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proteins are produced by bacteria, yeast, or mammalian cell lines in closed-vessel fermentation facilities. While they are costly up front, can take several years to build and bring online, and have limited capacity, these methods enjoy the advantage of being familiar to the pharmaceutical industry and they are constantly being improved by new R&D and learning-by-doing. Furthermore, crops are not the only “alternative” platform attempting to enter the market. Biomanufacturing based on other host organisms, including transgenic livestock, algae, and even insect larvae, are being rapidly researched and developed.

Agriculture’s direct contribution to this emerging industry, however, may be limited. While PMPs or PMIPs are highly valued, they often require only a small amount of land to satisfy demand. A recent report by bio-era (a research firm in Cambridge, MA) concludes that, in the next 10 years, an optimistic scenario would be perhaps 25,000 acres, worldwide, devoted to crop biomanufacturing. Even under this rosy scenario, it is apparent that biomanufacturing is not likely to affect many large-scale farming operations.

Furthermore, in an effort to comply with the expected stringent regulation, companies developing these crops are likely to maintain a tight control on the entire production cycle of the products, acquiring land or farm services under contract. And the implicit costs of regulation may induce crop biomanufacturing to locate away from the traditional areas of agricultural production, possibly outsourcing overseas. That is, it is precisely because they have a strong comparative advantage in food and feed production that locations such as Iowa may have a competitive disadvantage in growing PMPs and PMIPs. Ultimately, the returns to agriculture will be for use of the land and for services provided in the growing of the crop, a relatively small contribution to the long process of producing and delivering PMPs and PMIPs to end users.

**Prospects and Limitations**

Whereas the prospects of developing crops genetically engineered to produce pharmaceuticals and industrial products is exciting, there are four major factors that may limit the potential of crop biomanufacturing in the near future. First, both scientifically based risks and perceived risks to the food supply and the environment will drive up costs of regulatory compliance and containment. Considerable fixed-cost investments in land, equipment, and professional expertise will be required to enter the business. Also, the technology’s owners will likely maintain an effective control on the production of such crops in a tightly vertically integrated structure to ensure highly contained growing operations.

Second, the scale of production—while potentially large from the perspective of the biotech industry—is likely to remain quite small by agriculture’s standards. Third, competition from other biomanufacturing platforms will continue to be fierce, as innovation and development of capacity proceeds on all fronts at a rapid pace. Containment risks will always remain much less of an issue for in-vessel fermentation systems than for agriculture, particularly when food crops are involved. Fourth, competition and industrial structure within the crop biomanufacturing sector may keep margins low. Contract structure for the farm-level production stage will likely entail limited opportunities for primary contract growers to capture the value.

It is of course possible that newer biomanufacturing crops or technologies may prove to be exceptions to any of these four factors. For example, high-volume, high-acreage products, such as specialized bio-energy feedstocks or “functional” nutritional ingredients, that require little or no segregation from the food supply may emerge. With such products, of course, major agricultural producing regions will soon compete globally, just as they do in commodity markets today.

Guest co-author Gregory Graff is with the Public Intellectual Property Resource for Agriculture (PIGRA) organization at the University of California, Davis. He currently is a visiting research economist in the Department of Agricultural and Resource Economics at the University of California, Berkeley.
In his introduction of the inaugural issue of the *Iowa Ag Review* in December 1994, former editor John Kruse listed the quarterly publication’s goals:

- to communicate the findings of analyses, completed or underway, of proposed farm policy changes;
- to provide objective discussion of the issues and analytical results; and
- to summarize the current situation for Iowa agriculture and the potential impacts of international developments.

The *Iowa Ag Review* sprung from the creation of a new Iowa model in the Food and Agricultural Policy Research Institute (FAPRI) baseline analysis of commodities. As a result, the comprehensive analysis provided by FAPRI to farmers, agri-businesses, legislators, and other stakeholders in agriculture could be focused on the implications for Iowa. Naturally, researchers at FAPRI and CARD wanted a vehicle for sharing this information.

The inaugural issue of the *Iowa Ag Review* contained stories on the implications of the GATT agreement, the near-term outlook for the pork sector, implications of the 1995 farm bill, and how record yields were shaping up for Iowa and U.S. corn and soybeans.

Looking at the table of contents for this quarter’s issue, some stories mirror those of 10 years ago. We are again looking at record yields in commodities and the effect on prices. We continue to explore the playing field for agriculture in the context of GATT’s successor—the WTO. And we discuss the outlook for the pork sector in a year that saw tremendous growth in exports.

As we start our second decade of publication, we reaffirm the objectives given in the inaugural *Iowa Ag Review* to bring timely, objective analysis of the most challenging agricultural questions and policies of the quarter, year, and decade ahead.

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**Recent CARD Publications**

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**STAFF REPORT**


**MATRIC BRIEFING PAPER**


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