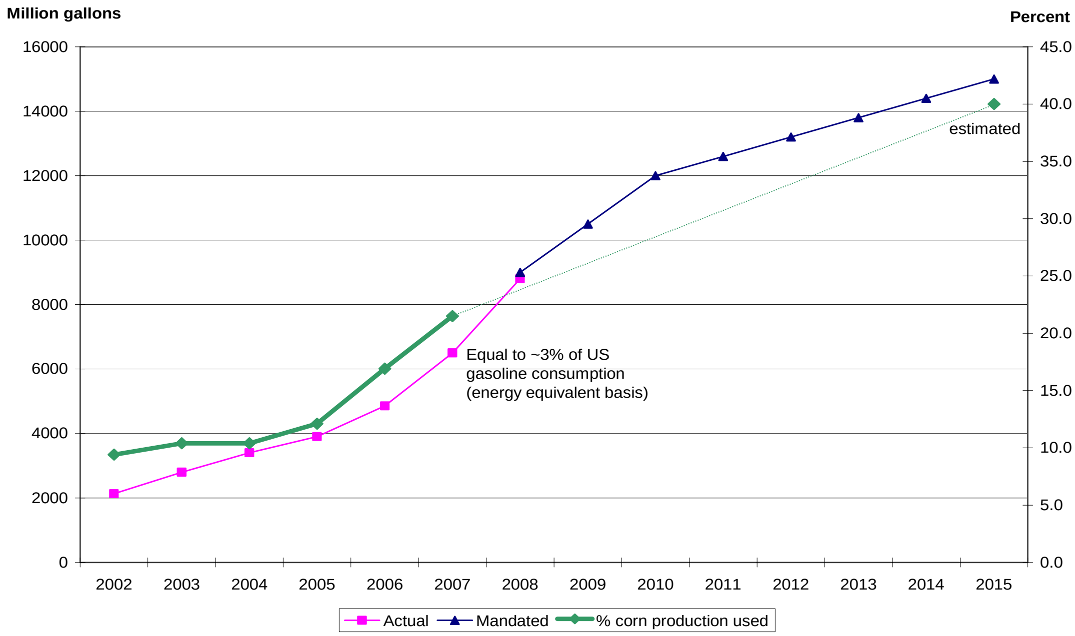
As shown in Figure 6, however, the initial mandate levels in the 2005 energy act were non-binding because the rising price of gasoline was driving demand for ethanol above prescribed levels. In 2007, in another effort to reduce dependence on imported oil, Congress doubled the mandated level for using renewable fuels to 9 billion gallons in 2008 and 15 billion gallons by 2015. The mandate continues to rise to 36 billion gallons in 2022, of which no more than 15 billion gallons should be from corn and the rest from "advanced" biofuels. In addition to development of the technology for advanced biofuels, however, automobile technology and regulatory policy will also have to evolve if the mandate is to be met. Currently, EPA regulations prohibit use of ethanol blends higher than 10 percent, called E10, except in "flex" vehicles, and automobile manufacturers will not warranty conventional vehicles running on blends of more than 10 percent ethanol because of concerns that higher levels could harm automobile engines.[9] While that would theoretically suggest a real-world limit for ethanol of around14 billion gallons, if gasoline consumption remains at around 140 billion gallons annually, experts say the real cap is around 11-12 billion gallons because of logistical constraints and state regulations with ethanol caps below 10 percent (Rohde 2008).

Figure 7 shows actual levels of production through 2008, with projected production expected to be at roughly the mandated level and then shows the mandate rising to 15 billion gallons by 2015, when it would require more than 40 percent of US corn production, based on recent acreage and yields (and assuming that the technical and regulatory issues are resolved). Conservatively assuming no increase in gasoline consumption from the current level of 140 billion gallons annually, and taking into account that a gallon of ethanol produces only about two-thirds as much energy as a gallon of gasoline, using nearly half the US corn crop for ethanol would reduce gasoline consumption by only around 7 percent, which seems a high cost for such a small step towards reduced dependence on imported oil. Another argument for ethanol that has been made in the midst of the current "energy crisis" is that it has prevented gasoline prices

[8] In fact, the United States scheduled the duty under the heading of "other duties and charges," as allowed by the Uruguay Round Agreement on Agriculture concluded in 1993. These other duties and charges are not a subject of the ongoing Doha Round negotiations on tariffs and will not be cut if an agreement on market access is reached.
[9] Flex vehicles can run on any combination of gasoline and ethanol. Brazil requires that all gasoline contain 20-25 percent ethanol and American supporters of ethanol, including Senator John Thune (R-SD) have appealed to the administration to raise the cap for conventional vehicles, but no action had been taken at the time of writing (http://www.greencarcongress.com/2007/03/thune_pushes_fo.html).

being even higher—20-40 cents higher by one estimate (Du and Hayes 2008). But to the degree that reduced consumption must be a part of any strategy for reducing dependence on fossil fuels and greenhouse gas emissions, then lower prices create perverse incentives.

Figure 7 US ethanol production: actual and mandated



Source: Renewable Fuels Association, Industry Statistics, online.

Ethanol production capacity was just over 8 billion gallons in early 2008, with another 5 billion gallons of capacity under construction. Bruce Babcock of Iowa State University's Center for Agricultural and Rural Development (CARD) estimates that removing the mandate would, in the short run (with high gasoline prices), reduce ethanol production by 4 percent and corn prices by only 1.2 percent. In the short run, the tariff and tax credit for blending ethanol in gasoline are more important because they help to offset the rising costs of corn, which is squeezing producer margins at current prices. Eliminating all three would reduce ethanol production by 21 percent but the corn price by only 12.5 percent. In the longer run, the CARD model underscores the close links between ethanol production, corn prices, and the price of gasoline. Even with the elimination of federal biofuel policies (many states have their own), Babcock estimates that, if wholesale gasoline prices stay at $3.00 per gallon, ethanol production would rise to 14 billion gallons, nearly the mandated level for 2015, and the corn price would stay at $4 per bushel, roughly the average price for 2007.

Illusory Benefits of Food-Based Biofuels

Recognizing the negative effects for food markets, Congress limited corn-based ethanol to 15 billion gallons when it set the mandate for 36 billion gallons of biofuels by 2022 to replace gasoline and home heating oil. As noted, that is also about the regulatory limit for blending ethanol in gasoline (10 percent) given gasoline consumption of roughly 140 billion gallons annually. As shown in Figure 7, when the lower energy value of ethanol is factored in, the mandated level would consume nearly half the US corn crop and reduce gasoline consumption by less than 10 percent. Measures to discourage consumption and promote efficiency in energy use would also reduce dependence on foreign oil and without the perverse incentive of lower gasoline prices, which move behavior in the wrong direction in terms of the long-term goals of discouraging oil consumption and reducing carbon emissions.

New scientific research also suggests that the climate change benefits of corn ethanol are not only illusory but that the sign is wrong. Previous life-cycle analyses of the impact on greenhouse gas emissions (taking into account the energy used in producing it) suggest that corn-based ethanol can reduce emissions by roughly 20 percent, depending on the process and the fuel used to refine it (biomass, natural gas, or coal). [10] Corn is a relatively energy-intensive crop and requires large amounts of water as well; run-off from the chemicals used to grow it also contributes to water pollution and, given the heavy production along the Mississippi, the large and growing dead zone in the Gulf of Mexico. These environmental costs are rarely calculated in assessing the alleged benefits of ethanol.

In addition, new research recognizes that increased demand for biofuels is likely to lead to new land being brought into production, either directly to produce the feedstock or indirectly by bidding up food prices and encouraging increased production of food on new land elsewhere. Chopping down forests or plowing up grassland releases the carbon that is stored, both in the plant and in the soil.

One recent study calculates the “carbon debt” created when forests or native grasslands are converted to biofuel feedstock production. Depending on the type of land converted and the type of biofuel produced, the time it would take to repay the carbon debt due to land use changes varies from 0, for grasses grown on marginal cropland, to 423 years for palm biodiesel produced from peatland rainforest. It would take more than 300 years to repay the carbon debt from deforestation of the Amazon to produce soybean biodiesel (Fargione et al. 2008, p. 1236). Sugarcane ethanol is the most efficient of the biofuels examined but even in that case, if demand for sugar for ethanol leads to land use changes, it would take 17 years to repay the carbon debt created (ibid.; also see box). The carbon debt created by corn ethanol produced from native grasslands in the United States would take 93 years to repay and 48 years if the corn is grown on abandoned cropland, such as the acreage that might be released from the US Conservation Reserve Program (CRP). In addition to the carbon emissions, renewed production on CRP land could contribute to local water pollution, soil erosion, and loss of wildlife habitat.

A second study tries to estimate the impact on greenhouse gas emissions when new land is converted to grow food if demand for food-based biofuels grows. In assessing the potential impact of diverting enough corn to produce 15 billion gallons of ethanol, the authors obviously must make a number of assumptions about the type of land and number of additional acres that might converted for food production, as well as where, and this creates significant uncertainty regarding the precision of the estimates. Qualitatively, the results are the same as those above in

---

[10] The Congressional Research Service (Yacobucci and Schnepf 2007) reviewed the literature on corn-based ethanol and found that the central estimate was that a gallon of ethanol contains, on average, 20 percent more energy than the energy that goes into producing it and that it reduces greenhouse gas emissions by 10-20 percent relative to gasoline., pp. 9, 12. See also EPA 2007; Searchinger et al. 2008, p. 1239.

finding that the net effect of increased production of corn-based ethanol would increase greenhouse gas emissions. Specifically, this study concludes that:

> Over a 30-year period, counting land-use change, GHG [greenhouse gas gas] emissions from corn ethanol nearly double those from gasoline for each km [kilometer] driven. (Searchinger et al., p. 1239)

Box 1 Is Sugar Ethanol Different?
Ethanol made from sugar cane is far more efficient, both economically and environmentally, than that made from corn, though the industry in Brazil, like the one in the United States, required substantial subsidies to get it off the ground. The government provided low-cost loans to processors and encouraged the development of "flex-fuel" cars to further encourage ethanol use, and it continues to require that all gasoline contain at least 20-25 percent ethanol (Goldemberg 2008, p. 1). With government support to cover the fixed costs of building production capacity and the distribution infrastructure, and with oil prices at well over $40 a barrel, sugar ethanol is competitive without subsidies and is replacing roughly 40 percent of the gasoline that would otherwise be consumed in Brazil (ibid., p. 2).

According to one study, US corn-based ethanol costs nearly three times as much to produce as Brazilian sugar ethanol and is still 70 percent more costly even after accounting for the sale of byproducts and government subsidies (ibid.). With corn, there is an extra step because the starch must be converted to sugar, which is then distilled into alcohol. In addition, bagasse, the fiber left after the sugar-containing juice is extracted from the cane, is used to power ethanol processing plants, which both lowers costs and provides environmental benefits relative to the coal or natural gas most often used to process corn ethanol.

Studies also suggest that sugar ethanol contains eight to ten times as much energy as goes into producing it and that it reduces greenhouse gas emissions by around 80 percent relative to gasoline, excluding land-use changes (ibid., *The Economist,* June 26, 2008). While concerns have been raised that increased sugar production for ethanol could contribute to further deforestation in the Amazon ecosystem, analyses do not suggest that is likely at least for the short-to-medium run. Sugar itself is not grown around the Amazon because it is too wet but it might indirectly contribute to deforestation if it displaced soybeans or cattle-grazing that were then relocated to the Amazon. But sugar cultivation currently occurs on just 2 percent of the land used for agriculture and grazing in Brazil and studies suggest that planned expansion of sugarcane will come mostly from degraded grazing land (Goldemberg 2008). Still, there should be safeguards to ensure that ethanol expansion does not indirectly contribute to further degradation of the Amazon.

Conclusions and Recommendations
While the precise contribution of biofuels to surging food prices is difficult to know, policies promoting production of the current generation of biofuels are not achieving their stated objectives of increased energy independence of reduced greenhouse gas emissions. Corn ethanol cannot make a significant dent in petroleum consumption without changes in automobile

technology and huge increases in the share of food (corn, soy, and palm oil) production diverted to fuel. Nor are these biofuels contributing to slowing climate change because new lands must be plowed to grow food. In sum, the food crisis adds urgency to the need to change these policies but does not change the basic fact that there is little justification for the current set of policies.

Specifically, if all of the Congressionally-mandated goal of 15 billion gallons of renewable fuels for transportation and home heating oil by 2015 were blended into gasoline, it would replace just 7 percent of current gasoline consumption and use roughly 40 percent of the corn crop (based on recent production levels). Moreover, while it has long been known that the net energy and greenhouse gas emission benefits of corn-based ethanol are relatively small, because its production is energy-intensive, recent scientific studies suggest that the current generation of biofuels, including biodiesel made from palm oil, soybeans, and rapeseed, as well as corn-based ethanol, actually adds to greenhouse gas emissions relative to petroleum-based fuels when land use changes are taken into account. That is, greenhouse gases are released when forests are cut down or grasslands cleared to plant biofuels, or food is planted on new acreage to replace crops diverted to fuel elsewhere. Sugar is far more efficient as a source of ethanol and may have a role to play, but the situation must still be monitored carefully to ensure that soybean and cattle production displaced from sugar-growing areas does not lead to accelerated clearing of tropical forests in the Amazon region.

EPA Administrator Johnson, or his successor, has the authority under the Energy Independence and Security Act of 2007 to suspend all or part of the mandate if there is a “significant renewable feedstock disruption or other market circumstance” (Sissine 2007). While the current food crisis, exacerbated by this spring’s flooding along the Mississippi, would seem to qualify, Johnson declined Texas Governor Rick Perry’s April petition to suspend half of the mandate for this year. Next year, the EPA should revisit this decision, giving Congress time to reconsider the mandate, either revoking it, the preferred option, or at least lowering it to no higher than the 2007 level. Congress should also pass new legislation revoking the excise tax credit and tariff, or at least allow the tariff to expire in 2010 as scheduled. If any money is saved from elimination of the tax credit, it could be dedicated to research and development of the next generation of biofuels using agricultural waste or perennial crops that can be produced on marginal lands not suitable for food crops (and without existing forests) and with minimal inputs.

At the same time, continued attention and additional steps will be needed to address the food price crisis. If oil prices stay above $60-80 per barrel, demand for ethanol as an alternative will remain relatively high, even without government intervention. That underscores the need for conservation measures to reduce energy use and for significant increases in investments in agriculture in developing countries, as proposed by UN Secretary General Ban Ki-moon, World Bank President Robert Zoellick, and others.[11]

[11] See the forthcoming Lustig paper for details.

References and Additional Reading

Abbott, Philip C., Christopher Hurt, and Wallace E. Tyner. 2008. "What's Driving Food Prices?" Farm Foundation, July.

Babcock, Bruce. "Statement before the U.S. Senate committee on homeland security and government affairs." Hearing on Fuel Subsidies and Impact on Food Prices. May 7 2008, 10:00am. Washington DC.

Boonekamp, Loek. 2008. "The grain of truth: Food prices have risen sharply. Why?" *OECD Observer*, no 267 (May-June): pp. 16-17.

Cline, William R. 2007. *Global Warming and Agriculture: Impact Estimates by Country.* Washington: Center for Global Development and Peterson Institute for International Economics.

Collins, Keith. 2008. *The Role of Biofuels and Other Factors in Increasing Farm and Food Prices: A Review of Recent Developments with a Focus on Feed Grain Markets and Market Prospects.* Supporting material for a review conducted by Kraft Foods Global, Inc. of the current situation in farm and food markets, June 19. Available at http://www.foodbeforefuel.org/facts/studies/role-biofuels-and-other-factors-increasing-farm-and-food-prices.

Du, Xiaodong, and Dermot J. Hayes. 2008. The Impact of Ethanol Production on U.S. and Regional Gasoline Prices and on the Profitability of the U.S. Oil Refinery Industry. Working Paper 08-WP 467. Center for Agricultural and Rural Development, Iowa State University Ames, Iowa, April.

Elliott, Kimberly Ann. 2006. *Delivering on Doha: Farm Trade and the Poor.* Washington: Center for Global Development and the Peterson Institute for International Economics.

Fargione, Joseph, Jason Hill, David Tilman, Stephen Polasky, and Peter Hawthorne. 2008. "Land Clearing and the Biofuel Carbon Debt." *Science*, vol. 319 (29 February): pp. 1235-1238.

Koplow, Doug. 2007. *Biofuels – At What Cost? Government support for ethanol and biodiesel in the United States: 2007 Update*. Global Subsidies Initiative. Geneva, Switzerland: Institute for International Sustainable Development.

Mitchell, Donald. 2008. "A Note on Rising Food Prices. Policy Research Working Paper No. WPS 4682. Washington: World Bank, July.

Naylor, Rosamond L., Adam J. Liska, Marshall B. Burke, Walter P. Falcon, Joanne C. Gaskell, Scott D. Rozelle, and Kenneth G. Cassman. 2007. "The Ripple Effect: Biofuels, Food Security, And the Environment." *Environment*, vol. 49, no. 9 (November): pp. 30-43.

OECD-FAO. 2008. *Agricultural Outlook: 2008-2017.* Paris and Rome.

Rohde, Peter. 2008. " New Challenges for Ethanol." *Kiplinger Business Resource Center,* February 21. Available at www.kiplinger.com.

Rosegrant. Mark W. 2008. "Biofuels and Grain Prices: Impacts and Policy Responses", International Food Policy Research Institute, Washington DC.

Sanders, Dwight R., Scott H. Irwin, and Robert P. Merrin. 2008. The Adequacy of Speculation in Agricultural Futures Markets: Too Much of a Good Thing? Marketing and Outlook Research Report 2008-02. Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign (http://www.farmdoc.uiuc.edu/marketing/morr/morr_archive.html).

Schneph, Randy. 2008. Higher Agricultural Commodity Prices: What are the Issues. CRS Report for Congress, No. RL34474. Washington: Congressional Research Service, May 29, updated.

Searchinger, Timothy, Ralph Heimlich, R.A. Houghton, Fengxia Dong, Amani Elobeid, Jacinto Fabiosa, Simla Tokgoz, Dermot Hayes, Tun-Hsiang Yu. 2008. "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change." *Science,* vol. 319 (29 February): pp. 1238-1240.

Sissine, Fred. 2007. Energy Independence and Security Act of 2007: A Summary of Major Provisions. Congressional Research Service (CRS) Report for Congress, Washington DC.

Slayton, Tom, and Peter Timmer. 2008. Japan, China and Thailand Can Solve the Rice Crisis—But U.S. Leadership Is Needed. CGD Notes. Washington: Center for Global Development, May.

Trostle, Ronald. 2008. Global Agricultural Supply and Demand: Factors Contributing to the Recent Increase in Food Commodity Prices. Economic Research Service, WRS-0801. Washington: US Department of Agriculture, May.

Tyner, W. E., and F. Taheripour. 2008. Policy Options for Integrated Energy and Agricultural Markets. Paper presented at a Conference on Transition to a Bio-Economy: Integration of Agricultural and Energy Systems, sponsored by Farm Foundation. Atlanta, February 12-13.

United Nations, Food and Agricultural Organization (UN FAO). 2008. Soaring Food Prices: Facts, Perspectives, Impacts and Actions Required." Prepared for the High-Level Conference on World Food Security: The Challenges of Climate Change and Biodiversity, June 3-5. Rome.

US Department of Agriculture (USDA). 2008. Grain: World Markets and Trade. Foreign Agricultural Service, Circular Series FG 06-08. Washington, June.

US Environmental Protection Agency. 2007. Greenhouse Gas Impacts of Expanded Renewable and Alternative Fuels Use. Emission Facts, EPQ 420-F-07-035. Office of Transportation and Air Quality. Washington, April.

Yacobucci, Brent D., and Randy Schnepf. 2007. "Selected Issues Related to an Expansion of the Renewable Fuel Standard (RFS)." CRS Report No. RL34265. Washington: Congressional Research Service, December.