

# **Entrepreneurial and Organizational Responses to Biotechnology Innovation**

*Submitted by Peter G. Klein, Michael E. Sykuta, Michael L. Cook, and David J. O'Brien,  
University of Missouri*

Klein: kleinp@missouri.edu  
Sykuta: sykutam@missouri.edu  
Cook: cookml@missouri.edu  
O'Brien: obriendj@missouri.edu

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### **Overview**

This project examines the adoption and diffusion of existing and proposed biotechnology innovations, focusing on the entrepreneurial creation and discovery of complementary organizational forms and marketing strategies. We draw on lessons learned from first-generation biotechnologies to ascertain the entrepreneurial and organizational innovations necessary to support the successful introduction of second-generation technologies. Our analytical framework draws on the modern economic theory of entrepreneurship (particularly, the contributions of Joseph Schumpeter and T. W. Schultz) and incorporates insights from social-network theory, contract theory, and organizational economics. Consequently we focus not only on potential farm-level returns, but also the need for supporting organizational and marketing infrastructures.

Our approach involves a detailed analysis of existing secondary data on the adoption of first-generation technologies; the development of theoretical and conceptual models for analyzing likely adoption paths for second-generation technologies; a set of interviews and research cases, guided by our theoretical investigation; and the formulation of policy recommendations for overcoming the resulting challenges arising from increased technological and organizational complexity.

### **Existing literature**

Existing literature includes studies of (a) the adoption and diffusion of new technology, based on neoclassical growth theory and evolutionary models of economic change; (b) the farm-level incentives to adopt agricultural biotechnology products; and (c) recent developments in agricultural biotechnology (nutraceuticals, fruits and vegetables with longer shelf lives, corn amylase optimized for ethanol production, etc.).

More specifically, several studies focus on the adoption of first-generation GM crops (2000-2007). These studies note that the adoption of GM crops benefits many farmers, but not all; benefits depend on specific producer characteristics such as farm size, human capital, risk preferences, location, and regulatory constraints. (There is very little existing research on second-generation technologies and virtually none focusing on the organizational and strategic issues at the heart of our analysis.)

## A new conceptual model and research design

Prior research suggests the following general adoption model: the likelihood of an individual producer adopting second-generation GM technology (or, if a region is the unit of analysis, the percentage of land or percentage of producers using the new technology) is positively related to producer perceptions of pecuniary and non-pecuniary benefits (including presumed social benefits), the number of adopters within a specified peer group (based on physical proximity or within a non-spatial network), and producer education, experience, and income and negatively related to perceived adoption costs, which are in turn determined by learning effort and complexity, and beliefs about consumer awareness and demand uncertainty. Regarding pecuniary benefits, existing literature indicates that use of genetically modified (GM) crops is mostly, though not always, more profitable than the use of conventional (C) crops. The following table summarizes findings on herbicide-tolerant (HT) and insect-tolerant (IT) soybean, corn, and cotton:

	<b>Soybean HT</b>	<b>Corn IT</b>	<b>Corn HT</b>	<b>Cotton IT</b>	<b>Cotton HT</b>
Profit	GM>C	GM>C		GM>C	GM>C
Yield	GM<C	GM>C	=	GM>C	Not clear
Production costs *	GM>C	GM>C	GM>C		
Pest control cost	GM<C	GM<C	GM<C		
Total cost/bushel	GM<C	GM>C			
Variance of total cost	GM<C	GM<C	GM<C		
Variance Yield	GM<C	GM<C	GM<C		

\* Pest control costs are separated from other production costs because GM input traits affect the producer's pest control options.

Source: Based on Marra, Pardey, Alston (2002) and Alexander et al (2003) (info US States, 1997-2002).

We have developed a survey instrument designed to identify (1) social network linkages among producers and (2) social network linkages to outside resources, including physical capital and information sources (e.g., legal and financial). The sample is under construction, but deployment and analysis of results are expected soon.