Research to Market/Public Good: Economic Perspectives

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This presentation provides an overview of the NABC-18 theme, *Economic Development Through New Products, Partnerships and Workforce Development*, from an economic perspective. With special reference to agricultural (bio)technology, specifically it outlines methods used for science/technology transfer to markets and public good, provides public and private sector examples of venture capital for early commercialization of agricultural science and technology, and describes issues and recommendations for effective technology transfer to market including public good.

The views expressed in this presentation are mine based on experience in academia, large and start-up industry, and government including as a board member of a government venture-capital corporation [Alternative Agricultural Research and Commercialization (AARC) Corporation] and as an advisory board member of a private venture-capital corporation (Foragen Technologies, Inc.). As president of NABC and a last-minute substitute speaker for Roger Wyse of Burrill & Company, a life sciences merchant bank, I emphasize that the views expressed here are not necessarily those of NABC.

Economic Methods Used for Technology Transfer

Licensing

Much of the research by not-for-profit institutions, *e.g.* universities, government laboratories, research institutes, is to generate knowledge, but such research also results in innovation with potential for commercial products and processes and public good. The majority of not-for-profit research is in this area, with most funding from the public sector. Based on the source of the funding and the mission of the not-for-profit institutions, it is their obligation to provide benefits to the public. In the past, plant breeding utilized

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public varieties as the transfer vehicle, but such transfer nowadays usually is done by licensing. In 2004, the top ten US universities (based on $$ of sponsored research) had $10 billion of sponsored research and gross licensing revenues of less than $300 million, or less than 3% of the sponsored research, ranging from 0.4% to 7% (Laurence, 2006). Licensing revenue makes a very small contribution to not-for-profit research, is highly variable and is not very predictable. The historic examples are the University of Wisconsin vitamin-D irradiation of milk and the rodent poison and human blood thinner warfarin, and more recently the Stanford/University of California fundamental process for making transgenics. Most not-for-profit institutions have established technology-transfer offices. In *Issues and Recommendations* below, I will recommend that maximization of public good should be the objective of technology transfer, not maximization of revenue. This view will be amplified by Mark Crowell in his presentation on *Knowledge Transfer and Economic Development: The Role of the Engaged University in the Twenty-First Century*.

Research Contracts

For-profit corporations provide contract support for not-for-profit research with the objective of generation of technology/know-how for improvement of existing products or processes or development of new products and processes. Research contracts may represent 5% to 20% of research support for more-applied not-for-profit research, such as agriculture and biotechnology. In most cases, the funder will obtain exclusive commercial rights to the technology, including patents for a license fee that is probably predetermined. It is preferable that the not-for-profit entity, not the funding industry, be the owner of the intellectual property, with licensing of rights to the industry. Research rights should be maintained by the not-for-profit. The government uses Cooperative Research and Development Agreements (CRADAs) and these will be discussed by Richard Brenner in his presentation, *Technology Transfer in ARS: Implications of Federal/Private Sector and Federal/University Partnerships to Commercialization Strategies*.

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Various Government Grants to Facilitate Early Development and Commercialization

These include Small Business Innovation Research (SBIR) grants to facilitate small-company product and process development, such as feasibility studies and business-plan development. William Goldner will describe this program (*The USDA Small Business Innovative Research Program: Vision, Challenge, and Opportunity*). The Defence Advanced Research Projects Agency (DARPA) has a similar grants program. These programs are important for cash-strapped new companies since they do not require repayment, and Michael Adang (*From the Bench to a Product: Academics and Entrepreneurship*) will provide a real example. The Department of Energy (DOE) has used major grants to drive biobased industrial products with major industry often the lead organization with subcontracts to other industries and not-for-profits; a recent example is the multifold reduction in cost of cellulase enzymes for use with cellulosics for ethanol production.

Technology Parks

Technology parks have been shown to be useful in bridging the so-called "valley of death," the gap between laboratory research and resultant potential technology and conversion to a commercial endeavor. Such parks enable direct interaction between the scientific innovator and the company seeking to develop and commercialize the product or process. Presentations by Allen Dines (*From Equines to Economic Development: The Story of University Research Park*) will describe the highly successful three-pronged approach in Wisconsin with over 80 years of highly successful experience and by Ashley O'Sullivan (*From Tools to Products and Processes: The Evolution of Saskatchewan's Ag Biotech Cluster*) who will describe what is probably the most successful agriculturally focussed technology park with about 20 years experience. Our visit to the Cornell Agricultural and Food Technology Park (CAFTP) in Geneva, NY, will provide an opportunity to explore issues facing a "just born" technology park.

International Examples

Other presentations at this meeting will provide examples from other countries of the transfer of research to market and the public. Zhangliang Chen (*Innovation: The Chinese Experience*) will describe the connected relationship between the university and the establishment and operation of major businesses, with substantial economic benefit to the university; such a relationship probably would not be acceptable in the United States. Wim Jongen (*Food for Innovation*) will describe the Wageningen Business Generator, which has similarities to Canadian and US research parks. Other examples include India, Brazil and Germany. This broad experience-base, and their respective strengths and weaknesses should guide future activities in this emerging area of technology transfer. A reality check is provided by Richard Broglie (*Translating Discovery Research into Commercial Products*), presenting the perspective of a major agri-food-chemical company.

Various Forms of Investment in New Companies

Equity investment is more useful for new companies than loans; new companies are almost always strapped for cash and, therefore, interest payments consume money that is needed to invest in the business. I have had several years' personal experience with a government-funded venture-capital corporation and with a privately funded venture-capital corporation. Both were investors in early-stage commercialization.

The AARC Corporation was authorized by the 1990 Farm Bill as a wholly owned government corporation within USDA. Its mission was to commercialize industrial uses of ag and forestry materials to create, in the long term, new markets and reduce subsidies for agriculture. AARC had many strengths, including a mainly non-bureaucrat board with initially over 50% having been presidents or vice-presidents of for-profit corporations. It was operated as a business, making investments in the most promising companies, with little emphasis on geographic location and with ability to make equity investments, which was unique to government where grants and low-interest loans were the norm, requiring matches of at least 1:1 of non-AARC to AARC investments, and in-depth due diligence with external expert review of proposals and on-site reviews by staff and at least one board member, prior to investment, with subsequent on-site annual or more-frequent monitoring. The weaknesses were the inexperience of government with venture-capital and the venture-capital approach where projected return is directly variant with risk, impact of shifting political "winds" on funding, ability only to invest if private funds were not available (in other words, the source of last resort) and, finally, the inability to move the "AARC activity" to a non-government-funded corporation with expanded resources for continuing and expanded equity investments in biobased products and processes. Equity funding for agriculture-related new companies is minimal; an exception may be occurring with the current exploding interest of Wall Street in cornstarch-ethanol investment where the possibility of too much/too fast is a real concern. There is a major continuing need for government to play a role with early venture capital, but it would need to avoid the above weaknesses. Up-front endowment-type government funding may work, as with the very successful Canadian Foundation for Innovation in the late 1990s.

Examples of products/processes funded by AARC [*e.g.* AARC Corporation (1997)] included milkweed fiber for hypoallergenic comforters and pillows, D-ribose for cardiovascular function, biodegradable plant oils for engine lubrication, capsaicins from hot peppers to keep mammals out of avian food, *e.g.* squirrel-free birdseed, and gasification of biomass and its high-yield biological conversion to ethanol.

Foragen Technologies, Inc., is a Canada-based venture-capital company founded in the late 1990s. Funding came from the private sector. It funded very early commercialization as mainly not-for-profit innovations were evaluated and developed as new businesses. A number of promising investments were made. However, a second round of investment in Foragen Technologies by the private sector did not occur, probably based on the perception that agriculture is not an attractive area for venture capital. This is in contrast to the abundant venture capital for human-health-related innovations.

Issues and Recommendations

Several issues and recommendations will be noted, with the hope of stimulating discussion and improving efficacy of research to market/public good transfers.

Maximize Public Good from Public-Sector Research

Licensing income is small. Technology transfer should maximize public good not maximize licensing income[1]. Evaluations by and of technology-transfer offices should use the public-good metric, not the income metric.

Intellectual Property

Seeking protection of IP should be based on a realistic assessment of potential. Business-experienced alumni can be helpful in providing guidance on decision-making regarding filing of patents. When it is decided not to file a patent, the right to file could be assigned to the inventors. The most promising patents should be filed broadly and patent estates built around them. Failure to find business interest in a patent within a reasonable time should lead to timely abandonment so as to avoid continuing maintenance costs. Although universities file and are awarded large numbers of patents (Rovner, 2006), only a few result in significant products and/or processes

Venture Capital

Venture capital for agricultural innovations, other than human-health uses—is inadequate. A method is needed for significant government funding of this area without the variability of political impact. Up-front endowment funding may be such a method.

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Path to Market

My experience is that the path to market is the single most decisive factor for success of a new company, more so than any other factor, such as entrepreneurial leadership, funding or technology.

[1]Robert E. Armstrong, senior research fellow at the National Defence University, suggests that the Apache "open source" community in the computer-software industry, as described by Tom Friedman in *The World is Flat* (New York: Farrar, Straus and Giroux, 2005), illustrates maximizing the public good while enabling economic return to industry. The Apache "open source" community is a collaboration of computer scientists self-organized to develop programming to run Web services. In the Apache collaborative community you could use community technology, but were required to make any improvements available to the community. In addition, industry could build a patented commercial product utilizing the "Apache code," but were required to include a copyright citation in their patent. Substantial revenue has been generated by IBM utilizing this approach in the Web-server business, while the base technology is broadly available. Plant breeding public research with seed-company development of commercial products is an earlier example. The recent collaboration of several not-for-profit research institutions to retain research uses and applications for developing-country uses of biotechnology patents is another example.

Deal Yield

A large number of deals need to be assessed to find the few that are worthy of investment. The yield is in the range of one out of every twenty-five to fifty considered. "Back-of-the-envelope" calculations eliminate many deals.

Business CEOs

Scientist innovators usually are not successful as business CEOs. A rule of one venture-capital manager was "Shoot the inventor." There are exceptions, but business CEOs need to focus, focus, focus on the business objectives, whereas scientists' success usually results from broad curiosity.

Difficult Areas for New Businesses

Some examples where failure is common (based on my experience) are construction and building materials that require a huge scale of production, *e.g.* the 100 million ft^2 straw-based particleboard plant in Manitoba, most recently operated by Dow, was closed in early 2006. Another difficult area is new crops. Most are long-term efforts and need the staying power of the public sector. Canola, as described by Keith Downey (*Rapeseed to Canola: Rags to Riches*), is an example of relatively rapid development of a new crop, but there are many other oil (and other) crops for which development has been tortuous. Another area with a low success rate is microbial pesticides. While plant-based biopesticide products have been quite successful, microbial pesticide-based companies have a history of failure. Technology platforms are difficult in defining the business path to market.

There are other issues that I am sure will be discussed at the breakout sessions. I hope the above will help stimulate your discussions. Improving the transfer of research to the market/public good has major opportunities for improvement

References

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