The New Paradigm in Agriculture

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Since man first discovered that fire could stave off the cold of winter, provide light, and cook victuals, energy has become as integral to our lives as food and water. Yet many of our energy sources, such as petroleum, coal, natural gas, and uranium ore, are finite. Renewable sources of energy, including energy from biomass, are virtually inexhaustible.

Agriculture has always been focused on the production of human food, feed for livestock, and fiber for clothing. Agriculture is now expanding its contribution to society with energy production. The sun is one of the energy sources that is inexhaustible, proposed to last for about 4 to 6 billion years.

Additionally, a number of industries are looking to substitute biobased products for petrochemical products to reduce dependence on foreign petroleum. These industries are convinced that alternative products are largely cost-effective and environmentally sustainable.

For example, several national retailers, including Whole Foods and Wal-Mart, are now using polyactic acid (PLA) packaging. PLA is a compostable biopolymer that can be used to produce bioplastic packaging materials, clothing, and bedding products. PLA is currently being produced from corn by a biorefinery in Blair, Neb.

There have been previous paradigm shifts in the history of agriculture. The advent of animal power, along with elementary mechanical devices (e.g., the plow) and

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the use of fertilizers and irrigation allowed civilizations to advance beyond subsistence farming. Over the past 150 years, our own food and agricultural system has been transformed by revolutions in mechanical, chemical, and biological sciences and technologies. These advances helped the United States become the most productive agricultural economy in the world.

The way we produce, buy, and prepare food has changed dramatically over this time period. Even what we produce, buy, and eat has changed. Until the 1920s, soybeans were virtually unknown in this country. Today, we are the world’s largest producer of soybeans. They are now a major crop and found in many different foods. Frozen foods were unheard of before the 1930s and are now a staple of the American diet. Understanding microbiology that led to developing ways to preserve food, pasteurize milk, and other means of processing food was a major breakthrough.

Over time, advances in crop and animal science have led to ever-increasing yields, lower energy intensities (energy used per unit of output), and more abundant, affordable food. The history of American agriculture is one of scientific progress and successes largely due to the publicly funded research conducted by the United States Department of Agriculture (USDA), including research conducted in cooperation with the nation’s land-grant universities. Private funding, which is now greater than public funding for agriculture, has also significantly increased investment in agriculture research in the past 20 years.

This new paradigm represents a new way of thinking about agriculture. This is because all of the traditional aspects of agriculture remain intact. But in the new paradigm, there is an additional responsibility – the production of energy. The effort and commitment that created the Green Revolution must now be applied in this new area. We can – and must – put a variety of disciplines to work to meet this challenge. The era of bioproducts and bioenergy will usher in significant change and will have the greatest impact on our agricultural sector to date. New crops, new engineering processes, and new enzymes that make biological processing possible are examples of technologies that are currently available. The track record for agriculture is pretty impressive. The bottom line is that American’s spend only nine percent of their disposable income on food – the lowest of any country in the world.

Energy derived from agricultural production must be undertaken in a sustainable way. The demand for both fuel and food is expected to more than double by mid-century. While the use of agricultural products for fuel is a concern, it should be clearly recognized that in the long run, energy is as necessary for our survival as is food. At present,
about one-fifth of our corn production is used for ethanol production. In the future, research on the technical and economic development of ethanol made from the cellulose contained in stalks, wood chips, and leaves instead of corn kernels, could yield a large supply of biofuels without competing with food crops. Grasses such as miscanthus or switchgrass could be used to produce biofuels that sequester carbon in the soil and provide wildlife habitat and erosion control. Wastes are another potential feedstock.

Currently, most green plants make use of only a very small portion of the sunlight that strikes their leaves. New discoveries in chemistry, biochemistry, plant physiology, and crop science could make even more of that energy available. Technological advances in the fields of molecular biology and plant genetics, information and communications technology, microelectronics, process re-engineering, and computer-based management can give us the tools to expand the prominence of agriculture as a significant renewable energy producer.

Progress is being made. Many more talented people are working in the area of biofuels than ever before. What’s happening is like a “perfect storm” or, on a more positive note, “a perfect opportunity” to bring about a new biobased, green economy. Agriculture is front and center in this opportunity as part of “a new paradigm for agriculture.”

There is a much bigger push today when it comes to the available resources for biofuels, and this is definitely pushing science further than it has ever gone in the past. Three new bioenergy centers were funded by the U.S. Department of Energy in 2007. There are also many ethanol companies, both small and large, that are receiving funds from venture capitalists to invest in biofuels production. The USDA is increasing its involvement in research, extension, and education related to biofuels. In addition, the Bush administration’s Farm Bill proposals will dramatically expand the role of the USDA in renewable fuels. Proposals include the provision of $1.6 billion in new funding for renewable energy research, development, and production focusing on cellulosic ethanol.

This feature is the first in a series that will examine how agriculture can play a significant role in America’s energy economy, both as a producer and as a more efficient consumer. Follow-up articles will examine the potential for and challenges of bringing the bioeconomy to fruition, including feedstock research, harvesting and logistics, conversion to fuels, and the development of co-products and bioproducts. The contributions of other renewable energy sources, like wind and geothermal in providing energy and alternative incomes to rural areas, will be reviewed. Education, partnerships, and policies will play a critical role in encouraging the development and use of these new technologies. Lastly, the topic of sustainability will be addressed in order to examine how bioenergy and other technologies can be harnessed in a fashion that protects the environment.

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