# 21st Century Agriculture and Energy

## Moderator – Neil E. Harl, Charles F. Curtiss Distinguished Professor in Agriculture and Professor Emeritus of Economics at Iowa State University, Ames, Iowa, and a member of the Iowa Bar Association

The Future of Economic Development in Rural America

Neil E. Harl said that energy ranks as one of the most critical factors in modern life because its impact is both personal and national. Conventional energy, primarily because of where it is produced, comes with substantial cost externalities, which are a major policy concern, Harl said. Although not rich in oil, Iowa and the Midwest can play an important role in the country's energy future.

Harl addressed the issue of where agriculture is headed in this century, and more immediately, over the next two decades. The answers are varied. Some believe that agriculture is not competitive and that in the near future it will cease to be part of the nation's economy. Others say that agriculture is competitive but land values must be driven down. Harl focused on where the Midwest's agriculture sector has been, where it is going, and what it holds for economic development.

"When driving up and down Iowa's country roads, today's farmsteads don't look much different than they did 80 or 100 years ago," began Harl. "But looks can be deceiving – a great deal of change has been occurring." U.S. agriculture has been through a dramatic transformation over the past 80-plus years, he continued. Much of the change is attributable to two major forces: (1) the technology of seed and genetics, which has boosted productivity to levels unimagined 80 years ago, and (2) the technology of power, which set the stage for larger farms needing less labor to produce food. Institutional change has also played a lesser role. The result of this dramatic transformation has been an unbroken evolution of increasingly larger, but fewer, farms.

**Figure H1: Effects of Technology on Corn Yields in Iowa in Bushels per Acre**

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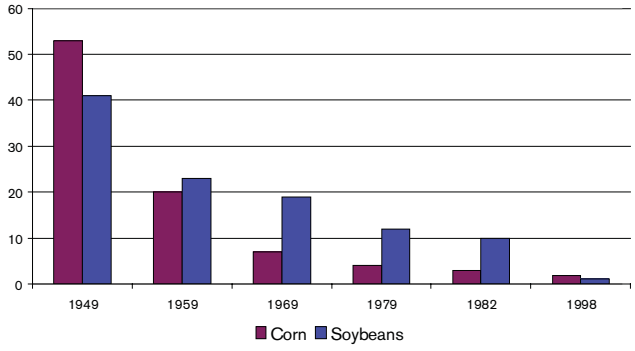
|---|---|
| 1866 - 32bu/A | 1972 - 116bu/A |
| 1896 - 43bu/A | 1979 - 127bu/A |
| 1920 - 46bu/A | 1986 - 135bu/A |
| 1937 - 45bu/A | 1992 - 147bu/A |
| 1942 - 60bu/A | 1994 - 152bu/A |
| 1952 - 62bu/A | 2002 - 163bu/A |
| 1963 - 80bu/A | 2004 - 181bu/A |
| 1969 - 99bu/A | |

Source: Iowa Agricultural Statistics

Harl cited the effects of technology on corn yields. Figure H1 shows corn yields in Iowa going back to 1866, when the average was 32 bushels per acre. By 2004, the average had skyrocketed to 181 bushels per acre. "This progress is heavily attributable to seed and genetics," said Harl, noting that other factors, including fertilizers and better management, have also contributed to the increase.

**Figure H2: Hours Per 100 Bushels in U.S. Corn and Soybean Production**




Source: Iowa Agricultural Statistics

The technology of mechanical power, explained Harl, has resulted in the massive substitution of capital for labor – setting the stage for larger and larger farms. Figure H2 shows the production hours per 100 bushels of U.S. corn and soybean production from 1949 through 1998. In 1949, it took about 54 hours to produce 100 bushels of corn and about 42 hours to produce 100 bushels of

soybeans. "We can see that the amount of labor required has diminished in a startling fashion," Harl said. "By 1998, the numbers got down so low that the USDA stopped keeping and publishing these records."

Harl identified international trade, globalization, and environmental concerns as the three main forces that he expects will shape the U.S. agricultural sector over the next 80 years. The major trend, he said, is an almost universal desire of consumers worldwide to live better. He predicts that food and other commodities will be produced at the lowest possible cost to the consumer. "It's led to outsourcing of everything imaginable – development of computer software, auditing of tax returns, surgical procedures, secretarial work, and manufacturing of almost every product used by the human family – where the product or service is mobile. The trend will almost certainly continue because consumers love a deal."

However, Harl explained that agriculture is different because soils and climate are not mobile. Therefore, crops will continue to be grown where the cost is lowest and in areas with a combination of good climate and productive soils, such as the Midwest. Although livestock is mobile, and could move offshore, large-scale outsourcing is unlikely because livestock production tends to be tethered tightly to low-cost feed grains, he said.

Furthermore, globalization is improving incomes in low-income countries where the percentage of additional income spent on food is especially high. Therefore, as incomes rise in countries devoting, for example, 75 percent of additional income to food (in the United States it's only about 20 percent), the result will be a dramatic increase in food demand. While that's good news for Midwestern farmers, it's also good news for efforts to eliminate hunger and malnutrition.

A potential disadvantage of globalization, Harl said, is competition created by greater availability of trade, capital, and technology in developing countries. "That is a great worry for employees with skills in competition with those in developing countries," said Harl. "It's also a major reason why we simply must put more of our resources into moving labor in this country up the productivity scale – so our workers are not in direct competition with low-income peoples around the world." Otherwise, there will be a great leveling effect worldwide, and the United States will find it increasingly difficult to maintain its higher standard of living, he said.

Harl also offered a few solutions. From a policy perspective, he said the task for the agricultural sector is straightforward – shape economic forces without losing the benefits of efficiency. To accomplish this, Harl suggested first that agriculture reduce its cost externalities (e.g., odors, and stream, ground-water, and ocean pollution, as well as pollen drift from genetically modified organisms) to acceptable levels.

Second, Harl said the benefits of federal farm programs (assuming these programs continue to exist in some form) must be crafted to erase the advantage of the largest operations that use their economies of scale to bid up cash rents and land values – to the detriment of midsize and smaller operators. Gains from efficiency from the largest operations are not passed along to consumers, but instead go heavily to acquire additional land. "Thus, federal funds are being used to help the largest operators become even larger," said Harl. "And there's little public interest in that."

Third, Harl said society needs to resolve whether it prefers an agricultural sector of independent entrepreneurs or a sector of serfs. "I believe a sector of independent entrepreneurs is more consistent with a healthy rural America," he said. "To maintain that model, though, increased attention must be given to mergers, consolidations, contract practices, and other factors that reduce the management role of the producer."

Harl said that from several perspectives (trade, food safety, food security, Third World economic development, and cross-border environmental problems), the need for a global food and agriculture policy is becoming increasingly clear. Harl added that supporting Third World economic development is clearly in the long-term best interests of the entire world. "Even if one's interests go no farther than national security, in a world of disharmony, eliminating world hunger by working to boost incomes is a worthy, priority goal," he concluded. "That's why we need to be peering ahead from a platform of a global food and agriculture policy in the twenty-first century."

## Iowa Energy Center

**FLOYD E. BARWIG - Director of the Iowa Energy Center, Ames, Iowa**

Floyd E. Barwig is director of the Iowa Energy Center, Ames, Iowa. The energy center is a research, education, and demonstration organization dedicated to improving Iowa's economy and environment by advancing energy efficiency and renewable energy use. The center was created by the Iowa General Assembly and is funded by the state's electric and natural gas ratepayers.

The overarching theme of Barwig's remarks was that Iowa's ubiquitous biomass represents a potentially very strong economic opportunity to extract chemicals and fuel from a renewable source. Although other speakers at the conference discussed making fuels (namely ethanol and biodiesel) from corn and soybeans, Barwig explained that fuels are only a small subset of a great many other chemicals that can potentially be derived from biomass. Moreover, he said it is also possible to make these other chemicals from materials now commonly treated as waste, such as: agricultural residues, food processing wastes,

livestock production wastes, municipal solid waste, obsolete seed corn, and wood waste. Significant quantities of these waste materials are abundantly available in Iowa and throughout the Midwest agricultural belt.

Years ago, many chemicals, such as celluloid for film and certain plastics, were made from biomaterials. Oil discovery meant biomaterials were replaced with the then cheaper resource. Today, of course, oil is no longer inexpensive, but there are biomass materials, such as feedstock, available that are much cheaper than petroleum.

In fact, Barwig continued, anything, including many chemicals, that can be made from petroleum or natural gas can also be made from an alternative biological source. Once these chemicals are created, they have a higher market value than the energy inputs needed to create them. According to Barwig, chemicals that are currently made from petroleum are a real market for biomass. Some examples of petrochemicals and their biochemical counterparts are: ethylene and ethanol, propylene and isopropanol, and MTBE and MTBE (from plants). The big question, he noted, is whether these materials can be made cost effectively.

As a world leader in agriculture, Iowa is uniquely positioned to capitalize on the development of chemicals and fuels from biomass. The Iowa Energy Center's Biomass Energy Conversion (BECON) facility in Nevada, Iowa, houses the state's most innovative and collaborative biomass projects. With BECON, the Energy Center has established a platform for researchers and educators to turn promising ideas into functioning commercial-scale conversion units.

The BECON facility converts biomass into numerous valuable chemicals and fuels. This concept is not new. Corn stover (the stalks that remain after the corn has been harvested), ethanol, methanol, vegetable oils, and a host of other biomass-based products have been in use since the 1800s to make products such as paint, glue, adhesives, synthetic cloth, and solvents. At the BECON facility, an entire portfolio of modern day processes and systems used to produce chemicals and fuels from biomass are being studied, all at the pilot plant scale. "This is because we don't think we're smart enough to pick the one and only technology that will work," quipped Barwig. "And also, we believe that the end result will be combinations and permutations of these different technologies."

"A biorefinery should run like a petroleum refinery," he continued, "that is our model." He explained that an oil refinery could make hundreds of different products (ranging from pharmaceuticals to road tar) from its feedstock, which is crude oil. The plant managers consult market prices to determine which products to produce and then operate the oil refinery accordingly. Biomass must get to the same place, where multiple products are made from biomass feedstocks, to ensure that the biorefinery is hedged and not reliant upon any one single product, Barwig explained.

Fortunately, he continued, Iowa has an abundance of feedstock available. According to agronomists, if one-half of the corn stover was utilized as feedstock for the biomass refineries, Iowa would annually produce 20 to 30 million tons. The other half would be left in the fields to prevent soil erosion. And, the market for biomass-derived chemicals is robust. Barwig estimated that 45 million tons of "big three" organic chemicals (ethylene, propylene, benzene) are used annually in the United States.

**Figure B1: Rural Economic Development Potential of Iowa Economics**

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|---|---|
| Iowa Gross State Product | $111 Billion in 2004 |
| Iowa Total Exports Outside US | $12.9 Billion in 2002 |
| Iowa Ag and Food Exports Outside US | $4.69 Billion in 2002 |
| 24 Million Tons of Corn Stover @ $0.02/Pound | $1 billion |
| 24 Million Tons of Corn Stover @ $1.50/Pound | $72 billion |

Source: Iowa Energy Center

Consequently, the rural economic development potential from biomass is enormous. Figure B1 illustrates the potential impact on Iowa's economy. If biomass is simply sold only as a commodity, revenues would total $1 billion (24 million tons of corn stover at $0.02/pound). Under this most basic scenario, Iowa is simply utilized as a "biomass strip mine." However, if new ways to produce chemicals and fuels from biomass can be developed and existing processes are enhanced, the economic impact could potentially be magnified to $72 billion (24 million tons of corn stover at $1.50/pound). By adding value to agricultural products through research and development, profitability for farmers and many Iowa industries (not just the biorefinery industry) would be greatly enhanced, Barwig explained. In 2004, Iowa's gross state product was $111 billion. In 2002, Iowa's international agricultural and food exports totaled $4.69 billion. Successfully developing full-scale biomass technologies and new products would provide Iowa with value added exports and have a tremendous positive impact on Iowa's economy, he said. Further, using agricultural byproducts, previously classified as waste, reduces environmental degradation and is more environmentally friendly than producing and using petrochemicals. "The potential is very real to have a biochemical industry as an extraordinarily significant part of Iowa's economic future," Barwig concluded.

## Institute for Local Self-Reliance

**DAVID MORRIS, PH.D. - Cofounder and Vice President for the Minneapolis and Washington, D.C.-based Institute for Local Self-Reliance and Director of the New Rules Project[24]**

David Morris, Ph.D. identified three long-term forces that will influence the future of agriculture: WTO rules, increasing international environmental consciousness, and technological change.

First, he said WTO rules are pitting farmers from different countries against one another. He sees this hostility between international farmers increasing as global competition increases, and predicts that the consequence will be a reduction in the direct payments that governments make to their farmers.

The second long-term force is an increasing international environmental consciousness. "By failing to ratify the Kyoto protocol, we in the United States have stepped aside from the development of international standards related to the environment," said Morris. "But that doesn't mean the rest of the world stopped." Because plants absorb carbon dioxide and sequester it, the Kyoto protocol puts great emphasis on agriculture. The Kyoto protocol, which went into effect in February 2005, for the first time in almost 150 years makes a legal distinction between living carbon (e.g., plants) and dead carbon (e.g., fossilized plants or fossil fuels), he explained. The implementation of that protocol will raise the value and importance of agriculture as a vehicle for reducing greenhouse gas emissions. Living organisms can also be used to extract the carbon dioxide from greenhouse gas emitting facilities, like coal fired power plants, and convert the carbon into useable products.

The third long-term force influencing the future of agriculture is technological change. In particular, Morris sees biological science as predominating. "We are learning to manipulate living matter to the point where we can make ever higher quality products, chemicals, and fuels at ever lower cost," Morris said.

"Coming out of these long-term trends, one begins to foresee a carbohydrate economy substituting for a hydrocarbon economy," opined Morris. He sees evidence of this trend in many instances. The carbohydrate gets rewarded and the hydrocarbon gets penalized as the economy begins to rely more on renewable materials. Morris points to Brazil as an example of a functioning carbohydrate economy. "In Brazil, 40 percent of all their transportation fuel comes from ethanol made from their sugar cane. So, ethanol is not an additive – it's becoming Brazil's primary fuel." If the overall economy begins to move toward a carbohydrate economy, then biofuels and biochemicals begin to substitute for gasoline and petrochemicals. This shift would lead to a doubling or tripling of the amount of plant matter consumed by the economy for all purposes, including food, fuel, feed, clothing, construction materials, and others.

Morris believes the United States is moving in the direction of a carbohydrate economy. This transformation creates an enormous opportunity to promote not only the demand for plant matter, but also to think about what the structure of agriculture will be like. "We are creating the equivalent of a new agricultural system in terms of the processing techniques, the land area utilized, and the crops themselves," he said. A carbohydrate economy is not only desirable from the standpoint of the domestic rural economy and necessary an environmental standpoint, Morris explained, but it also dampens the farmer versus farmer competitive dynamic currently occurring in international agricultural trade. "Because if we create these new markets, then the world's farmers don't compete against one another – rather, they compete against the fossil fuel industry," Morris said.

Despite the enormous possibility of the carbohydrate economy, Morris cautioned that such a future is not inevitable and/or might not happen in the desired manner. The crucial factors are the laws, regulations, and ordinances that channel the entrepreneurial activity surrounding biochemicals and biofuels.[25] "These rules must be implemented in a manner that maximizes the benefits redounding to rural areas," he said." What Morris wants to avoid is a repeat of the mistakes of the last revolution and simply have the new carbohydrate economy yield only marginal benefits to rural areas, with slightly more jobs and modestly higher values for rural outputs. Through the crafting and implementation of appropriate rules that channel ingenuity, investment capital, and entrepreneurial energy in the direction of creating local ownership structures and technologies, Morris believes that increased and sustainable economic development can be achieved in rural areas.

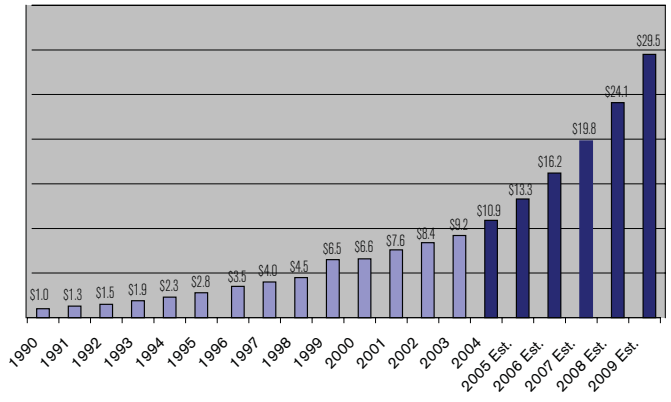
## Food Production and Marketing in Rural America: Moving from Commodities to Differentiation

**RICHARD PIROG - Program Leader for the Marketing and Food Systems Initiative of the Leopold Center for Sustainable Agriculture, Iowa State University[26]**

Richard Pirog is the project director for the Value Chain Partnerships for a Sustainable Agriculture (VCPSA) project. He also leads the Regional Food Systems Working Group (one of three VCPSA working groups), and serves on the Iowa Food Policy Council.

Pirog's remarks focused on how the businesses involved in the production, processing, and marketing of highly differentiated food products could be a key part of a rural economic development plan. In order to achieve this plan, Pirog believes that agriculture's role in the future of rural America needs to include: a significant increase in highly differentiated food products and businesses; development of place-based foods that are linked to agritourism; and more focused and synchronized funding, research; and development to support these food businesses.

**Figure P1: Total U.S. Organic Sales Projected Growth**




Source: Leopold Center for Sustainable Agriculture

### Highly Differentiated Food Products and Businesses

Sales of organic food products in the United States have grown dramatically in recent years, with double-digit growth rates projected to at least 2009 (see Figure P1). Pirog attributed much of this growth to the aging baby boomers who are demanding more healthy food choices. Although the United States is experiencing dynamic growth in organic food sales, there has been little growth in the number of acres devoted to growing organic foods. "If you want to see a really expanding organic industry, go to India and China," pointed out Pirog. "The increase in organic acres in these two countries has been astronomical." He added that the United States is running a significant trade deficit with regard to organic products. However, despite a dearth of a homegrown organic food, most market research shows that if given a choice, most Americans prefer to purchase food grown as close to home as possible. And they are willing to pay higher prices to get it. "So, there is potential in organics, but it also comes with a big caveat given the current global production system," Pirog said.

### Place-based Foods

One way that farmers may be able to avoid "commoditizing" niche markets for highly differentiated food products is to limit production to certain geographic areas that are best suited, ecologically and/or traditionally, for production, and build brand identity and reputation based on quality, Pirog explained. Theoretically, if farmers control the amount and the quality of the product that enters the market, they can better maintain premiums and lower the risk of "commoditizing" the product.

According to Pirog, placed-based foods have a unique role to play in rural economic development because of their potential link to agritourism and the "experience economy." "The experience economy is the phenomenon where people no longer just want to go out to eat, he explained. "Rather, they want a unique experience. After these consumers have physically left the area, they may still be able to re-live the experience by accessing the food products that are unique to that area."

Europe has many lessons to offer regarding place-based foods because several of its countries invested resources in developing a system of geographic indications (GIs), which identify a good as originating in a region or locality where its quality, reputation, or other characteristic is essentially attributable to its geographic origin. All other countries must prevent use that misleads the public, creates unfair competition, or suggests a product originates in a geographical area other than the true origin. For example, Pirog offered, a ham and cheese producer in Denmark who marketed its ham and cheese as if it were produced in Italy's famous "food valley" where Prosciutto di Parma ham and Parmigiano-Reggiano originate would be violating GI protections.

Using GIs has advantages, such as maintaining very high quality, limiting supplies, and enabling premium prices. These price premiums reach back through the supply chain to producers. Because the products are less likely to be commoditized, the regional brand identities increase the likelihood that profits stay in the local region.

The United States incorporates protection of GIs within the trademark system. A certification mark is used to certify such characteristics as: origin, material, mode of manufacture, quality, accuracy, or that the labor was performed by members of some organization, such as a union (e.g., "Look for the Union Label"). A certification mark can also be used to designate geographical origin.

"A great example in the marketplace is the Vidalia onion," Pirog said. "An onion may only be called a Vidalia if it is grown within 19 counties in Georgia that have a predominant soil type."

The ultimate goal for place-based foods is to provide new opportunities for rural regions faced with globalizing markets. "If the product is unique to the place, you can't take it away from the place," Pirog said. "This is the inherent logic behind development of these products."

## Programming to Support Food Businesses

Pirog argues that the funding and programming for sustainable agriculture and food systems is inadequate. Although there has been good work in systems thinking, it has only been at the farm level and not across the food value chain. This approach is fine for direct markets and selling within a community, but it is not going to have a large impact in many rural areas, which need additional resources to be able to sell across the food value chain (i.e., producers, processors, distributors, and markets). Also, foundations and investors supporting this work need to make funding decisions on a synchronized basis across the food value chain. This approach should be used for highly differentiated and place-based products so that challenges in production, processing, and distribution can be addressed simultaneously, and a more dynamic approach to solving the problem can be taken, Pirog said.

Pirog ended with a challenge for the future. He said that the United States is either in the early and most difficult stages of a long, slow transition to a food system driven by a desire for healthful, safe, high quality foods and knowledge about the sources and production methods of that food. Or, as some skeptics claim, Pirog said the country is playing around with permanent small niche markets that will never grow into something significant enough to support tens of thousands of small- and medium-sized farms. He concluded that it is essential to move beyond assisting the permanent small niche markets to provide more farmers the opportunity to be an essential part of a thriving rural economy.