

Evaluating Outcomes of IMBA Research

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Executive Summary

We evaluated the extent to which research funded by the Illinois Missouri Biotechnology Alliance (IMBA) led to new and improved technology employed in the industries involved in producing, processing, distributing, marketing, and utilizing corn and soybeans. Specific objectives include:

1. To identify useful practical achievements of IMBA biotechnology research projects.
2. To identify relationships and linkages that helped transform IMBA biotechnology research results into useful practical achievements.
3. To compare IMBA biotechnology research projects with other, similar research projects (provided by the United Soybean Board-USB) in terms of tangible and intangible contributions to desired practical outcomes.
4. To develop and disseminate guidelines for establishing and expediting relationships and linkages that foster rapid, efficient technological development.

Many of the IMBA projects did in fact produce prototype plant materials and technologies meriting further testing or commercialization. These included transgenic lines, markers, plant constructs, improved seed lines, improved technology services, and processing technology techniques and improvements. IMBA researchers were very good at publishing results in peer reviewed journals and presenting results at various meetings. Evident from the proposals was that many studies required long term commitments after IMBA initial funding to realize a commercialized product or service.

All IMBA proposals clearly identified the research outcomes as goals, and many identified practical uses and end-users for their work. Less effort was made to involve industry in the eventual outcome of their work. When this was done, there were direct benefits in research alliances that provided further testing of research outcomes or further developing outputs.

A thread common between IMBA and the USB projects appears to be the timelines to successful implementation of biotechnology. Conventional biotechnology research has a shorter time to reach implementation than does basic biotechnology research, although IMBA projects' anticipated timeline to commercialization was shorter when industry interest was fostered and maintained along during the research process.

To enhance rapid, efficient technological development of biotechnology results, researchers should have an awareness of the benefits their research can have in the private and public sectors, beyond furthering more research. Clearly outlined tasks to be done to complete the project and identifying planned deliverables is desirable, with ongoing communication between researchers and interested end-users of the research outcomes.

Individual research projects, in general only provide one or a few components of a complex technological development, such as an improved crop cultivar. Often the results of basic biotechnology research funded by IMBA, combined with results of other studies, lead to developmental research conducted by private firms. The results of the developmental efforts lead to prototype technology, which is subsequently refined and ultimately commercialized through adaptive research and technology transfer programs, some of which are conducted by public agencies and institutions. Sometimes the path by which the basic research results find their way to practical application is so complex that the connection to the basic research is lost. This difficulty in measuring final results makes it harder for decision makers to justify their investments in research.

Our perception is that the quality of IMBA-funded research is excellent. It is yielding useful results and patented and licensed technologies. Because of IMBA, investigations are undertaken that would not be undertaken by private firms because of the risk involved and the time and money that must be invested. Publicly funded research continues to be essential to success in technology-based competition.

Objectives

This project investigated how research funded by IMBA contributed to new and improved technology employed in the industries involved in producing, processing, distributing, marketing, and utilizing corn and soybeans. This is directly related to evaluating how IMBA funded projects further the first objective of IMBA under the Enhanced Profitability Program, which states IMBA research ‘provides innovative discovery research that is linked explicitly to outcomes’. Thus, this study looked to how IMBA funded researchers considered and implemented commercialization plans throughout their project. It was hypothesized that early and continual consideration of such planning would ease the utilization of biotechnology research results into practical achievements, resulting in value to producers or other end users.

This study’s objectives were:

1. To identify useful practical achievements of IMBA biotechnology research projects.
2. To identify relationships and linkages that helped transform IMBA biotechnology research results into useful practical achievements.
3. To compare IMBA biotechnology research projects with other, similar research projects in terms of tangible and intangible contributions to desired practical outcomes.
4. To develop guidelines for establishing and expediting relationships and linkages that foster rapid, efficient technological development.

Methods

Nineteen Projects initiated between 1997 and 2003 were considered for analysis. Information from IMBA proposals, reports, and principal investigators was used to complete questionnaires. These questionnaires identified how researchers considered usefulness and commercialization of their future research results before and during IMBA funding periods. How the researchers approached and included collaborations with private sector research and development entities was considered. Whether these entities would be able to convert the anticipated biotechnology-driven results into practical 'products' of value to agricultural industry was evaluated. The questionnaire also looked at how well researchers incorporated information systems to further an environment supporting collaboration with fellow researchers and potential end users of their research results. Finally, IMBA projects with a basic biotechnology emphasis were compared to projects with conventional technology research to compare progress towards technology commercialization by project end.

Results

Fifteen IMBA projects considered were plant focused biotechnology projects, with the remaining four projects investigating methods of improving uses of corn or soybean products. Regardless of the emphasis on plant biotechnology or utilization technology, there was a high performance level among investigators involved with these IMBA studies, with the most effective results coming from researchers who gave early consideration to how their results would be translated into tangible, valuable products for commercialization.

Objective 1. To identify useful practical achievements of IMBA biotechnology research projects.

Many of the IMBA projects did in fact produce prototype plant materials and technologies meriting further testing or commercialization. Some of these include: high lysine transgenic corn; sudden death syndrome and soybean cyst nematode resistant soybean markers; plant constructs with modified cell death genes for testing by Pioneer; soybean and potato transgenic lines for swine PRRSV antigenic properties; protocols for predicting and selecting bioactive defense peptides for Phytophthora root rot; seed lines for further heat stress experiments; expanded maize gene transfer capacity with transformation services available to academics; and butanol fermentation from enzymatically hydrolyzed corn fiber.

The few projects not resulting in such tangible outcomes would be considered satisfactory, as these studies were usually early attempts to apply a technique in a novel way or develop a new procedure. It was evident from their proposals that these studies would require long term commitments after IMBA initial funding to realize a commercialized product or service.

Some IMBA projects resulted in enhanced or new procedures being ready for implementation beyond the research venue. For instance, examples of useful methods of technical agricultural research are a new, less costly and time consuming test for measuring bioavailability of isoflavones, a unique high moisture extruder method for producing high-quality fibrous meat analogs, and modeling ways to enhance meat and milk quality with improved corn and soybean products.

Besides producing tangible outcomes for possible commercialization, the IMBA researchers are active in documenting their progress in the form of peer reviewed publications and presentations

at scientific meetings. For the investigators involved in this sampling of projects, they were responsible for publishing 38 journal articles and 23 abstracts of their IMBA supported work. Applications for at least four patents are in progress, one of which was successful. At least three electronic databases of research results are available through one investigator.

Objective 2. To identify relationships and linkages that helped transform IMBA biotechnology research results into useful, practical achievements.

Ideally, for research to translate into useful, practical achievements, the researchers would identify tangible results in their proposals and give early consideration of who would use their results and how the results would be used. All IMBA proposals clearly identified the research outcomes that were the goals. All but two projects adequately identified how their results would be used. For the two that did not, one could read between the lines and assume which business sector could benefit from the results; the researchers simply did not specify this in their proposal.

Yet, for basic science work involving biotechnology methods for such concepts as plant modifications, logical steps to take to ensure research would translate into tangible, commercialized outcomes would entail early identification of companies or individuals within the industry that would realistically be open to applying the scientific results in creating a viable product of use to the public. Then input would be sought from this sector on specific outcomes, and timelines for achieving these outcomes so results would move relatively quickly from research to commercialization to products improving agricultural production and agriculture product uses. This input would hopefully be ongoing throughout the work, to make sure the work remains topical and timely to the industry.

IMBA researchers seeking early industry input succeeded in keeping their industry contacts open at least through the initial product testing phase. Some involve the key company in their construct testing or partnered for industry use of their methods for fine mapping and gene discovery. Others worked with cooperative extension to develop methods for effective information dissemination of their work. Others simply had to delay commercialization of their results as intellectual property protection steps are followed.

One researcher appeared to do all the correct steps to work with an end-user, yet the result was that one of the outcomes achieved in accordance with the proposal was in fact not something the industry partner wanted in the end. Another investigator initially envisioned a start-up company using their technologies and has seen this idea succeed.

Thus, communication is one element intrinsic in developing the relationships necessary to see research results translate into commercialized products. This may have occurred, but it was rarely explicitly planned to happen. Neither proposals nor reports by IMBA researchers mentioned the need or desire for internal periodic research progress updates occurring with potential industry partners, or between academic partners. This level of communication was not necessary for IMBA work to succeed. In fact, identifying support and interest from industry in proposals was desirable, and most included such statements. Evidence of further communication was lacking until research outcomes were available and contact was again pursued. It is unclear

if contact occurred in between, so it is impossible to know if communications during the research phase assisted in seeing research outcomes become a tangible outcome.

Objective 3. To compare IMBA biotechnology research projects with other, similar research projects in terms of tangible and intangible contributions to desired practical outcomes.

The IMBA studies evaluated were compared to twenty-one projects funded through the United Soybean Board (USB). The USB studies fell into two obvious types of studies, of which eleven used basic biotechnology and ten used more conventional biotechnology. “Basic” biotechnology involved techniques such as gene transfer, antisense technology, etc., while “conventional” biotechnology, involving marker-assisted selection, genomics, etc., producing conventional germplasm, varieties. It is important to note that conventional breeding often involved biotechnology-based techniques, such as marker-assisted selection. In comparison, thirteen of the studies from IMBA would be classified as basic biotechnology, and the other six would use either conventional biotechnology or other technologies (e.g. processing techniques, bioavailability evaluation). USB researchers using conventional approaches were more likely to foresee quicker implementation of their research outcomes and products into practical results (3-5 years) than research using more basic biotechnology methods (10 years). In contrast, the IMBA researchers using more basic biotechnology methods provided a more optimistic view of how quickly their outcomes would translate into technology being used by other researchers or industry. In some cases the delay was simply pending patent approval, or the industry link was already established, and awaited industry preliminary work with the new technology.

One benefit to IMBA funded research appears to be early consideration of private sector needs. If private sector interest is solicited early in the research process, it appears their involvement at the end of the basic research work is more assured.

Still, generating practical technology from “basic” biotechnology approaches is expensive, time-consuming, and politically sensitive. This discourages investment by commodity groups and private firms unless major markets will be created or positively affected. Yet, in biotechnology research, there is no such thing as a simply inherited trait. Some desired results probably cannot be achieved with “conventional” breeding, but can be achieved with “basic” biotechnology.

Objective 4. To develop and disseminate guidelines for establishing and expediting relationships and linkages that foster rapid, efficient technological development. Such guidelines would maximize the rate of development of practical technology from biotechnology research results.

Researchers funded by IMBA could be identified by various strengths. They usually have a strong interest in showing how their research will provide benefits beyond furthering research, although there are cases where the latter emphasis is very appropriate. To accomplish their work, the researchers often clearly outline tasks to be done to complete the project and identify planned deliverables. The biotechnology research completed within IMBA also has a higher than usual rate of becoming products with the potential to become a product useful to agricultural producers and/or industry.

Given their strengths, IMBA research could be stronger in the following ways. Plans of work would be improved if they included development and implementation of formal internal communication and information systems to enhance collaborations, or at least make this system more transparent. Similarly, showing there was periodic internal review of progress towards

goals, especially regarding fostering contacts with potential commercialization partners, would make research results much more marketable and likely to benefit producers and industry. Finally, it would be desirable to develop measures of accountability to mark progress and evaluate deliverables at project end. This would entail specific timelines for achieving research benchmarks and communication goals.

Finally, specific questions one could ask of researchers seeking funds for biotechnology work to evaluate projects seeking to have the greatest public sector impact include:

- What is the desired practical outcome?
- When will a practical technology be available?
- What are the tangible deliverables?
- Who wants the deliverables?
- Is there working relationship with them?
- Is the project scientifically feasible?
- Is the project practically feasible?
- What additional research will be required?
- What will it cost relative to this project?

Abstracts

Holt, D. A., and M. L. Nash. 2006. Anticipating research outcomes. In Annual meetings abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI.

We reviewed research proposals and progress reports and queried their authors concerning progress toward practically useful technology. The proposals were sampled from those funded by the Illinois Missouri Biotechnology Alliance, Illinois Council for Food and Agricultural Research, and the United Soybean Board. For this group of projects, the practical outcomes sought by researchers and sponsors were usually crop cultivars with improved disease resistance, composition, and/or yield. In our sample, researchers using “conventional” plant breeding approaches, which included such advances as marker-assisted selection, anticipated useful practical applications within three to five years from the end of funded projects. Researchers using “cutting edge,” basic biotechnology techniques, such as gene transfer and gene silencing, did not expect practical outcomes within ten years. While basic biotechnology techniques are powerful, the genetic modifications sought in these studies were complex. Also, what appears as a simply inherited trait in conventional plant breeding is not so simple when it is necessary to transfer not only the gene but all of its attending apparatus of promoters, modifiers, etc. When this has been accomplished, there are still years of regeneration, greenhouse tests, variety development, field comparisons, further refinement, and marketing studies, complicated at each step by regulatory concerns and anti-GM sentiment. In the projects we studied, it was evident that achieving a desired practical result, say cultivars with improved disease resistance, through advanced biotechnology approaches was likely to be slower and more costly than using conventional approaches. Of course, some of the most challenging objectives probably could not be achieved by “conventional” approaches, no matter how sophisticated they might be. Attention should be given to reducing the cost of translating basic plant biotechnology research results into desired practical outcomes.