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Business Challenges in Commercialization of Agricultural Technology

Michael Boehlje [a]ⓘ

[a] *Professor, Center for Food and Agricultural Business, Purdue University.*

Abstract

Technology has been a major driver of both the agricultural productivity increases of the past century and the financial success of many farm and agribusiness firms. The challenges of bringing new technology to market in the agricultural industry are changing – it is no longer adequate to conceive a new invention and convince farmers with a strong marketing campaign that they should adopt the technology that results from this invention. One of the plenary sessions at the 2003 IAMA meetings in Cancun focused on the challenges and opportunities in creating value from new technology. Participants included: Michael Boehlje, Center for Food and Agricultural Business, Purdue University; Lynn White, Vice President, Global Ag Services, Deere; Marcello Arguelles, CEO of Biosidus; and Greg Clarke, Technical Director, FXA Group. This synopsis attempts to capture the key observations of the session presenters and the discussion that followed.

ⓘ Corresponding author: Tel: + 1-765-494-4222
Email: boehljem@purdue.edu

Introduction

Technology has been a major driver of both the agricultural productivity increases of the past century and the financial success of many farm and agribusiness firms. Generally, farmers are perceived to be rapid adopters of new technology, and those agribusiness firms that have been innovative and creative in their R&D activities have been rewarded with strong market positions and financial success. But the challenges of bringing new technology to market in the agricultural industry are changing – it is no longer adequate to conceive a new invention and convince farmers with a strong marketing campaign that they should adopt the technology that results from this invention. The business challenges in the commercialization of agricultural technology are both more complex and broader with respect to those who will be impacted by that technology.

Much of the technology and innovation research in the food and agribusiness industries has focused on producer adoption and purchasing behavior. Early work by Rogers on the adoption and diffusion of innovations focused on farmers and identified various categories of technology adopters including innovators, early adopters, the early majority, the late majority and laggards. Assessment of the impacts of technology and innovation on productivity and structure of agriculture has also been the focus of significant work in the agricultural sector (Busch, et. al., Sunding and Zilberman, Kislev and Peterson, Huffman and Evenson, Thirtle and Ruttan, Ruttan and the National Research Council).

Possibly because of the dominant role of the public sector in both R&D and technology transfer in the agricultural sector, analysis of the innovation process and of innovation management and commercialization of technology from a business strategy perspective has received only limited attention. In contrast, the innovation process, technology commercialization, entrepreneurship and innovation management have been the focus of extensive research and writing in Schools of Management (Afuah, Christensen, Foster, Burgelmann and Sayles, Christensen and Raynor, Arora, et. al., Shavennce, Libecop, McGrath and MacMillan for example). A review of that work and applying it to the agricultural industries suggests six business challenges in commercialization of agricultural technology.

Creating Value

The most basic business challenge in introducing any new technology is that of creating value for the customer. But even if the technology will create value for the customer, the rate of adoption and speed of commercialization – in essence the time to market – may dramatically impact the financial/business success of the technology. This speed of commercialization or time to market has been a particular challenge in both the information technology and the biotechnology industries in recent times. The related issue of the rate of time and risk discounting

and its impact on managerial and market expectations of the speed of commercialization is also critical. With recent lowering of market rates of interest and returns, the hurdle rate for new technology in terms of financial performance has been lowered compared to what it has been in the past.

In fact, the challenge of creating value in the biotech industry combined with issues of consumer acceptance may be one reason why biotech companies have been much more successful in the commercialization of input traits that will increase agricultural productivity then product or output traits that may encounter resistance from consumers as well as processors and food retailers.

Gaining Customer/Consumer Acceptance

Understanding the customer has always been one of the key determinants of successful commercialization of new technology in agriculture. But gaining customer/consumer acceptance has a broader focus and new challenges today compared to the past. Understanding the marketplace and customer base including segmentation analysis and technology adoption rates by segment is increasingly important with the profound structural changes in agriculture -- in particular the transformation of much of the industry to larger scale vertically aligned value chain systems in contrast to the modest scale independent family-based businesses of the past. But not only are the direct customers changing profoundly, other stakeholders are increasingly having significant impacts on the acceptance or adoption of new technology. The biotechnology industry is well aware that down-stream participants in the food value chain -- processors, retailers and even consumers -- can have a significant and dramatic impact on market acceptance as exemplified by the GMO controversy. And not unrelated to food consumer acceptance issues are those of the regulatory approval process, food labeling and food safety regulations which have the potential to significantly slow the approval and acceptance of some technologies which are perceived to have negative impacts on consumer health and food safety, and at the same time accelerate the rate of adoption of those technologies including traceability and identity preservation systems that might mitigate or reduce the potential for food contamination and food-borne health concerns.

Capital Market Access

Technological innovation typically requires large capital outlays, and consequently access to capital/financial markets is critical to the success of discovery and commercialization of new technology. The dominant new technologies in agriculture – biotechnology based on biological advances, and information technology based on advances in sensing systems and computer software – have faced severe capital market access challenges in recent years. These challenges are two-fold: first, technology providers in both the biotech and information technology

industries over-promised with respect to their ability to create value for customers as well as the speed of bringing new products and services to market. And second, once the capital markets begin to realize that their expectations of very high performance possibly would not be fulfilled (precipitated in significant part by the dot.com bust), technology in general fell from favor and the capital markets became much less accessible not just to specific under-performing firms, but to all firms whose business model was technology driven. Some have argued that technology, and biotechnology in particular, is best served by patient and private capital rather than impatient public capital providers.

Value Capture/Sharing

A fourth challenge in commercializing agricultural technology is that of value capture. Even though new technology may create value for the user, if the provider does not have a mechanism for capturing some of that value, it is unlikely that the technology will be commercialized. In the information and biotechnology fields, increasingly the value capture mechanism is the intellectual property rights that have historically been used by mechanical and other similar technology providers. But in some cases the value creation process occurs in the form of a value chain benefit rather than an individual firm benefit, and the value capture process for individual firms is more difficult to implement. Consequently, creative ways to share both value as well as the risk of that value among participants in a value chain becomes important to the adoption and utilization of the technology. This value sharing arrangement may be as simple as licensing and royalty arrangements, or as complex as proportional sharing of the total value created by the chain participants.

A second concern about the value capture/sharing process is that value creation for any technology is not stable over time. The process of commodization and substitution results in a natural process of value decay over time as competitors producing the same technology as well as new technologies come to market. Furthermore, processor or buyer substitution and mitigation again limits the amount of value that can be captured from a new technology, because if buyers are required to pay higher prices for the attribute or benefits of a product or service produced by a technology, they have more incentive to use alternative products or services which are lower priced or develop internal capacities that mitigate or reduce the need for the particular attribute produced by the new technology. This issue of processor mitigation is particularly important to the biotechnology industry as it attempts to bring new output traits to market; an essential issue is what output traits the processor not only needs, but also can not produce themselves using new processing technology or through using substitute products or raw materials. In many cases, the attributes that processors have the most difficulty in mimicking or mitigating are process attributes such as for example organic or

natural production, rather than product attributes such as higher energy or higher protein content.

Protecting Intellectual Property

As suggested earlier, one of the common approaches to capturing value from new technology is to protect the technology from analogues or competitive suppliers through intellectual property rights. In fact, intellectual property has been expanded in recent years to not only apply to traditional mechanical, electronic or similar inventions, but to software, plant genetics, and even business models. But protecting intellectual property is increasingly fraught with controversy and difficulty. Intellectual property law is not uniform throughout the world, and in many countries the protections that might apply to new technology in the U.S. or Europe do not apply in South America or China. Consequently, technology that has value only if it can be marketed worldwide faces more difficult commercialization challenges compared to technology that is commercially viable based on introduction and utilization in markets that will protect intellectual property. And in some cases the public policy debate about what is public information/knowledge and what is private and therefore can be protected by intellectual property rights has generated uncertainty about current and future intellectual property protection even in the U.S. and Europe. In particular, there is a significant debate about whether the genome which provides the base of information for the biotech industry is public or private information/knowledge, and consequently what is and is not truly patentable.

Innovation Strategy

A final challenge in the commercialization of technology is the decision process by which R&D expenditures are allocated and commercialization is funded. Technology development and commercialization is clearly an issue of making critical and costly strategic decisions in a profoundly uncertain environment; uncertainty associated with the breakthroughs necessary to develop the technology, uncertainty associated with the market acceptance of the technology, and uncertainty associated with the ability of competitors to bring similar technology to market. Clearly, scientific breakthrough assessment, technology adoption analysis, market/customer acceptance assessment and competitor response evaluation are all essential in evaluating or modeling the innovation and commercialization process. Given the profound uncertainty associated with this process, an options approach that enables managers to make sequential commitments to R&D and commercialization activities, thus increasing flexibility while maintaining upside potential, can be very useful. In fact, one approach to strategic positioning with respect to R&D and commercialization investments is to maintain and manage a portfolio of R&D and commercialization options rather than focus exclusively or primarily on one block-buster breakthrough.

Responses of Technology Providers

So these are some of the critical challenges in the commercialization of technology. How do individual businesses respond to these challenges? Let's listen to some successful technology providers in the agricultural industry to hear their responses. First we will hear from Lynn White, Vice President, Global Ag Services, Deere, a globally recognized technology provider in machinery/equipment and related services. Next Marcello Arguelles, CEO of Biosidus will discuss these challenges from the perspective of a biotechnology company in Argentina. Finally, Greg Clarke from FXA will tell us about the challenges and opportunities of bringing information technology to market to facilitate traceability along the food chain.

Summary of Comments by Lynn White, Vice President, Global Ag Services, Deere

The business proposition of Deere Global Ag Services is to identify and bring to market new business opportunities that will expand the footprint of Deere in the agri-food marketplace. These new business opportunities are driven by three fundamental developments in the agricultural sector: 1) the evolution of a consumer driven sector that embraces coordinated food chains resulting in information across the stages of the food chain being critical to maintain brand value, food quality and safety; 2) increased concerns with respect to environmental regulation and food safety which require disciplined process control as well as new technology to comply with new regulations; and 3) manufacturing models of production which include such phenomena as operational/organizational modeling, outsourcing, process control technology and other manufacturing processes applied to production agriculture as well as food chains.

The products being introduced by Global Ag Services include: 1) chain information and management services which focus primarily on processors with Food Origins the initial offering; 2) production productivity products and services including new automation systems such as robotics, geospatial data including precision agriculture, risk management services driven by intensive data systems; and 3) environmental products and services with a particular focus on the livestock industries.

The product/service offerings always start from a value proposition with technology being used as a means to deliver that value proposition. The feasibility of the value proposition depends upon applications of high resolution resource management technologies to reduce variability and the management of risk (in most cases risk management is heavily information driven) including sensing, data collection, modeling and process control technologies improving the timing of operations which is a major source of production risk in agriculture; and cost effective integration capabilities and information systems that include data mining and analysis,

communications and delivery using wireless technology and internet applications and systems.

Success in deploying new technologies depends fundamentally on the following arguments; 1) customers are looking for answers -- not tools -- which requires packaging of technologies in a system context; 2) the applications must have supply chain data/information capability so as to integrate the stages in that chain; 3) the approach of adapt from other industries rather than invent new, is critical to cost effective delivery; and 4) field testing is a necessity.

Summary of Comments by Marcello Arguelles, President, Biosidus

The business proposition of Biosidus is fundamentally to use agricultural biotechnology, particularly animal biotechnology, to create products for the health/pharmaceutical industry. The original focus of the parent company – Sidus – has been human health, specifically interferon or growth hormone for children with dwarfism symptoms. The current interest in agricultural biotechnology is to use transgenetic animals to produce human growth hormone – more specifically, to produce growth hormone in the milk of transgenetic cows.

Biosidus has produced the first clone cow in South America, and is now in the process of producing transgenetic animals for milk production that contains human growth hormone. Further research focused on producing pharmaceutical and health industry products using the science of biology and biotechnology using potatoes, sugar cane, and blueberries as the host plants is underway. In summary, Biosidus is a pharmaceutical company that is attempting to develop and commercialize human pharmaceutical and health products through biotechnology applications using plants and animals rather than industrial manufacturing facilities to produce those products.

Summary of Comments of Greg Clarke, Technical Director, FXA Group

FXA Group is a software/information company focused on producing traceability products and systems for the food industry. The Thailand based company is global in focus with current partnerships in the food chain with Syngenta and Costco. Interest in food traceability systems has grown in recent years because of increased government regulations including restrictions on acceptance of biotech food products in certain countries and by certain food companies; consumers increased concern and awareness of the characteristics of the products they consume; and retailers and processors concern about food safety and brand protection. Traceability is increasingly important in the food industry because food safety lapses are often fatal to food companies. And even in cases where traceability systems are in place as is the case with the recent BSE event in Canada, the system

of documentation is manual rather than electronic based which makes it extremely difficult to quickly interrogate the data.

A serious problem in the food industry is the diverse processes and documentation systems used in different geographic locations and by different participants in the value chain from genetics to retail. In essence, there are no standards or systems in terms of processes, so an information/documentation system must be sufficiently flexible to handle this diversity and yet guarantee compatibility. The FXA products include a suite of traceability software across the entire production/distribution chain including Farm Smart, Quality Smart, Production Smart, Ship Smart, and Trace-It Smart. Data is collected from specific workers in the value chain using hand-held devices and then is distributed via Internet. A unique feature of the software systems is that the data belongs to whoever entered it, and access is provided by agreement between the owner of that data and those who request or require it. Consequently, the software provides an integrated, compatible-across-the-supply-chain traceability system, but protects the proprietary nature of that data with appropriate firewalls. This information driven technology attempts to respond to the very real and current concern about issues of food safety, food quality and bio-security across the food production/distribution value chain.

Interview Dialogue

Question: Mr. White, most of the technology you are talking about is not the technology that Deere is noted for, and a manufacturing company with a lot of engineers might be expected to struggle with corporate acceptance of information and non-engineering technologies that are perceived to not be part of its core competencies. How do you get corporate support for these new, non-traditional technologies?

Answer: There are a lot of capabilities that Deere has, which probably are not obvious to those outside the company, that support what we do. They are capabilities we have used to develop the products we currently have --Deere has been successful for many years in applying certain types of information technology and management techniques to manufacturing. It is rare that when we talk about technology with senior management or other members of our group that we are talking about something that no one knows about -- this is the case for example when we talk about data collection or guidance in the field or communication -- we are talking about ideas that are based on commercial products and technologies that are available from other industries. As to senior management, to some extent this was their idea, which always helps. There is also the question of motivation -- remember that agriculture is about half of Deere's business, the other half is in other marketplaces including a very large financial services

company. One of the key motivations was to look for new sources of growth in spaces we understood pretty well and in which we felt we had a reasonable position. This motivation is fairly strong because from a long-term 8-10 year time frame it is easy to see limits to the existing business. If you look at the farm equipment business it is a slow growth business in which we generally have large market shares. Overall it is growing at 2 percent a year and our chairman set out a goal to double value twice, and at that growth rate it would take 75 years to do so which is clearly not acceptable. So that is the context we work in – an expectation that we are looking for new areas, that these are ventures that will have failure rates, etc. But it is not easy – it is often difficult for some to grasp the value propositions we are talking about. So far it has been reasonably successful and part of my job is to bridge between the innovative staff that are part of our team and our partners elsewhere in the company and senior management.

Question: Mr. Clarke, with respect to capital market access, you are a privately held company, you have capital needs to develop your technology like everyone else. Why not get a venture capitalist involved so you can grow the business more rapidly. Are you thinking about that? What is the capital market challenge you are facing?

Answer: The principal of the company has invested quite a bit of personal money – he is a former executive of Microsoft and so he had some to invest, and a decision was made to not use venture capital to finance the business because you give up such a large share of the company to gain the capital. So that puts us in an interesting position – the business is growing much faster than anticipated which means the need for capital is growing faster than anticipated, and we are 3-4 months away from being cash positive in our cash flow. So what do you do – what kind of capital do you look for, do you fund it more yourself, do you try to find additional people to fund it, or do you look to the venture capital market. It is a decision we are wrestling with at this point.

Question: Mr. Arguelles, let's talk about your business model. In the U.S. the approach of trying to leverage the biotechnology science base into both the agricultural and the pharmaceutical markets has not worked well – the capital providers didn't like that idea. Some people say that agriculture was contaminating the pharmaceutical side of the business. You are taking this science to both product markets – is that working – are your markets more accepting of this strategy?

Answer: We have followed the same approach as that followed originally by other biotech companies. But remember we don't have much investor risk or venture capital in Argentina. All of the investment has been made by the owners of the company. When we started in the 1980's, Sidus the pharmaceutical company put money into Biosidus the biotechnology company for 13 years. In 1993, Biosidus reached break-even and currently is the principal source of profits for the group. But basically the investment funds came from the owner of the company, so the capital market challenge to the business model was not as serious as with public capital markets.

Question: Mr. Clarke, I noticed from your presentation that you focused on American farmers. How do you expect to work with farmers in third-world countries when you need access to the Internet to hook up to your system? How do you envision the use of this tool you're developing at the farmers' level in third world countries?

Answer: We are currently working with Syngenta and Syngenta is working with farmers, so they will be the company that we sell to, not the farmer. Syngenta will be providing access to the farmer. We're also currently working on an agreement with the government of Thailand for shrimp producers (and that's now expanded beyond shrimp to other products) where they will be supplied handheld devices and the data input will occur at the factory level. Shrimp farmers are entering data through the handheld and the data will be input to the processor. Periodically the processor will be making inspections at the farm to make sure that what they've said is what is actually happening. So the processor will test for chemicals on a randomized basis to make sure what the farmer has put in on the handheld is reasonable.

Question: Mr. White, you mentioned two drivers of change as first consumer responsiveness and another was shifting to biological manufacturing or more industrialization. The discussion we have had recently in the Netherlands on technology was on more targeted consumer groups, and that means more flexibility in technology that focuses on a more micro scale production technology. Would you comment on whether you think that is important for the near future?

Answer: By micro scale, I presume you mean small-scale production. We think that this is one of the great benefits of information technology. It's a lot less scale sensitive than earlier versions of agricultural technology. We look at our other product lines. They have gotten bigger and bigger over time so that they have been drivers of scale. A combine costs $300,000 more or less. It takes a lot of acres and a lot of production to

pay for that. I talked earlier about high-resolution management of the environment, which means water and drainage in the soil and all of these things. As far as we can tell, this is applicable at a very small scale to a very large scale. It's a question of what you want to do. We didn't set out with any particular model in mind. A key issue though is being able to actually use it, rather than its cost effectiveness. It's not unrelated to the last question -- how do you deal with technology and smaller producers, especially smaller ones in places without much infrastructure. I think it's a big issue, and we basically have taken the view that you can't do it without some sort of intermediary to help support it, and that could take a lot of different forms. It could be producer groups such as co-ops; it can be professional organizations that are providing agronomic advice; any number of different approaches. Given that service – the ability of the delivery channel to service the technology to make sure it works – we don't see any particular scale type of issue. In fact, some of my colleagues would tell you that if you can manage the resource at the level that we're talking about or really understand it in a very precise way – the relationship of the genes that you're using, the environment that you're producing it in, the management techniques that you are applying, the product attributes that you are producing – this could be highly advantageous to small scale production because it becomes very, very tailored and very, very specific. We haven't demonstrated that, but we think it's feasible. But we do think there are some real issues in delivering it cost effectively.

Question: A question for all three panellists. I noticed the title is creating value through technology and my question is: how from an economic or financial point of view, do you demonstrate to your funders, capital markets, senior management and your potential purchasers of your product, the value of what you have to offer in terms of information technology. I can understand intuitively to some extent the nutricuetical technology, but I'm curious about the information technology.

Answer: Mr. Clarke – In our case, companies frequently have recalls. The faster the recall can happen and the more efficient it is, the larger the savings of time and money. If production, for example, has to be shut down for eight hours while they're trying to find the product and where it went, that's eight hours of production that is lost. If we cut that down to an hour or two hours, that is a dramatic savings of money. Country of origin labeling (COOL) for example, is almost an impossibility for most companies to deal with in the U.S. There are over a million producers of beef in the U.S., and the beef may for

example be born in Montana then transported to Canada where it's grown to feeder size and then moved to a feedlot in the U.S. and slaughtered in the U.S. If you take a product like ground beef, it may have a certain percentage of cattle that were grown in Canada or born in the United States, raised in Canada, slaughtered in the U.S., and all those things have to be on a label. You have to know the percentage of all that according to COOL. So there's two drivers of value: there's both a dollar driver as well as a meeting the regulations driver.

Mr. Arguelles – The perception of the client with biotechnology is different. I think that the biotechnology company has two concerns. One is the perception of the scientific community, and the other is the perception of the user of the product. In our case in the pharmaceutical product, the physicians are a combination of the scientific and user. And really for us, the perception of our new technology probably was very, very important. It's not frequent for a company in a developing country to be able to produce a product on the frontier of technology. In the case of the blueberry product in the agricultural industry, this adoption was fantastic because we introduce all the technology in a single package (a technology box) for the development of the business, and the production of this product is world-wide. This packaging for the client really was very, very important for rapid adoption and acceptance.

Mr. White – In our case, we aren't really a technology business – we are a technology employing business. We start with value propositions – customer value propositions – and if there isn't one, it doesn't get past that stage. Most of the effort we spend in the second proof of concept stage is collecting evidence that the cost of the value proposition is correct, or that it's real. The secondary part of the proof of concept stage is to get some early sense as to whether it can actually be implemented or not. We have had a couple of cases where we demonstrated a superb customer value proposition, but it turned out to be difficult to deliver it cost effectively. As you can see, we're working in several different areas, there are different types of value propositions, but they all boil down to basically the ones you find anywhere – more production, or lower cost, or a more valuable attribute of some type. I think compliance is an interesting case that Greg Clarke was talking about. Our view is compliance essentially starts out as an absolute requirement, but rapidly develops into an efficiency issue. Also, what we've done in our Food Origins program is to look for other sources of value that might come out of compliance, and we find that many cases, those do in fact exist.

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