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# Ethanol and Water Quality in the Mid-Atlantic Region

**Jim Pease**

Ethanol (ethyl alcohol) is a flammable colorless liquid compound that has about 70 percent of the energy of an equivalent amount of gasoline. It is also the "green" liquid fuel of choice in the U.S. economy. During his recent trip to South America, President Bush stated that greater ethanol use would diversify energy supplies, create jobs, and clean up the environment (*Washington Post*, March 9, 2007). The drive for more energy independence has resonated across party lines in Congress and has resulted in substantial incentives. The 2005 Energy Bill put in place an attractive subsidy structure for production of renewable fuels. Although the most publicized incentive is the $0.51 per gallon of ethanol tax credit for fuel blenders, many other programs provide attractive business opportunities for the renewable fuels industry. Overall, public policy has shifted the investment credit environment in the past few years such that investment capital has become readily available for ethanol refinery construction.

Virtually no U.S. ethanol production facilities existed when the Energy Security Act of 1978 began the process of stimulating ethanol production. Following at least $10 billion in new investment, at least 115 biorefineries are now producing ethanol in the U.S, with total production capacity of 5.9 billion gallons per year (Renewable Fuels Association, Figure 1). Seven of the existing biorefineries are building expansions, and 79 new plants are under construction, bringing total U.S. ethanol production capacity to 12.1 billion gallons per year (BGY). Only 9 of these biorefineries are able to use feedstocks other than corn grain.

Most corn grain ethanol biorefineries are located in the Midwest, close to the corn feedstock. More recently, announcements have been made of corn grain ethanol refineries planned for the East Coast, close to most ethanol consumers. Agri-Ethanol Products announced a 108 MGPY plant to be built in Aurora, N.C. that will begin producing in 2008. Two other plants of the same size are in the planning stages. The three plants would require 120 million bushels of corn grain per year, an amount equal to 72 percent of the average total production of North Carolina, South Carolina, and Virginia. The *Chesapeake Bay Journal* (April 2007) reported that Pennsylvania has approved construction of a 108 million gallons per year (MGY) ethanol biorefinery and has as many as seven other plants in various stages of planning. Maryland is reviewing an application for a biorefinery permit, with at least two more plants in the planning stages.

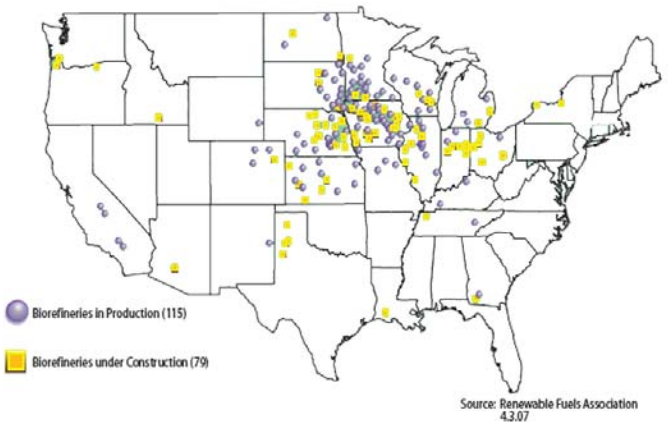


**Figure 1. U.S. Ethanol Biorefineries**

Ethanol industry expansion was one of the factors causing a dramatic spike in U.S. corn grain prices in 2006 (Figure 2). Futures price for December 2007 delivery are currently at $3.80/bushel. Because of these high prices, crop producers all over the country saw big profits in raising corn for grain, and planting intentions indicate that corn acreage will increase by 15 percent over 2006, to 90.5 million acres—the highest corn acreage since 1944. Estimates indicate that as much as 30 percent of the 2007 corn crop will be utilized for feedstock in ethanol biorefineries.

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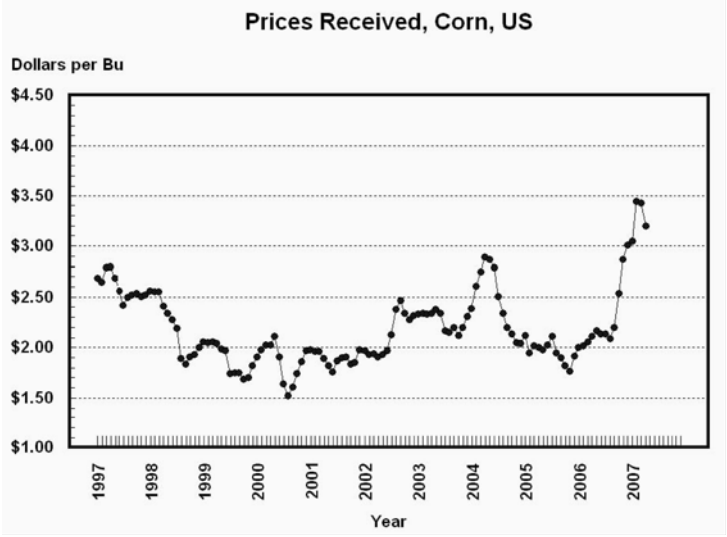


**Figure 2. U.S. Corn Price Received by Farmers, 1997 — 2007.**
Source: Agricultural Prices, USDA/NASS, April 2007

Some observers have commented on a wide range of negative environmental impacts from corn grain ethanol industry expansion, such as nutrient pollution, soil erosion, and wildlife habitat (Ogg 2007). This newsletter concentrates on two potential environmental impacts of ethanol production in the Chesapeake Bay Region: 1) expansion of Mid-Atlantic corn acreage, and 2) greater availability of Dried Distiller's Grain with Solubles (DDGS) for incorporation into regional livestock and poultry rations. Increased corn acres in the Mid-Atlantic will be necessary to fuel regional ethanol production. DDGS availability is linked to increased use of corn grain for ethanol production.

### Increased Corn Production

The most critical unknown for an East Coast ethanol industry is the availability of corn grain feedstock. Because of intensive poultry, swine, and dairy production, the region has long been dependent on imported grain. From 2002 through 2006, the states of the Chesapeake Bay region from Virginia to Pennsylvania have produced, on average, approximately 221 million bushels of corn grain per year (Figure 3). Broiler production in the region can consume 75 percent of total production, with lesser proportions for the region's 34.5 million turkeys sold, 31 million layers in inventory, 800,000 dairy cow inventory, 2.1 million beef cattle and calves sold, and 5.3 million hogs sold. Pressures are building in the Mid-Atlantic to produce more corn grain for the regional livestock industry.

Corn acreage in the five Mid-Atlantic states has averaged 1.87 million acres from 2002 through 2006. Prospective plantings as reported by USDA/NASS are 2.75 million acres, a 47 percent increase. Since prospective plantings are often inaccurate predictors of harvested acreage, assume for purposes of this discussion, that over the longer term, as planned ethanol plants are developed on the East Coast, corn acreage will increase by about 1/2 million acres on average to 2.3 million acres (+29 percent). What current land use would be diverted to corn production? The most likely source of new corn acreage is soybean cropland, since the soils needed are similar, and soybeans are often grown in rotation with corn. A second source of new corn acreage in Virginia is cotton. Some hay acres could be converted, and Conservation Reserve Program (CRP) land could also provide some additional corn acres. If 20 percent of soybean and cotton acres, 10 percent of hay acres, and 10 percent CRP acres in counties that produced over 3,000 corn acres on average from 2002 through 2006, just over 1/2 million new corn acres would be added in the Mid-Atlantic states. If average yields were obtained, total corn production would rise to approximately 277 million bushels. If completely dedicated to ethanol production, the expanded Mid-Atlantic corn grain harvest would be sufficient to produce approximately 767 million gallons of ethanol and 2.35 million tons of DDGS, or enough for seven ethanol plants such as those described above.

With reasonable soils, good crop management, and typical rainfall, corn, an intensive nitrogen-using crop, requires approximately 1.1 pounds of nitrogen fertilizer per bushel of expected yield. If plant growth is not sufficient to take up the nitrogen (as is the case in drought years), nitrogen remains in the soil until taken up by the following crop (often a winter annual such as wheat or barley or cover crop) or is lost from the field, possibly entering surface or ground water. More acreage in the Mid-Atlantic requires more nitrogen fertilizer applications and, inevitably, results in greater nitrogen losses from fields. Based on the Chesapeake Bay model and taking into account the forgone losses from land that was previously planted to soybeans, cotton, or hay, or had been "set aside" in CRP, Table 1 indicates the potential net losses of nitrogen from the expected 1/2 million new corn acres. With all crops under reasonable management and nutrient applications at rates consistent with agronomic recommendations, 8.1 million

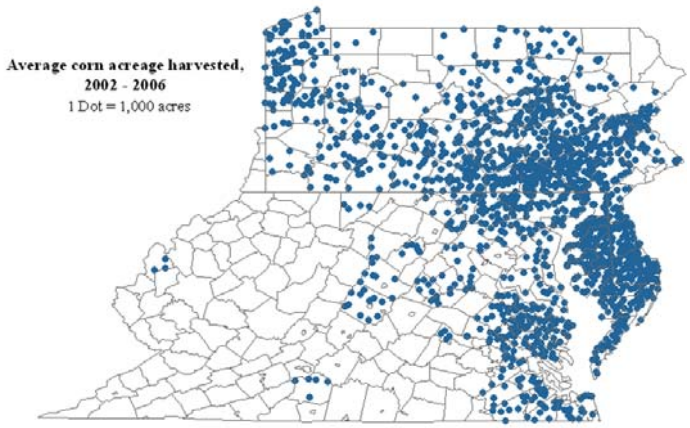


**Figure 3. Average Mid-Atlantic Corn Acres, 2002—2006**
Dots only in counties with more than 3,000 acres

additional pounds of nitrogen could be delivered to the edge of streams or other surface water. Assuming that new corn acreage is planted within the Bay watershed, this additional loss represents a movement in the opposite direction of the Chesapeake Bay Program goals.

How could these losses be averted? The loss estimates are predicated on "basic nutrient management" on corn land, but advanced control measures such as precision application, no-tillage, and other practices could reduce losses substantially. However, if new corn land is managed with basic nutrient management, the nitrogen losses associated with meeting corn demand for ethanol production would likely have a negative impact on water quality in the Mid-Atlantic.

Table 1. Potential Net N Losses in Mid-Atlantic from New Corn Acreage

| Cropping Changes | Acreage | Expected N Loss | N Loss |
|---|---|---|---|
| | (000) | (lbs/ac) | (m. lbs) |
| New corn acres | 538 | 30.0 | +16.1 |
| Soybeans | 290 | 22.5 | -6.5 |
| Cotton | 15 | 14.25 | -0.2 |
| CRP | 27 | 3.0 | -0.08 |
| Hay | 206 | 6.0 | -1.2 |
| Potential Net N Loss Increase (m. lbs) | | | +8.1 |

## DDGS for Mid-Atlantic Livestock Feed

Because of increased corn demand from the ethanol industry, Mid-Atlantic livestock producers will be faced with higher corn grain costs for feed. Some of the increased cost in ruminant feed can be offset by increased incorporation of DDGS into rations. A 100 MGY ethanol biorefinery produces approximately 306,000 tons of DDGS by-product, which is a relatively high-protein, high-oil livestock feed. DDGS also contains a relatively high concentration of soluble phosphate, which could be overfed if DDGS is added to the ration for its protein value. Non-ruminants such as poultry and swine are less able to digest DDGS, although small percentages of DDGS in rations are possible. For ruminants, the current and expected higher cost of corn grain in rations will be partially offset by increased supply and lower costs of DDGS. Although not currently incorporated in Mid-Atlantic dairy rations, dairy producers will likely find DDGS to be cost-competitive if ethanol biorefineries are constructed in the region. Schingoethe (2001) indicates that 20 percent of dairy ration dry matter could be DDGS. Figure 4 indicates where and how much DDGS could be utilized in Mid-Atlantic dairy rations for the region's 803,000 dairy cows. Incorporation at 20 percent of dry matter implies 1.5 million tons/year DDGS in regional dairy rations or the output of about four MGY ethanol plants.

Water quality implications of this potential change in dairy rations are unclear. The extent of use in livestock rations is not yet apparent, and the effects of ration balancing with respect to phosphorus intake and excretion in manure have not been extensively investigated. Will incorporation of DDGS in dairy rations stimulate over-feeding of phosphorus and subsequent increases in manure phosphorus? Could the higher solubility of DDGS phosphorus result in increased solubility of manure phosphorus, with potentially greater losses of phosphorus to surface and ground water? There are as yet no clear answers to these questions, but these and other consequences of Mid-Atlantic ethanol industry expansion on water quality and other environmental resources deserve careful study.

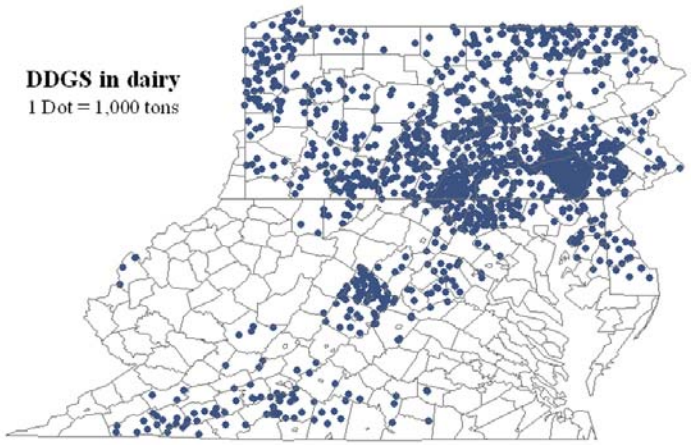


**Figure 4. DDGS Potential Use in Dairy Rations as 20 Percent Dry Matter**

## Other Impacts of Ethanol Production

Environmental concerns form only a portion of the unanswered questions about ethanol production in the region. High corn prices resulting from increased demand for ethanol production are imposing substantial costs on the region's poultry industry. Testifying March 8, 2007 before a House of Representatives Agriculture Subcommittee, a Tyson representative, speaking on behalf of the National Chicken Council and North Carolina Poultry Federation, stated that 1.3 billion bushels of corn were fed to U.S. young broiler) in 2006. Corn makes up approximately two-thirds of all broiler feed, and feed cost is roughly two-thirds of all broiler production costs. The Tyson representative stated that, "Last year the chicken industry's feed bill was $7.5 billion, and this year total feed costs to the chicken industry will very likely be over $10.5 billion, a 40 percent increase." Such a dramatic increase in feed costs will result in lower profits for our region's poultry industry and eventually in higher meat prices for consumers. We would not wish the regional poultry industry to falter or food prices to rise in order to develop a renewable ethanol fuel industry.

## Conclusions

At least 12 BGY of corn ethanol production will occur in the U.S. within a couple of years, and some biorefineries will be built in the Mid-Atlantic Region. Tax incentives (which contribute 35 to 50 percent of ethanol market price) will drive continued expansion until economic factors limit profitable

production. These economic factors may include high corn prices, which are the major operating cost of biorefineries, and world oil prices, which set the competitive barrier to ethanol production beyond the 10 percent mixture level. Corn production may not expand as anticipated, because of increased fertilizer, land, or equipment prices. On some soils, growers are seeing that net profit for producing soybeans is as great as for producing corn due to increased nitrogen and phosphorus fertilizer cost, as well as seed and herbicide expenses. However, for the foreseeable future, ethanol refineries represent a demand for corn that will be willing to pay higher prices than other demand sectors, such as livestock production, have faced in the past several decades.

All of the above issues must be carefully examined to determine impacts on water quality. Implementation of technologies and practices to reduce runoff losses to surface waters will need to accelerate if corn acreage increases are sustained. Faster implementation of such technologies and practices as continuous no-till, split N applications, injection of manures, sensor based N fertilizer applications, increased use of soil testing, and band application of fertilizers are already needed to improve water quality. Sustained corn acreage increases will only pressure water quality programs to redouble their water quality protection efforts.

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