ESSAYS ON ISSUES
THE FEDERAL RESERVE BANK OF CHICAGO
JANUARY 2008
NUMBER 246a

Chicago Fed Letter

The Role of R&D in Agriculture and Related Industries: Today and Tomorrow—A conference summary

by David B. Oppedahl, business economist

On September 24, 2007, the Federal Reserve Bank of Chicago held a conference that explored the role of research and development in agriculture and related sectors, focusing on policies that promote industry growth and rural development.

Materials presented at the conference are available at www.chicagofed.org/news_and_conferences/conferences_and_events/2007_agriculture.cfm.

At the conference, participants examined the role of research and development (R&D) in agriculture, biofuels, and the food industry. The goals of the conference were to analyze agricultural R&D from a midwestern perspective, explore the implications of R&D for industry growth, and discuss the influence of government R&D policies on industries and rural development.

William Testa, Federal Reserve Bank of Chicago, kicked off the conference with opening remarks emphasizing the role Chicago has played in the development of agriculture in the Midwest. "Almost from its inception, Chicago has been the nexus and commercial center for a broader region whose wealth emanates from production agriculture," Testa said. Yet, shifts in agricultural labor due to increased productivity have affected the region's economy. Testa noted that fewer production jobs in agriculture and related industries have led to struggles in rural development, though agriculture remains a key sector. "At heart, production agriculture must remain in the Midwest where land, climate, and transportation infrastructure are superior," Testa stated. Moreover, R&D activities have played a key role in shoring up the economy of the Midwest, and they offer hope for a bright future. The web of R&D efforts in the Midwest is likely to grow, creating more opportunities for the region through better products and new technologies. Testa concluded, "I am optimistic here today that the dissolution between research lab and factory and farm that has taken place in other regions and in other industries is not our Midwest region's destiny."

Agriculture R&D and funding

In the first session, three presentations outlined the relationship of agricultural R&D to productivity and funding sources, both private and public. David B. Oppedahl, Federal Reserve Bank of Chicago, opened the session and emphasized the link between the amazing productivity in agriculture during the last 60 years and agricultural research. Recent data from the U.S. Department of Agriculture (USDA) demonstrated that, while using fewer inputs than in 1948, the agricultural sector in the U.S. produced more than 2.5 times as much output in 2004 as it did over a half century ago.[1] Of course, the use of some inputs, such as fertilizers, increased. However, the contraction in farm labor more than offset these increases. Furthermore, there was a shift in the source of agricultural productivity during this period. In the 1948–80 period, almost three-quarters of this productivity was derived from an increase in inputs per worker, whereas in the 1981–2004 period, two-thirds was derived from growth in total factor productivity (TFP), which

reflects changes in technology and other factors rather than labor-saving productivity alone. Government policies fostering agricultural research have promoted the long-term health of agriculture through increased TFP. According to Fuglie and Heisey, "There is a consensus that the payoff from the government's investment in agricultural research has been high."[2] There are even greater benefits to the public from agricultural research when one considers the social returns from private research as well as public funding.

Next, Eric C. Larson, Linden LLC, focused on the role of R&D in agriculture and related industries from an investor's perspective. He developed the context for his remarks, starting with a skeptical view of collaboration. His firm helps build mature companies in the health care and life science fields. The firm provides human and financial capital, which returns companies to growth. In particular, noncore units of big corporations are a strategic focus. Larson emphasized that his firm is an owner, not just an investor, and it employs an active governance model. His firm's approach utilizes technology accelerators to foster the transformation of mature businesses. Larson offered the National Center for Food Safety and Technology (NCFST) at the Illinois Institute of Technology as an example of a technology accelerator because it is a research consortium with a new initiative in foods that promote better health (a recently added designation by the U.S. Department of Health and Human Services' Food and Drug Administration). Moreover, nutritional clinical trials and substantiation of specific health claims will build consumer confidence and awareness for healthy food choices. These capabilities place the NCFST at the point where health care and medicine intersect with agriculture and food. Since many of the leading causes of death are related to diet and lifestyle, the area of nutrition provides growth opportunities for firms. Larson also mentioned the Illinois Global Partnership as an organization that can promote international trade and economic development via a collective policy for strategic opportunities and innovation promotion. Ending on a hopeful note, Larson quoted Vannevar Bush, a science adviser to President Franklin D. Roosevelt: "Research is the pacemaker of technological progress."

Mark E. Cook, University of Wisconsin–Madison, examined public collaborations with the private sector, as well as the need for agricultural research funding. Cook provided a unique perspective as a poultry science professor, a developer of new technologies, and a founder of biotech companies. He argued for increased public funding to fulfill the mission of universities: namely, to educate, to innovate, and to translate. Using his university's department of animal sciences as an example, Cook illustrated the decline in resources for education and research as facilities, support staff, and faculty all shrank in recent decades. Moreover, the cost of training a graduate student exceeds $300,000, with sources for agricultural training grants falling behind those for other grants. So, even as the faculty base erodes at universities, there is no sustainable system to develop new faculty. In addition to threatening the educational mission, agricultural research has lagged behind research in other fields in securing technological innovation. With the Bayh–Dole Act of 1980, government-funded R&D began to transfer into enterprise valuations, fueled by the increase in U.S. patents issued to universities—from 250 in 1980 to 3,800 in 2004. Despite the overall positive changes in government-funded R&D over the past few decades, agricultural R&D has continued to be underrepresented because of its lower funding levels and restrictions on covering overhead costs. Given the stunted flow of agricultural knowledge, both technology capture and translation suffer, too. Money flows globally to the best technology, even when funds originate from angel investors and venture capital in the U.S. In order for economies to grow, gaining knowledge is paramount; according to Cook, without adequate funding, universities will not hire faculty, train students, spur innovation, nor need translators to convert agricultural technologies into growth opportunities.

Visit to the National Center for Food Safety and Technology

The conference concluded with a tour of the National Center for Food Safety and Technology, part of the Illinois Institute of Technology. The tour sponsors were the Illinois Global Partnership and the Economic Development Council of Chicago. The center provides a unique research environment where scientists from the U.S. Department of Health and Human Services, Food and Drug Administration can interact on food safety issues with colleagues from academia and the private sector. The tour highlights included cutting edge food preservation research, the pilot plant area, and a laboratory under construction to meet a higher level of biosafety protocols.

Biotechnology and food R&D

In the second session, two presenters looked at R&D from an industry context. Beth J. Calabotta, Monsanto Company, discussed the evolution of R&D in agriculture, especially the contributions of biotechnology. Plant breeding and biotechnology are the primary means to increased crop yields. Breeding led to major yield gains over 5,000 years; biotechnology has dramatically accelerated the advances in yields. Biotechnology R&D requires a long product development cycle (from discovery to market takes eight to ten years on average), and involves large financial investments. Moreover, global genetic databases and advanced testing technology are vital in determining the best genetic combinations for desirable seed traits, such as drought resistance and protection from pests. Monsanto has been able to develop molecular markers that substantially increase the chances of finding the desired combinations within a few cycles, doubling the genetic rate of gain. Combining biotechnology and molecular breeding will significantly increase the potential gains in crop yields. Other new technologies include corn fractionation,

which splits kernels so that ethanol production results in more useable coproducts; soybeans that reduce trans fats in foods; and soybeans with omega-3 fatty acids for healthier diets. Biotech crops have benefited agriculture by enhancing productivity gains and increasing economic returns while reducing pesticide usage and lowering greenhouse gas emissions. Agricultural R&D has helped meet the rising demands for food, feed, and fuel, positioning agriculture for more advances in the future.

Martin Cole, National Center for Food Safety and Technology at the Illinois Institute of Technology, shared his perspectives on R&D in the food industry. The global food industry is huge. The main drivers in the food industry are the global retailers, whose buying power has increased because of consolidation and the introduction of private label brands. There is immense market growth potential around the world as countries reduce poverty, spurring greater demand for food—and for higher-quality food. Moreover, world trade in food must expand as a percentage of production, since agricultural resources do not match the locations of higher demand. In order to meet the increased demand, new product development is important for food manufacturers. Yet, innovation requires investment, and patience is necessary to wait out the travails of testing and marketing new products. The R&D investment in the food industry ranks low compared with the R&D investment in other sectors of the economy. A key obstacle to innovation is a lack of coordination, so collaboration in earlier stages of new product development could reduce the risks faced by firms. Changing consumer drivers (e.g., health, convenience, pleasure, and ethics) present additional challenges for innovators. In addition, food safety issues are critical, especially for trade across borders through complex supply chains. Business risk involves both real and perceived food safety concerns. The government perspective differs from that of the industry because, for the government, facilitating trade is secondary to the safety of consumers. So, reforms to the management of food safety could benefit innovation. For instance, governments could use more flexible risk-based systems, rather than traditional command-and-control methods. Thus, regulators have a part to play, as new processing technologies (such as ultra high pressure) may help balance safety concerns and product value. Cole gave examples of the impacts on various food categories, as well as the research challenges involved. Foods promoting better health, in particular, offer vast opportunities for the food industry and play a key role for R&D.

Orion Samuelson, agribusiness director at WGN Radio Chicago since 1960, presented the keynote luncheon speech, expanding on the theme of the changes in agriculture due to government policies. He passed along a few of his many experiences related to the changes in agriculture during his association with the industry. Samuelson touted rural electrification as the single factor that changed agriculture the most in the twentieth century; farm life was transformed by a reliable supply of electricity. He also said that research played a vital role in agriculture's growth and that research funding should be expanded to sustain the industry's growth. One example of the key role of research is the ongoing development of drought-resistant crop genetics, which has contributed to the record corn crop this year. Samuelson contended that we are just seeing the beginning of biotechnology's impact across the industry. Moreover, he predicted that U.S. agriculture would rise to the challenge of helping feed the world through agricultural R&D, just as it has over the past decades.

Biofuels R&D

In the third session, Seth Snyder, Argonne National Laboratory, covered biofuels R&D, beginning with the rapid expansion of ethanol production in the U.S. In order to meet the stated goals of U.S. energy policy, biofuel production must move beyond using primarily corn as an input. Moving beyond corn will require a strong R&D effort. Biofuels, biobased products, and chemicals must compete on a cost basis, since product differentiation is difficult. Hydrocarbons from corn compare favorably in terms of costs with those from fossil fuels, especially when one includes the full environmental costs. Biobased feedstocks are cheaper than petroleum, but lower manufacturing costs are needed. Better conversions, separations, product recovery, and process integration would accomplish this, along with large volumes of energy crops. Leveraging federal funding of R&D with chemical industry funding will spur innovation in biofuels and, in turn, boost the economy. Still, the product cycle is at least 18 years. There are risks for biofuels with respect to the necessary infrastructure, especially for distribution and blend availability. Energy crops, particularly for growth on marginal land, present another opportunity for R&D. A biobased future will require both biochemical and thermal processes to produce fuels and chemicals using multiple feedstocks, based on regional factors.

What are the best policies to promote ag-related R&D?

The final session explored policies that would strengthen agricultural R&D in the U.S. John Caupert, National Corn-to-Ethanol Research Center (NCERC), used his organization to illustrate the key role of technology commercialization.

Chicago Fed Letter is published monthly by the Research Department of the Federal Reserve Bank of Chicago. The views expressed are the authors' and are not necessarily those of the Federal Reserve Bank of Chicago or the Federal Reserve System.

ISSN 0895-0164

The NCERC serves as a site for third party validation and commercial testing, with firms making production decisions based on the results. The staff's expertise combined with the unique mix of facilities located together creates a one-of-a-kind place for ethanol R&D. The NCERC helps meet the needs of the biofuels industry through a work force development program, and it fosters work on ethanol co-products, offering a template for commercialization of other technologies.

Jeffrey D. Armstrong, Michigan State University, discussed CREATE-21, a set of proposals to integrate the USDA's research, extension, and teaching functions and to double U.S. funding of agricultural research to about $5.4 billion per year over a seven-year period. Moreover, the funding would become more competitive under CREATE-21, making research better suited to the changing needs of agriculture. The need for these changes stems from the relatively small increase in USDA research funding from 1970 to 2005 (less than 2% per year), with recent declines in important areas. In particular, additional R&D funding would allow expanded research in critical areas, foster the dissemination of knowledge via the existing networks of agricultural extension services, and better educate the next generation of scientists and farmers.

Lastly, Robert L. Thompson, University of Illinois at Urbana–Champaign, looked at the resource constraints facing world agriculture, even as world food demand could double by 2050. In this scenario, research investment is particularly essential for the future as it has been in the past. Also, the Midwest may play an even larger role in feeding the world with exports because of the water and land constraints that many regions across the globe face. But increased funding of R&D is needed to meet the rising global demand for food products. Indeed, R&D plays a key role in enhancing productivity, which will allow for more exports. Moreover, a better mix of funding with enhanced government participation would benefit U.S. agriculture and the world's food supply because private sector investment alone will not reach the socially optimal level in all areas of research.

So, it appears that R&D in the Midwest and the nation is essential for future growth in agriculture, as well as in the food and biofuel industries. Revised government R&D policies and additional R&D funding could help these industries take advantage of the nascent opportunities poised before them, especially in collaboration with the strong midwestern research universities. A slowdown in productivity growth would represent a threat to these industries and the economy. Enhanced R&D efforts are vital to meet the challenges presented by the increasing demand for food and fuel in a changing world while minimizing the environmental costs.

[1] Keith O. Fuglie, James M. MacDonald, and Eldon Ball, 2007, "Productivity growth in U.S. agriculture," *Economic Brief*, U.S. Department of Agriculture, Economic Research Service, No. 9, September.

[2] Keith O. Fuglie and Paul W. Heisey, 2007, "Economic returns to public agricultural research," *Economic Brief*, U.S. Department of Agriculture, Economic Research Service, No. 10, September.