Biodiesel Developments and Concerns

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With ample supplies of reasonably priced feedstocks, a blenders’ tax credit, and fuel industry acceptance of the product, biodiesel producers in 2013 experienced the best profits since late 2011. Favorable profits led to a sharp increase in production in 2013. However, unsettled government policy issues cloud the industry’s future for the year ahead and possibly longer, and are causing uncertainty in the industry. In this article, we provide more detail on these developments and implications for the biodiesel industry. Biodiesel has advantages over corn-starch ethanol because (1) it is an advanced biofuel and can play a role in helping to meet government-mandated levels of advanced biofuels blending, and (2) it does not have a precise blend wall, although there has been some talk by users that 10% biodiesel and 90% conventional diesel fuel may be a realistic upper limit on the market for now. A disadvantage of biodiesel is that its production cost per gallon has been relatively high when compared to conventional diesel fuel. To help make it competitive and feasible to blend with diesel fuel, it has had a $1.00 per gallon tax credit.
Biodiesel Profitability

When compared with other motor fuels, biodiesel has a relatively short history dating back only to the mid-2000s. Figure 1 shows its estimated profitability in recent years, as well as total costs and total revenue for typical plants using soybean oil as a feedstock. The data shown in the chart are from the AgMrc model, using soybean oil as the feedstock. The model is available at: http://www.agmrc.org/renewable_energy/biodiesel/tracking_the_profitability_of_biodiesel_production.cfm

Soybean oil is the most common feedstock for biodiesel although corn oil, animal fats, and small amounts of oil from minor oilseeds also are used. Costs and profitability vary somewhat, depending on which feedstocks are used in their production.

As shown in Figure 2, feedstock costs are the largest expense of producing biodiesel, by a wide margin. Soybean oil feedstock costs declined from a monthly average of $4.26 per gallon in April 2011 to $2.97 per gallon in November 2012. The reduced cost resulted from a decline in the soybean oil price from $0.56 per pound in April 2011 to $0.39 per pound in November 2013. From mid-November to late January, soybean oil prices declined by an additional 5% to 6%, further reducing the cost of biodiesel production. Soybean prices declined by a much smaller amount during the same period because of increased demand for soybean meal. Strong protein meal demand allowed soybean meal to carry a higher portion of the value of soybeans than in a number of previous years.

U.S. Biodiesel Production Trend

Figure 3 shows monthly U.S. biodiesel production for 2011, 2012, and through October 2013. Data for the charts are from the Energy Information Administration (EIA) of the U.S. Energy Department. (http://www.eia.gov/dnav/energy_detai1.cfm?id=12331) Due to the lag in data availability, October was the latest production information available in late January when this was written. Production data from earlier years are not available.

The decline in production in 2012 reflected the temporary loss of the biodiesel blenders’ tax credit and high feedstock costs. Production increased sharply in 2013 with reinstatement of the blenders’ tax credit and a 28% increase in the Environmental Protection Agency (EPA) mandated volume of biodiesel to be blended in the nation’s diesel fuel supply. Production in July through October of 2013 continued to set record levels, with the industry operating at approximately 72% of monthly capacity. We calculated an approximate monthly capacity by dividing EIA’s estimated annual capacity by 12 months.

Price Relationship of Biodiesel to Diesel Fuel

Figure 4 shows monthly average prices for B-100 (pure, unblended biodiesel) FOB plants in the eastern Corn Belt and the U.S. average highway price for petroleum-based biodiesel since April 2007 (1). The lower line in the chart shows the monthly premium of biodiesel prices over petroleum-based diesel fuel. As indicated by the chart, biodiesel prices in most months have been well above those for diesel fuel.

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Biodiesel & Diesel Fuel Prices through Nov. 2013

Figure 4. Biodiesel & Diesel Fuel Prices through Nov. 2013

Trend in U.S. Distillate Fuel Consumption

Unlike gasoline, the nation’s consumption of distillate fuels has continued its upward trend in the last several years, as shown in Figure 5. Data for the chart are from...
the Energy Information Administration (EIA) of the U.S. Department of Energy (DOE) (2). Exact consumption data are not available, but fuel supplied is a close approximation of consumption. Distillate fuels include No. 1 and No.2 diesel fuel as well as various other fuel oils that are used for heating oil. The potential market for biodiesel includes home heating oil as well as diesel fuel. The last three years in Figure 5 also show monthly biodiesel production (lower right-hand corner of chart). Biodiesel production represents a very small portion of the total domestic distillate fuels market. The record monthly biodiesel production of July-October 2013 represented only 0.36% to 0.38%, or total monthly domestic distillate fuels distribution. Alternatively, October 2013 biodiesel production accounted for 2.58% of monthly distribution of distillate fuel that contained 15 parts per million (ppm) or less of sulfur. This distillate fuel would be a close approximation of distillate fuels used for diesel fuel.

**Major Issue No. 1 for Biodiesel**

The trend in U.S. biodiesel production in 2014 will depend on (1) whether the blenders’ credit is continued and (2) EPA’s mandated volume of biodiesel blending in diesel fuel. Both of these decisions were not yet settled as this was written in late January. If these concerns can be ranked in order of importance, the number one concern for biodiesel producers, fuel refiners and blenders, corn and soybean farmers, and the retail diesel fuel industry is whether the biodiesel blenders’ tax credit will be continued in 2014 and future years. History indicates that it has been essential in maintaining profitability of the industry and in providing a positive return on investment in biodiesel production facilities. Washington, D.C. contacts expect the tax credit will be continued for 2014, but there is no guarantee of that as this is being written.

**Mandated Blending Volume, the Second Major Issue**

Annual mandates for the volumes of biodiesel and other types of biofuels to be blended with U.S. motor fuels originated from the 2007 Energy Independence and Security Act (EISA). The Environmental Protection Agency (EPA) has been assigned to translate these mandates into quantities for individual fuel blenders and to specify the total annual mandate volumes. Two types of biofuels mandates apply to biodiesel. First is the specified biodiesel mandate from the EISA that requires 1.0 billion gallons of bio-based diesel fuel per year for biodiesel to be blended in the nation’s diesel fuel supply for the 2012 through 2022 period. This is a minimum amount to be blended in biodiesel. EPA is given authority to require a higher blending level if economic conditions make that feasible. In 2013, EPA’s mandate for biomass-based diesel fuel was 1.28 billion gallons. EPA has proposed a continuation of this 1.28 billion gallons mandate in 2014 and 2015 (3), and the industry is waiting for an official confirmation of this number. Last year, the final biofuels mandates were issued on August 7.

The second type of mandate that may affect biodiesel is the “Advanced biofuels mandate.” Biodiesel is an advanced biofuel because it reduces carbon emissions by at least 50% from EPA’s baseline level. A portion of the advanced biofuels mandate can be met by biodiesel, provided that it is a lower cost alternative than other advanced biofuels. The 2013 advanced biofuels mandate was 2.75 billion gallons. For 2014, EPA has proposed that this mandate be reduced to 2.2 billion gallons. Cellulosic biofuels are projected to fill 17 million gallons of the 2014 advanced biofuels mandate, up from 6 million gallons in 2013. The major potential sources of advanced biofuels for 2014 are biodiesel and imported sugar-cane ethanol. A very limited amount of advanced biofuel also is expected to come from other sources of advanced biofuel production. Reducing the advanced biofuels mandate from last year could reduce the demand for biodiesel from what it might be with no change in the mandate. As with other biofuels mandates, EPA’s final advanced biofuels mandate for 2014 has not been announced as this is being written, and may not be announced until much later in the year.

**References**

2. EIA, DOE, Monthly Energy Review

Can We Meet the World’s Growing Demand for Food?

We have recently experienced years of variable crop yields and volatile commodity markets. This spectrum has raised the concern of our ability to feed the world’s growing demand for food in the long term. Food demand is expected to increase substantially by the middle of this century. Can we meet this growing demand? More specifically, can we meet this demand without putting enormous pressure on the world’s resources and causing environmental damage? I do not attempt to answer these questions in this article. Rather, I discuss several of the major factors driving the supply and demand for food over the coming decades.

Several issues impacting world demand and supply of food over the next 40 years are examined in this article. The primary demand factors are the world’s growing population and rising incomes in developing countries. Food supply factors of increasing yields, expanding agricultural areas, closing yield gaps and increasing the productivity of crop and animal agriculture are discussed. Additional issues touched on are reducing food waste, improving international trade and reducing/eliminating world hunger. Climate change will also greatly impact future food supply and demand but will be addressed in future newsletters. Another factor that will be addressed in future newsletters is the impact of biofuels on future food supplies.

**Food Demand Factors**

The demand for food is expected to grow substantially by 2050. A major factor for this increase is world population growth. Demographic projections have a high degree of certainty, so projections of future world food needs based on population growth are quite reliable.

The other major factor contributing to this increase is rising incomes of individuals in this growing world population, especially those living in developing countries. Although increasing the incomes of millions of people in the world is a great benefit to those individuals, it does increase food needs and the demands on the world’s agricultural resources.

Increasing people’s income is generated by world economic growth. However, long-term projections of world economic growth are relatively uncertain. Basing expected food needs on projections of future world economic growth has considerable uncertainty.

**Growing Population**

The rate of population growth increased greatly from the 19th to the 20th Century. The year Lewis and Clark embarked on their historic journey in 1804, world population reached one billion people. World population continued to increase but didn’t reach two billion until 1927, 123 years later. At that point, population started to grow rapidly reaching three billion people in 1960, only 33 years later.

Historic and projected world population from 1965 to 2050 is presented in Figure 1. Four billion was reached in 1974 (14 years later), five billion in 1987 (13 years later) and six billion in 1999 (12 years later). The rate of increase seems to have reached its peak at the turn of the century and has begun to slow decline. It is projected that an additional 15 years will be required before we reach eight billion and an ad-


**Figure 1. World Population (1965 – 2050)**

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Figure 1. World Population (1965 – 2050)

Can We Meet the World’s Growing Demand for Food?
The world’s fertility rate declined from almost 5 births per woman in 1950 to a projected 1.6 births per woman by 2050 (13). The current fertility rate is approaching the replacement fertility rate. The fertility rate and population for selected countries are shown in Table 1. Although China’s one-child policy results in a fertility rate well below replacement, other Asian countries like India and the Philippines are well above replacement. The fertility rate of many European countries is below the developed country replacement rate of 2.1. So, population in several of these countries is expected to decline over the next 40 years. The opposite end of the spectrum is countries in Africa such as Nigeria and the Democratic Republic of Congo where the fertility rate is well above replacement rate and population growth is expected to continue into the future. If a woman has two children, she will have replaced herself and her husband. If she has more than two, population will grow. If she has less than two, population will decline. To calculate the replacement fertility rate we must also take into account mortality from birth to reproductive age.

In addition to population growth, food needs will rise due to the increasing incomes of people in developing countries as they move from low income to middle class. As incomes increase, people tend to eat fewer grains and increase their consumption of meat and high value foods. This transition requires higher levels of resource use. It takes multiple pounds of grain to produce a pound of meat. So the total pounds of grain consumed per person, directly as grain and indirectly through meat, increases significantly.

Rising incomes are generated by growing world economies. Although projections of future economic growth are more tenuous than projections of population growth, there is general consensus that the world economy will expand in the long-term in spite of the current financial problems in the developed world. Table 1 shows the increase in world production of top ten major commodities from 1960 to 2009 (in million metric tons). The top ten commodities in the world’s production area in 2009 and have since remained relatively constant or linear rate for 27 percent of the world’s production area. A yield plateau occurs when yield in an intense cropping system system has reached a yield plateau in 31 percent of the world’s production area. A yield plateau has occurred over the past 40 years. Wheat and rice more than doubled in production. Maize experienced a fourfold increase and soybeans a fourfold increase. Cassava, an important commodity in developing countries, more than doubled during this time period. Vegetable production increased by 230 percent while potatoes experienced just a modest increase.

Table 2 shows the increase in the top ten commodities in the world (by physical production level) has been the last 40 years. Wheat and rice more than doubled in production. Maize experienced a fourfold increase and soybeans a fourfold increase. Cassava, an important commodity in developing countries, more than doubled during this time period. Vegetable production increased by 230 percent while potatoes experienced just a modest increase.

Table 3 shows the number of countries and regions that have reached a yield plateau in 31 percent of the world’s production area. A yield plateau has occurred over the past 40 years. Wheat and rice more than doubled in production. Maize experienced a fourfold increase and soybeans a fourfold increase. Cassava, an important commodity in developing countries, more than doubled during this time period. Vegetable production increased by 230 percent while potatoes experienced just a modest increase.

The relationship between births and deaths is called the “fertility rate”. Essentially it is the number of children the average woman will give birth to in her lifetime. If a woman has two children, she will have replaced herself and her husband. If she has more than two, population will grow. If she has less than two, population will decline. To calculate the replacement fertility rate we must also take into account mortality from birth to reproductive age.

The replacement fertility rate for industri- alized countries is about 2.1 but is higher for developing countries because their mortality rate is higher. The world aver-

age replacement fertility rate is estimated to be about 2.3 births per woman.

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Yield gaps occur where yields are not at their potential. Let’s use maize yields as an example. Although the U.S. has used technology to improve corn yields, some parts of the world lag in their application of these technologies. Figure 2 shows regions of the world where maize yield gaps occur. Most noticeable are areas of Eastern Europe, Africa and Eastern Asia.

Closing yield gaps offers great potential to increase crop production. A recent study estimated that increasing the yields of 16 important worldwide crops up to 95 percent of their potential could increase production by 58 percent. Bringing yields of these crops up to only 75 percent of their potential could increase production by 28 percent (3).

## Improving Agricultural Productivity

Researchers at the Economic Research Service of USDA have examined changes in agricultural productivity (6). Essentially, productivity means developing new technologies that increase agricultural output per unit of agricultural input, or decrease the amount of agricultural inputs needed to produce a unit of agricultural output. For example, if the quantity of agricultural output increases by five percent and the quantity of agricultural inputs increases by two percent, then agricultural productivity increases by three percent, the difference between the output increase and the input increase.

Total Factor Productivity (TFP) is defined as the amount of output per unit of total factors (production inputs) used to produce the output. Five factors or inputs were used in the USDA analysis – land (acres), labor (hours), tractors (number), head of livestock (number) and amount of inorganic fertilizer applied. The analysis showed that global agricultural output grew by about 2.2 percent per year from 1961 to 2007, as shown in Figure 3. During this period, almost half of the growth in output was due to increased use of production inputs and the remainder was due to increased productivity. In other words, a substantial amount of the growth in agricultural output was due to the increase in the efficiency of production inputs in producing agricultural outputs.

An important ingredient in meeting the world’s food demand in 2050, while minimizing the impact on the world’s resources, will be increasing or maintaining the rate of agricultural productivity. High levels of productivity require significant investments in agricultural research and extension across the world. There is a long lag time from initiating research to the actual application of new technologies. So, these investments need to be made soon for the impact on productivity to fully emerge by 2050.

## Other Factors

In addition to food demand and supply conditions, there are other factors that impact our ability to meet food needs in 2050. Factors discussed below include reducing food waste, improving international trade and addressing world hunger.

### Reducing Food Waste

Food waste in high-income countries is generally assumed that all of the food that is produced is consumed. This is a faulty assumption. Estimates of the amount of food wasted vary but 30 percent appears to be a reasonable estimate. In low-income countries there is waste along the entire food chain but it is primarily in storing production after harvest. It is caused by poor post-harvest infrastructure and technology. Examples include losses from spillage, drying, contamination and consumption by pests.

Food waste in high-income countries is primarily at the point of consumption. Waste is prevalent at restaurants, buffets and other food service establishments. Food waste is also prevalent in the home.

The magnitude of the problem should not be underestimated. Assume we will need to increase agricultural production by 70 percent by 2050 to meet the food needs of nine billion people. Cutting food waste in half over the next forty years, which seems to be a reasonable goal, means we will only need to increase agricultural production by 45 percent instead of 70 percent. This is a much easier food production goal to reach and would reduce the negative impact on the world’s resources.

## Higher Food Prices

Higher food prices are a way to reduce waste. Much of the waste in high-income countries stems from the fact that food is cheap relative to the income levels of many consumers. However, higher food prices place a burden on consumer’s in low-income countries and low-income consumers living in high-income countries.

There are other ways waste can be reduced. Reducing consumer and food service waste in high-income countries should start with information campaigns to make people aware of the magnitude of food waste and ways in which food preparation and consumption habits and processes can be changed. A part of this awareness is to highlight the financial impact of reducing food waste. Also, new technologies can be implemented to better inform consumers of food quality and extend shelf life. It can be reduced in...
Table 5. Where People Live vs. Where Food Is Grown (acres per person) (2009)

<table>
<thead>
<tr>
<th>Region</th>
<th>Arable Land per Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oceania</td>
<td>3.85</td>
</tr>
<tr>
<td>North America</td>
<td>1.68</td>
</tr>
<tr>
<td>Europe</td>
<td>0.96</td>
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<td>Sub-Saharan Africa</td>
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<tr>
<td>Middle East and North America</td>
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</tr>
<tr>
<td>Central America and Caribbean</td>
<td>0.49</td>
</tr>
<tr>
<td>Asia</td>
<td>0.32</td>
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</tbody>
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Source: 2011 GAP Report, Global Harvest Initiative

low-income countries by utilizing existing technologies to minimize waste from storage and transportation.

Improving International Trade

Countries with large areas of arable land relative to the size of their population tend to have the most food security. As shown in Table 5, the amount of arable land per person is highest in Oceania, North America and Europe. However, this is not where population will be increasing over the next forty years. North America’s population is expected to grow by only 4 percent and Europe’s population is expected to actually decrease by 1 percent (15). Half of the population growth is expected to occur in Sub-Saharan Africa where arable land per person is currently only three-quarters of an acre. Assuming arable land does not change, the land area per capita will drop to half of an acre by 2050. Asia’s population is expected to grow by 41 percent with arable land currently only one-third of an acre. The larger population will decrease per capita land area to less than a quarter of an acre by 2050. So countries in these regions will need to either substantially increase their agricultural production (yields and/or land area) or import a larger portion of their food needs.

Although FAO projects that developing countries will be able to meet most of their consumption growth by increasing domestic production, the world net imports of cereal grains are expected to increase by 2050. It is not uncommon for countries to impose restrictions like export taxes or export embargoes to limit food exports and dominate commodity markets sold to other countries. Restrictions become increasingly common when world food prices and high prices exist. These policies are meant to discourage exports and keep food within the country for domestic consumers. Essentially, the restriction means that our citizens eat first. If there is anything left over, your citizens can have some.

The long-term implications of export restrictions are negative to the world’s consumers and world agriculture. It distorts trade in agriculture commodities at the precise time when there should be no distortion. It greatly increases the vulnerability ability of poor countries that are net food importers. It penalizes long-term agricultural development and growth in exporting countries.

Addressing Hunger

Currently there are over one billion chronically undernourished and malnourished people in the world. Seventy five percent of the poor in developing countries live in rural areas and are directly or indirectly tied to agriculture. Despite the large movement of world population from rural to urban predicted over the next 40 years (increase from 50 percent to 70 percent urban), population growth in rural areas is still expected to increase faster than employment opportunities. FAO expects the number of undernourished and malnourished people to decline by 2050 but hunger will still exist for a large number of people. This will occur even if there are ample supplies of food in the world. Although notable exceptions exist, many hunger situations are not caused by an actual shortage of food. Rather, hunger is caused by the financial inability to buy food. About 20 percent of the world’s population lives on less than $1.25 per day. So this problem is more a sign of poor worldwide income distribution than a worldwide shortage of food.

The situation is exacerbated if there is a shock to the food system and commodity prices escalate. Volatile prices can lead to disruptions of international trade and have a significant impact on food distribution and prices, especially during periods of low reserves. Low-income food deficit countries need to reduce their vulnerability to international agricultural market shocks such as happened in 2008 when the price of commodities rose rapidly.

Conclusion

There are many moving parts in determining our ability to feed over nine billion people by 2050. We have examined many of them in this article (although there are additional factors we did not discuss). How these parts unfold will determine whether we are successful in meeting the needs of a growing population.

However, we are not helpless bystanders of this unfolding story. We have the ability to influence the outcome. We must be diligent in meeting this challenge and make the necessary public and private investments of resources. We can start by championing the worldwide funding of agricultural research and extension programs along with investments in agricultural production and infrastructure to increase productivity and close yield gaps. In addition we can strive to minimize international trade distortions, reduce food waste, improve rural education and job creation in developing countries and find ways to meet the food needs of the world’s chronically undernourished and malnourished population.

References