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Special Issue on Agri-biotech Studies from Policy and Regulatory Perspectives: Introduction

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Agri-biotech is seen as a key driver for agricultural production within a global context. Managing agri-biotech policy related issues, including low level presence, is one of the most significant areas in terms of agri-biotech development. According to the International Service for the Acquisition of Agri-Biotech Applications (ISAAA), a record 175 million hectares of biotech crops were grown globally in 2013 in 27 countries. This is up from 170 million hectares in 2012, rising at an average growth rate of 12.2% since 2000. The unprecedented 100-fold increase since 1996 makes biotech crops the fastest-adopted technology in modern agricultural history. The primary objective of this special issue is to look into the global agri-biotech policies and regulations and discuss potential implications. In this preamble, we briefly discuss why there is an urgent need to look into the agri-biotech policies. We then briefly discuss the findings of this research collection, which involves a number of well-known social scientists, economists, and policy analysts. Finally, we examine the role of civil society in the agri-biotech policy debate.

Why We are Concerned

The modern biotechnology revolution has surpassed any previous human experience with technological change. Looking into the history, we can see two previous technological revolutions that significantly impacted human society: James Watt's steam power in the 18th century (Whipps, 2008) and computer science and information technology starting in the 20th century.[1] The biotech scientific and industrial revolution, which began in the last half of the last century, has become more remarkable because it may not only change the economy and society, but also transform human life itself.[2]

The Food and Agriculture Organization of the United Nations (FAO) forecasted in 2009 that feeding the growing population in the world, which is projected to surpass 9 billion by 2050, requires producing 70% more food on less land than ever before (FAO, 2009). While agri-biotech has the potential to close that gap, the relevant policy and regulations lag far behind the technological development. Apart from the Codex Alimentarius intergovernmental standards for food safety, there have been no internationally agreed rules or regulations on agri-biotech development. Although the Cartagena Protocol of the Convention on Biological Diversity (CBD) provides us with some capacity for assessing the environmental impact of gene technology, we still need to develop agreed standards, both internationally and nationally, for assessing the benefits and risks of new genetics related to agriculture and agri-food (De Groote, 2012).

According to the CBD, biotech is "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use" (Secretariat of the CBD, 1992, p. 3). This conception includes medical and industrial applications as well as many of the tools and techniques. The FAO defines it as "a range of different molecular technologies such as gene manipulation and gene transfer, DNA typing, and cloning of plants and animals" (FAO, 2000), which concentrates on the applications in agriculture and food production.[3] We understand that GM products are results of any intentional change to the heritable traits of an organism (Health Canada, n.d.). In this special issue, GM products normally refer to GM crops, including both plant and food crops, unless otherwise specified.

Regulations involve rules or standards prescribed by certain authorities (Dictionary.com, n.d.). In terms of

1. *For more information, see Shallit (1995).*

2. *A paper related to this can be found from McLean (2012).*

agri-biotech policies, we generally talk about a series of rules or orders formulated and implemented by governments and/or authorized institutions to promote or regulate relevant research and development (R&D) and the products emerging from research (Tzotzos, 1999). In this sense, the agri-biotech policies and regulations serve as the two sides of the coin, with promoting agri-biotech R&D on one side and regulating the relevant developments on the other.

While considering theoretical and/or empirical contributions to the existing literature, we hold that, on a global scale, three categories of agri-biotech policies need to be clarified: a) international policies, such as those from the Codex Alimentarius and the Cartagena Protocol; b) North American policies; and c) European policies. At a national level, we may also categorize three types of agri-biotech policy approaches based on relevant studies in the Asia Pacific area. These include: a) a unitary or centralized model, such as in China; b) a dualistic model, such as in India, and c) a pluralistic model, such as in Japan. In these initially clarified categories, more research is thus encouraged and envisaged.

Looking at the existing literature, we can identify some individual studies related to agri-biotech regulations and institutions. In 2004, Bernauer's *Genes, Trade, and Regulations* detailed food biotech policy and institutional analysis in the European context (Oehmke, 2004). More recently, in 2012, De Groote's *Plant Biotechnology and Agriculture* dedicated one chapter to the topic of biotech policy. In reviewing a number of scholarly journals, such as *AgBioForum*, *Regulation*, and *Governance*, we have come to realize that most of the studies tend to focus on the analysis of agri-biotech-related policy issues in specific periods and specific countries while focusing less on international considerations. The status of the existing literature, therefore, calls for more theoretical scrutiny and empirical exploration into agri-biotech policies, particularly from an international perspective.

What We Contribute to Literature

As discussed, there is an urgent need to bridge the current research gaps, which requires investigating agri-biotech policy and regulatory issues with a more expansive approach. Being keenly aware of the gaps, the authors in this special issue aim to map out the agri-biotech policy-related issues so as to facilitate the development of internationally agreed regulations, rules, or standards for regulated agri-biotech, including application, industrialization, and commercialization.

First, Stavroula Malla from the University of Lethbridge and Derek Brewin from the University of Manitoba in Canada examine the value of a new biotech product with regulatory issues. The study evaluates the potential benefits of new biotechnologies such as herbicide tolerance and hybridization over time; to assess the overall impact in Canada; and to examine whether there is a need for government intervention and, if so, what form it should take. The research explores important trends in Canada's canola crop adaptations over time, including area planted, yield, varieties, and health traits, as well as assessing the estimates of the rate of returns to agricultural investment and returns to breeding firms and producers. Externalities created by biotech adoption, including but not limited to environmental impacts (weed resistance, soil loss, GHG emissions, soil moisture retention, etc.) are also examined, as well as the indirect effects of biotech adoption on incentives to research, and intellectual property rights (IPRs) related issues.

Next, Stefan Mann from Germany looks into genetically modified organisms (GMOs) through the economics of chain segregation. The author argues that, after organic farming arose as a chain separate from conventional food production in many parts of the world in the last quarter of the 20th century, another separate chain emerged in recent years—the chain for food free of GMOs. The study examines the lessons learned from segregated organic chains and compares them with new findings gathered from GMO-free chains of soybeans, maize, and milk in Western Europe. Two mechanisms are found to be widely used to cope with the transaction costs of segregation—a specialization of businesses or entire countries and a "down-washing" process, during which a sequence with decreasing quality requirements is used in facilities. The main role of the state, according to the authors, is to create a framework which provides a high degree of credibility for the product information provided.

3. *Genetically modified organisms (GMOs) are modified by the application of transgenesis or rDNA technology. Recombinant DNA (rDNA) techniques are also known as genetic engineering or genetic modification (refer to the modification of an organism's genetic make-up using transgenesis). The terms "GMOs," "genetic modification (GM)," "genetically engineering (GE)," and modern biotech are often used interchangeably, although they are not technically identical. See FAO (2004).*

Then, Michael R. Reed and Vijay Subramaniam from the University of Kentucky in the United States examine biotech regulation and its effects on industrial structure. Their research analyzes the developments in biotech crops, changing attitudes of regulatory agencies, and impacts of these factors on the agri-biotech industry. The research provides details on deregulated products, including the timing of the process, the companies involved, and the regulatory costs. If the product failed in the market, the study examines the reasons for failure. The article illustrates the deregulatory process and how this timing has changed during the last 25 years. It also discusses how the increasing costs and risks in developing, deregulating, and marketing a new product has forced small biotech companies either to exit the business or merge with other companies. Thus, the number of companies conducting agri-biotech research has significantly decreased over time. The industry has fewer firms, but companies have become larger in size, presenting the possibility of reduced competition among firms. This reduced number of firms has likely contributed to a more narrow research focus.

Next, Mauro Vigani from Spain and Alessandro Olper from the University of Milano in Italy explore the patterns and determinants of GMO regulations. In the authors' view, slow diffusion of GM crops may be due to the regulatory system. GMO regulations differ considerably across countries, creating a strong polarization between rich consumer countries (with restrictive regulations hampering the cultivation and commercialization of GM crops) and rich producing countries (with permissive GMO regulation). This approach to GMO regulation triggers uncertainties, in turn reducing the incentives for adopting GM crops and discouraging developing countries that may benefit from the improvement of food security.

Xiaobing Wang, Cheng Xiang, and Jikun Huang from China discuss the adoption and uptake pathway of GM technology by Chinese smallholders based on the evidence from Bt cotton production. Bt cotton is well reported as a successful case of biotech adoption in China since it was commercially released in 1997. Introduction of Bt cotton helped Chinese farmers expand cotton production in the late 1990s. In the first stage of Bt cotton diffusion, both seed companies and the technology developers (e.g., research institutes or biotech companies) that conducted Bt cotton field trials and demonstration in cotton production regions played important roles in farmers' use of Bt cotton. The descriptive statistics and findings from focus group discussions show that the adoption of Bt cotton by farmers was mainly motivated by better traits, such as the effective control of bollworm and reduced yield loss from bollworm attacks, reduction of pesticide usage, and more environment-friendly production methods.

Then, Brad Gilmour and Hugh Deng from Canada and Xiaobing Wang from China look at China's agri-biotech policies, regulations, and governance. With the new leadership established at the 18th National Congress of the Communist Party of China in 2012, the Chinese State of Council released its Biological Industrial Development Plan one month later. Along with other significant documents, the Plan reveals China's latest policy developments related to biotechnology, which influences the country, possibly the Asia Pacific region, and the rest of the world. While reviewing the latest policy developments, this study looks into China's agri-biotech related policy, regulations, and programs and also reviews the governance institutions. Focusing on policy and institutional analysis, the study looks at China's challenges with its bureaucratic system.

Hugh Deng and Brad Gilmour from Canada and Nawal Kishor from India examine India's agri-biotech policies, regulations, and decision-making process. India is one of the most significant emerging economies in the world. With a population of over 1.2 billion, India's agri-biotech development—from cotton to brinjal (eggplant) and other crops—and its concerns about trade is growing in importance. While agri-biotech is still highly controversial in India, its major agri-biotech product, Bt cotton, was cultivated on 10.8 million hectares in 2012, an increase of 2% compared to the previous year. With 6% of the global agri-biotech crops, India ranks in fifth place as a mega-adopter, right after the United States, Brazil, Argentina, and Canada, and before China. India has been identified as a key market for Canada. The market access for Canadian canola seed and canola oil in India is complicated by several issues, including the GM regulatory issue. This study discusses aspects of India's agri-biotech crops, including the current status, policy development, and institutions. It also looks into its potential impact of trade with India on Canada and the rest of the world.

Finally, David J. Spielman, Xingliang Ma, Patricia Zambrano, and Fatima Zaidi from the International Food Policy Research Institute in the United States and Hina Nazli from Pakistan examine the technological opportunity, regulatory uncertainty, and the economics of Bt cotton in Pakistan. Genetically-modified, insect-resistant Bt cotton has been adopted extensively across Pakistan's cotton-growing regions during the past decade, and prior studies have linked Bt cotton adoption

to both reduction in on-farm production costs and increases in cotton yields It characterizes cotton-producing households across several dimensions using household survey data collected in 2012 and estimates the contribution of Bt cotton to increasing yields and improving technical efficiency. The study explores the controversy that has accompanied the adoption of Bt cotton in Pakistan during the past decade.

The impact of agri-biotech has proven revolutionary and far-reaching. This technology has triggered a long-standing and widespread debate about the appropriate approach to new technologies. With this debate still going on, these agri-biotech policy studies play a crucial role in illustrating and informing research and policy work related to promoting or regulating agri-biotechnology developments. We hope that this special issue will attract global-based general readership, in particular from field faculties and students, relevant institutions and governments, and business practitioners.

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Authors' Notes

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