Introduction

A seething debate over genetically modified (GM; genetically engineered, genetically altered, bioengineered, or transgenic [*zhuanjiyin*]) crops and foods has been unfolding in China. On March 1, 2014, Cui Yongyuan, a former anchor of China Central Television (CCTV, China's predominant state television broadcaster) and then on the faculty of the Communication University of China, uploaded a documentary on his fact-finding mission on GM foods in the United States for free viewing on China's three main internet portals—Sina, Tencent, and Sohu. Using one million renminbi (RMB) ($163,000) of his own money,[1] Cui shot the sixty-eight-minute film over a period of ten days, December 8–18, 2013, in Los Angeles, San Diego, Chicago, Springfield (Illinois), Seattle, and Davis (California). He visited supermarkets and farmers' markets and interviewed some thirty government officials, academics, campaigners in nongovernmental organizations (NGOs), and consumers to learn about the production of GM crops and consumption of GM foods in the United States. The documentary, which received millions of hits in a matter of days, was criticized as purportedly misleading by supporters of genetically modified organisms (GMOs), most notably Fang Zhouzi, a biochemist turned science writer who had been embroiled in a dispute with Cui over the issue since September 2013.[2]

The release of the documentary coincided with annual sessions (*lianghui*) of the National People's Congress (NPC), China's legislature, and the Chinese

People's Political Consultative Conference (CPPCC), a political advisory body, both of which convene in early March. As so often happens, Cui was a CPPCC member who later submitted several anti-GMO proposals at the meeting. These proposals called for an investigation into illegal planting of Bt (*Bacillus thuringiensis*) rice, a GM variety that had received biosafety certificates but had not been approved for production.[3]

This episode marked a climax of more than a decade of debate on GMOs in China. Since the turn of the twenty-first century, the nation has been caught in a tug-of-war between polarized anti- and pro-GMO camps. On one side stand well-known personalities such as Cui Yongyuan, as well as the international environmentalist NGO Greenpeace, some academics, and consumers. The anti-GMO camp does not simply oppose putting GM foods on Chinese dining tables; some activists promote organic and ecological farming over agricultural biotechnology. In addition to concerns over whether GM foods might cause health problems that go undetected for years and whether GM crops could damage China's biodiversity and environment, the anti-GMO group has trafficked in a nationalistic rhetoric that the United States has a hidden agenda or is engaging in a covert operation to harm the Chinese by introducing transgenic technology and exporting GM crops to China. The stakes seem highly significant to the Chinese, especially the political leadership.

On the other side, the GMO research community has been unrelenting in its insistence that the irrational rhetoric and actions taken by the activists have lost China momentum in the research and commercialization of GM crops. China started its GM-crop research and development (R&D) program in the mid-1980s. By 2000, it had become the most advanced among developing countries and was ranked fourth globally measured by arable land devoted to GM crops, with Brazil and India not even appearing on the list of leading GM nations. Since then, however, China has been overtaken by both Brazil, in 2003, and India, in 2006, and has experienced an overall decrease in GM-crop-growing land.[4] Scientists use the evidence that China has to import an increasing amount of soybeans—more than 95 million metric tons in 2017,[5] mostly genetically modified, from the United States, Brazil, and Argentina—to argue that this situation could have been prevented, or at least ameliorated, had domestic research and commercialization efforts been encouraged. They also claim that various issues raised by GMO skeptics are not only logically flawed but also politically sensational and irresponsible. As an example, leading Chinese agricultural biotechnologists have

been labeled "American agents" worthy of scorn simply because of their scientific and professional origin in and/or scientific and professional associations with universities, multinational corporations (MNCs), and other organizations in the United States, such as Washington University in St. Louis, the University of California at Davis, Cornell University, Monsanto, and the Rockefeller Foundation. They have been character-assassinated and attacked on traditional media and increasingly on the internet and social media, and even harassed and humiliated in public.

In fact, the world is deeply divided over any given country's choice regarding GMOs—promotional, permissive, precautionary, or preventive—along policy dimensions of intellectual property rights (IPRs), biosafety, trade, food safety and consumer choice, and public research investment.[6] Most countries promote public R&D investment in transgenic technology, but their attitudes toward other dimensions of GMOs are quite different. For example, despite resistance, the United States has been permissive toward safety and consumer rights regarding GM foods. While preventive in IPR and trade, India has adopted permissive or precautionary policy choices regarding food safety and biosafety.[7] And the European Union has been at least precautionary, if not completely preventive, on most policy aspects.[8]

In the past three decades, as the world's largest agricultural country, and one of the most important, China has seen dramatic changes in its policy toward GMOs. Having consistently promoted public investment in R&D of GM crops to take advantage of the global biotechnology revolution, China has long been a frontrunner in the development of GM crops. It planted virus-resistant tobacco as early as 1988 and approved its commercialization in 1992, thus becoming the first country in the world to commercialize a GM plant. At one time, China's ambitions were to genetically modify "the majority of rice, wheat, corn, cotton, soy, and canola" by 2010.[9] It has been largely permissive in trade, as evidenced by imports of GM crops such as soybeans and corn in large quantities. However, its policy in other dimensions has been inconsistent. In 1999, the country was promotional in food safety and permissive in biosafety, more flexible than the United States, although its policy toward GM-food labeling has been among the most restrictive in the world. The introduction of Bt cotton for commercial planting from 1997 onward has been well received by cotton farmers. Domestically developed Bt-cotton seeds now dominate China's farmland, reversing an earlier monopoly by Monsanto, one of the leading agricultural biotechnology MNCs, although this is partly attributed to the

restriction placed on foreign companies in carrying out R&D on GMOs and breeding GM seeds in China. Since entering the twenty-first century, China also has turned promotional through improving its weak IPR regime regarding GM crops.

A milestone was reached in August 2009 when the Ministry of Agriculture (MOA) issued five-year biosafety certificates for commercialization to Huahui 1 and Bt Shanyou 63, two strains of Bt rice, and phytase maize (corn). As well as overcoming a major hurdle for their planting,[10] the move signified that China could soon become the first country in the world to genetically modify rice, a major staple food. Nonetheless, the GMO policy later again became precautionary, if not preventive, regarding biosafety and food safety, and to a lesser extent, trade, thus significantly slowing the pace to develop and commercialize more GM crops. It is particularly notable that the commercialization of Bt rice and phytase maize stalled as the biosafety certificates were allowed to expire because of the leadership's inaction amid rising public concerns and other factors. (However, these certificates were renewed in early 2015 for another five years.) As a whole, China has thus far approved seven GM crops involving twelve transgenic events for commercialization, with only Bt cotton and papaya commercially available.

This book represents an effort to systematically document and analyze how China's policy toward research and commercialization of GM crops has evolved over the last three or so decades. Instead of taking the constructivist approaches of science and technology studies or anthropology,[11] it will focus on the complexity of the process through which policy has been put forward, debated and deliberated, formulated, modified, and implemented, and especially on how China's agricultural biotechnology community has set the agenda on research and commercialization while encountering resistance because of concerns over food safety and the rights of consumers, biosafety, IPR protection, and food sovereignty. In particular, this book is about how intertwined and multifaceted factors have influenced the evolution of policy toward research and especially toward commercialization of GM crops and foods, which in turn has affected the trajectory of transgenic technology in China. Moreover, against the backdrop of globalization, the shift of China's GMO policy has closely followed global trends, so that external pressure has also influenced this already multifaceted domestic policy issue. Given the size of its population and market, China has become a "battleground" where domestic as well as international stakeholders have engaged

in heated "battles" over GMOs. Therefore, an examination of China's policy in conjunction with changing global attitudes toward GMOs will help achieve a better understanding of how China has interacted with the world.

The comprehensive analysis presented in the book has been made possible through the utilization and triangulation of data collected from various sources, including documents issued by the Chinese government and other stakeholders, scientific literature and patents, public discourse, and media coverage. More important has been the fieldwork conducted over more than a decade, between 2002 and 2014, in China, including some thirty interviews with scientists and other academics, government officials, policy analysts, activists, and journalists. Identified from scientific literature, media reports, and other sources, these interviewees were either contacted directly or introduced by other interviewees and colleagues. In the course of my research, I was able to assess the representativeness of the interviewees and to check the information collected from different sources to produce an accurate and balanced presentation.

This book has been written with a diversified audience in mind. As the development of transgenic technology in China has been embedded in a larger political, economic, and social context, and China's GMO policy is part of the leadership's policy portfolio, the book tries to provide a broader perspective of analysis to meet the interests of scholars of China studies. Scholars of science and technology studies will find the Chinese case a welcome addition to the analysis of dynamics and complexity in the development of an emerging technology with global political, economic, and societal ramifications. This book will also engage with analysts of science and technology (S&T) policy and government officials in an informed and intelligent dialogue about China's S&T policy and S&T development strategies in general, and GMO and agricultural biotechnology policy in particular. Finally, executives of agricultural biotechnology MNCs interested in doing business in China also will find this book informative and helpful.

In writing the book, I have chosen to begin by narrating the evolution of policy regarding transgenic technology and GMOs, globally and in China, and to defer conceptualizing and theorizing until the end. Specifically, chapter 1 details the global development of agricultural transgenic technology and the controversies around GMOs. Chapter 2 discusses GMO policies adopted in the United States, Europe, and India to establish a background for analyzing how China has been influenced by global trends

in formulating and evolving its GMO policy. Chapter 3 situates the development of transgenic technology in China in a mostly promotional policy environment and then examines the R&D and especially commercialization of GM crops in China. Attention will be given to government policy, the role of foreign technology transfers embodied in human resources, and the efforts of domestic scientists to advance the technology. Chapter 4 analyzes the formulation and evolution of China's biosafety regulatory regime pertaining to GMOs and the rationales behind the establishment of such a regime, including associated risk assessment, in the context of globalization and China's evolution into a regulatory state. The cases of Bt cotton and Bt rice will be thoroughly examined in chapters 3 and 4, respectively. Discussing the tension between the research community and the public, chapter 5 focuses on how Chinese agricultural biotechnologists have played the roles of both technology developers and policy advocates, as well as how the public's response to the issuance of biosafety certificates to Bt rice, the staple crop, has reshaped policy toward research and commercialization on GM crops and biosafety regulations. The trial of Golden Rice among Chinese school-age children and its implications will also be examined. Chapter 6 explores how Chinese newspapers' coverage might have influenced the evolution of policy on GM crops and foods. Chapter 7 turns to patenting activities related to GM crops. By analyzing the patent portfolio of China's Bt rice specifically, this chapter will reveal not only the ownership of IPRs of the Bt rice but also the patent-infringement litigation prospects if China commercializes and exports Bt rice. Finally, in addition to summarizing the findings of the book and speculating where China will go in the near and medium future in its pursuit of becoming a GM nation, chapter 8 theorizes about the policymaking of post-academic science and post-normal science, as well as China's S&T policy cultures as they are applied to GMOs. Together, I hope these chapters paint a realistic picture of how China's changing views on GMO technology reflect its evolving position on the world stage.

GMO CHINA