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A FARM LEVEL PERSPECTIVE ON AGROBIOTECHNOLOGY

Nicholas Kalaitzandonakes
Associate Professor of Agribusiness
University of Missouri-Columbia

It is a pleasure for me to be here this afternoon to offer a farm-level perspective on agrobiotechnology. In the next few minutes, I will address the following questions:

- How much have farmers benefited from first-generation agrobiotechnologies (e.g. herbicide resistant and insect resistant crops)?
- If tangible on-farm economic benefits from such technologies do exist, how sustainable are they?
- How much value will be created by second-generation agrobiotechnologies (e.g. quality-enhanced crops)?
- How soon will such value be delivered to the market?
- What will the farmers' value share be?

Let's begin with the first question whose answer is often clouded by the significant variation in the performance of first-generation biotechnologies. I will use here two different indicators to gauge on-farm economic benefits from these technologies. The first indicator is indirect and infers economic benefits from the response of farmers. The second is more direct and measures average economic benefits from technology adoption.

Farmer Response: A Look at Current Adoption Rates

Even the optimists among biotechnology proponents have been caught off guard by its extremely fast adoption rates at the farm level. In 1999, just four years from commercial introduction, almost 50% of the total US corn, soybean and cotton acreage will be planted with transgenics. To put this level of adoption in perspective, consider for example the adoption curve of Roundup Ready® soybeans against that of the most dominant agricultural technology of the past: hybrid corn. To make the comparison more pronounced, I have used the average adoption curve of hybrid corn for only Iowa, Illinois, and Wisconsin, which exhibited some of the highest adoption rates among different states. The comparison is revealing. In 1999, an estimated 55% of soybean acres will be planted with Roundup Ready® soybeans (figure 1). It took seven years for the selected states to reach similar adoption levels in the case of hybrid corn. In some states it took twenty years or more. Bt-corn, Roundup Ready® cotton and Bt-cotton also exhibit adoption rates significantly faster than hybrid corn (figure 2).

Economists tend to believe that people are rational, responding to incentives and potential opportunities. So, looking at these adoption rates, one should assume that opportunities must abound. This assumption is consistent with the slim empirical evidence available at this time. University trials and impact studies across different agrobiotechnologies lead to the following two conclusions:

- There is tremendous variation in the yields and economics of first-generation agrobiotechnogies across time and space. Various location- and time-specific factors (e.g. weed and pest pressures) are partly responsible for this variation.

- *On average* there is significant value delivered at the farm level.

To put things in perspective, consider Roundup Ready® soybeans again. University trials and farm production data suggest that typically average Roundup Ready® soybean yields vary from 3 bu/a below to 3 bu/a above the average yields of conventional varieties. In many trials, there are no statistically significant differences in the yields of conventional and Roundup Ready® varieties. A farmer typically enjoys a net profit of $10.00/acre - $25.00/acre after all extra technology costs have been paid. The profits vary with specific cultivation practices and product pricing. Back-of-the-envelope calculations suggest that in 1999, the on-farm value delivered by Roundup Ready® soybean technology alone could range from $400million to almost $1billion. That's significant value and it does not even account for relevant environmental benefits from lower chemical loads or for the economic value of risk reduction associated with the technology. Similar calculations suggest that substantial value is being delivered through the rest of the commercial agrobiotechnologies as well. Given the value that is being delivered, adoption of first-generation agrobiotechnologies will likely continue to expand at a fast pace.

It may be argued, however, that on-farm economic benefits from first generation agrobiotechnologies are transitory. Professor Willard Cochrane taught us back in the 1950s that as long as farmers deal with technical innovation in commodity markets they are on a "technological treadmill. " The faster they adopt technology and increase supply the faster prices fall due to inelastic demand, ultimately resulting in loss of value. This may or may not be true in the case of agrobiotechnology. It is possible that most of the first-generation agrobiotechnologies are not strongly yield-increasing but instead input-reducing. In such a "no substantial yield increase" scenario, the treadmill effects may be small and relevant economic benefits may be sustainable.

Will second-generation biotechnologies deliver additional value in the future? And if so, how much? Corn, soybeans, canola, sunflower and other crops are being genetically modified to have improved qualities that match the needs of feeders and food processors or provide direct health and nutritional benefits to the consumer. More exotic technologies that turn plants into protein factories are also being advanced. Several presenters in this conference have discussed the truly exciting technologies slated for commercial introduction over the next several years. They also expressed their optimism about the value that such agrobiotechnologies will deliver.

Fundamentally, the optimism about the value of such technologies results from simple economic principles. Segmentation of a commodity market into a new sub-market where previously unmet end-user needs are satisfied and a residual commodity market, result in higher total market value. If the commodity market has an upward supply function then both the specialty and the commodity market benefit from the segmentation. In addition to creating value, such segmented markets are less vulnerable to the technological treadmill phenomenon as demand is typically more elastic. Given the large number of crops that are being genetically modified, the product attributes being created and the potential end-uses that exist, the possibilities for significant decommodification of agricultural markets and sustainable value creation are extremely positive.

A key question then is how soon will such value be delivered to the market? Unlike first-generation agrobiotechnologies, which fit existing systems with few or no adjustments, second-generation biotechnologies require many. Most importantly, end-users must reach a level where they are able to appreciate and take advantage of the value created by quality-enhanced crops. Feeders, through feeding trials, must experiment with and align these technologies with genetics. Processors must learn how to leverage quality enhancements and build additional value around them. Consumers must learn to recognize the products and to correlate nutritional benefits and value. Other parts of the system must also adjust. Crop merchandisers, for example, must learn how to effectively segregate quality enhanced crops and how to optimize identity preserved supply chains. And so on.

The higher the investments required for the commercialization of quality-enhanced crops -- whether in learning or physical infrastructure-- the slower market penetration will be. To be sure, there is significant innovation and investment taking place in all parts of the supply chain at this time. Feeders and integrators are experimenting with a variety of quality-enhanced crops and animal genetics. Significant investments are being made in information systems for the creation of virtual markets and management systems appropriate for identity preserved supply chains. Most elevators expect that within five years 25% of their turnover will come from quality-enhanced crops and are either preparing for or carrying out relevant investments in storage suited for identity preservation. And so on. All these investments are in line with the high prospect values of second-generation biotechnologies. Nevertheless, they also suggest that market penetration of such technologies will likely be slower than that of the first-generation.

The final question we need to answer then is how much value will the farmers capture from second-generation agrobiotechnologies? An answer to this question is by necessity speculative. What is clear at this time is the lower bound of such value. Since farmers can always choose to produce commodities, quality-enhanced crops must deliver value at least equal to that delivered by commodities. And since as I argued before commodity markets will also benefit from market segmentation, farmers will, at minimum, capture value equal to the boost of the commodity market. Beyond that, and given that value from quality enhanced crops is distributed through up-front conjecture and negotiation across the supply chain, individual assets brought to the negotiating table by each player will likely determine value distribution. Hence, the relative negotiating position of individual farmers in each supply chain will likely determine their share of value from second-generation agrobiotechnologies.

Let me then close with an observation. The increasing value share of knowledge inputs in agriculture is unmistakable. Agrobiotechnology is currently leading this structural transformation. Precision farming, the Internet and other knowledge assets will only strengthen the trend over the next few years. Farmers may be in a position to claim a larger share of the value created by agrobiotechnology by actively participating in the knowledge transformation of agriculture. But that's a topic of another presentation. Thank you.

FIGURE 1

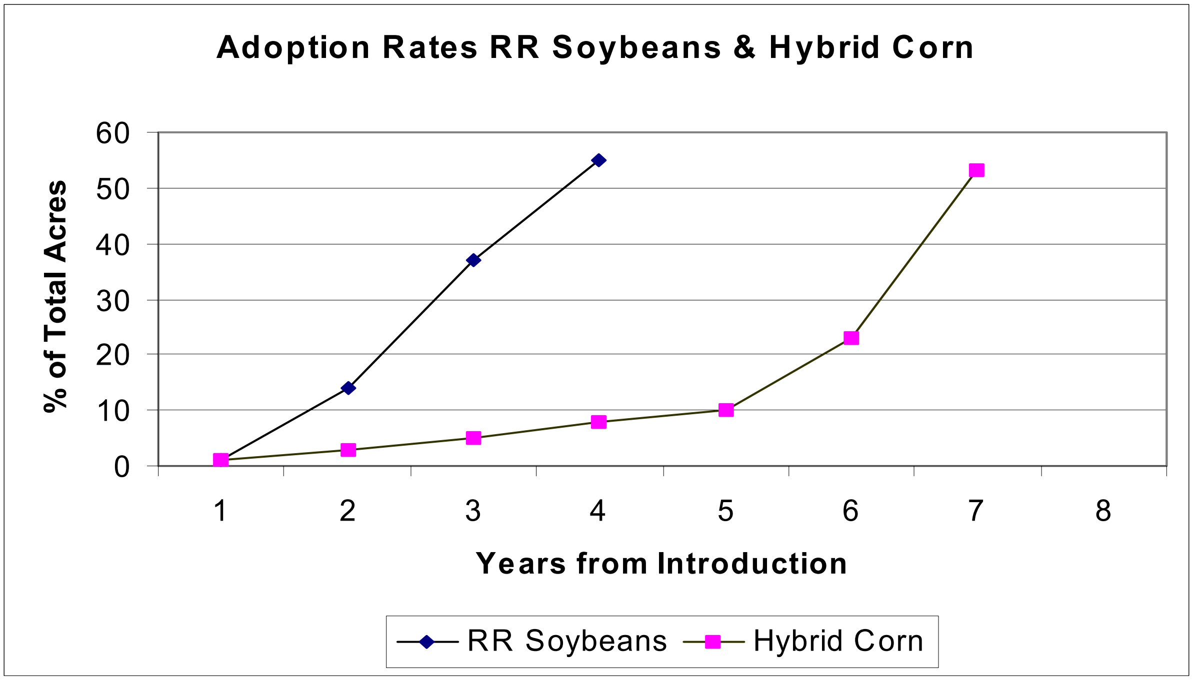

FIGURE 2