Discussion on Biotechnology and Food Policy: Taking China's Genetically Modified Organisms (GMOs)

Review Article

Abstract

This article presents the context of food system in China, and discusses how genetic modification policy of the country is affected by change in the food system which is reflected in the debate on genetically modified organisms (GMOs). An overview of the development of biotechnology in China followed by an analysis of the theoretical framework of food system will be given to analyze the transformation of China's genetic modification policy. This article concludes with a brief review of the Chinese government's framework and contemporary propositions based on the major research questions and the debate about biotechnology as reflected in China's food policy.

Key Words: *Biotechnology; Food Policy; GMOs; China*

Introduction

Beginning in the mid-1960s, the first green revolution (which was characterized by the widespread use of chemical pesticides, synthetic fertilizers and modern irrigation systems) caused many problems, and at the same time agricultural production increased significantly. Some critics believe that these practices have created problems that are not conducive to environmental sustainability (Evenson, R.E., Gollin, D., 2003; Bharadwaj, P., et al., 2020), while others believe that due to the close connection between agriculture and other parts of the economy, productivity growth in developing countries has declined and slowed overall economic growth (Bustos, P. et al ., 2016). In the past few decades, the development of biotechnology has changed the conventional knowledge about crop breeding, and this "gene revolution" seems to have become a powerful response to these critics.

Genetic modification (GM) is "the insertion, transfer or deletion of one or more genes in the genome of an organism" (Morse, 2013). By artificially exchanging genes between species, the recipient plant will express the new characteristics conveyed by the inserted gene (Kaare M. et al., 1998; Hou, H. et al., 2014). Proponents believe that genetically modified organisms (GMOs), herewith the modified crops are a promising technology to solve world hunger, promote sustainability and promote food security, because it can obtain a wider range of required genetic characteristics, and improve plants in a more targeted and faster approach (Zhang , C. et al., 2016). Opponents question is how beneficial this technology-based growth cycle is (Herrera, E. L., & Alvarez, M A. 2001). They believe that GMOs are not a panacea for developing countries, and they may bring a series of related problems. Biosafety is one of the main concerns, as genetic modification may reduce biodiversity and affect environmental sustainability (ibid). Another major issue is the concern that genetically modified seeds controlled by large multinational agricultural companies may increase the imbalance between farmers and seed suppliers (David Kruft, 2001). Other issues have been raised including the trade of genetically modified products and the hazardous effects on health (Brainerd, E., Menon, N., 2014).

Both parties are working hard to promote food policies to support or oppose the further development of genetically modified technology. Although organizations such as the World Bank have launched aid programs related to genetically modified organisms, many food policy committees have emerged to reflect local resistance. In China, agricultural technology is one of the main areas that receive the most attention (National Academies of Sciences, 2016). Since 1988, China has become the first country to start commercial production of genetically modified crops in virus-resistant plants (Autor, D.H., et al., 2013), and has invested a large amount of funds to support biotechnology research projects. However, more and more biotechnology debates have also attracted China's attention, and since the late 1990s, many safety regulations have been issued.

Overview of China's biotechnology development

After 1970, the increase in the use of pesticides and other agrochemicals greatly benefited China's crop production, and at the same time caused many negative effects and social costs (Zhang and Zhou 2003; King JL, Heisey PW. 2007). After recognizing that chemicals pose a serious threat to ecological sustainability through pollution of water and soil, regulations on production, sales and application have been established. However, other methods are needed to radically reduce the use of pesticides, and biotechnology seems to be a kind of ideal alternative. It is largely promoted by developed countries and international institutions (Adenle, A.A. 2011).

In the late 1970s, genetic engineering and computing and space technology were included in the main areas of Deng Xiaoping's reform policies (Falkner 2006). In order to improve the agricultural biotechnology system and catch up with the advanced technologies of Western countries, the Chinese government has provided increasing funding for biotechnology research and development programs since the early 1980s. A series of "The Seventh Five-Year Plan" formulated by the Communist Party of China approved in 1986 is a series of guidelines for social and economic development. The budget from 1986 to 2000 was 1.3 billion yuan, supporting the development of biotechnology. After that, biotechnology research accelerated rapidly (Huang and Wang, 2003). In the past two decades, China has established about 150 agricultural biotechnology laboratories at the national and local levels, and China's investment has accounted for more than half of developing countries' investment (Huang and Wang 2003). By 2003, about 130 projects for genetically modified organisms had been launched, involving more than one hundred genes, including 47 plant crops, four kinds of animals and 31 kinds of microorganisms (Zhang and Zhou 2003). The state’s support has paid off. Since 1997, the gene of *Bacillus thuringiensis* (Bt) has been successfully transferred to cotton and used for large-scale commercial use, marking the prosperity of the state’s research results. Today, it has covered a quarter of the country’s cotton production. Plants such as soybeans, rice and corn have also made further progress (Zhang, C. et al., 2016).

Theoretical framework

Since it was proposed two decades ago, the concept of food system has been widely used to understand the global food system from a historical and structural perspective. The food system is basically defined as "the structure of food production and consumption controlled by rules in the world" (Friedman 1993a; McMichael 2009). Through the historicization and politicization of food, the analysis of food system enables people to understand the relationship between agricultural food and political ecology in the world capitalist economy. The three stages of the food system have been set as parameters of the emerging global food system. The first food system presented by the British "World Workshop" (1870-1930s) was characterized by importing products from colonies and accelerating industrial development in Europe, followed by the flow of excess food from the United States to the south of the world (Dicken, P. 2011)). As to the second food system (1950-1970s) aid materials, the system promoted the adoption of green revolution technology and the popularization of industrial agriculture (McMichael 2009). Third, the corporate company food system (1980s to present) emerged with the widespread expansion of neoliberal capitalism (Haque, M. 1999; Giménez and Shattuck 2011).

The corporate food system is characterized by a neoliberal world order, unparalleled market power, and is associated to the rise of monopolistic agricultural companies (McMichael 2009; Giménez and Shattuck 2011). The forced replacement of high-value products with grains reflects the imbalance of political power between the northern countries and the southern states. The second green revolution further empowered multinational companies and institutions because genetically modified seeds and other forms of biotechnology are under their control. The dominant neoliberalism regards industrial agriculture as the main form of agricultural production that increases output and reduces world hunger. Technology is a key component of the company's food system, and biotechnology is seen as the forefront and future of agricultural science (Hoffmann, U., 2011). Although the chemical industry system has many negative effects on environmental sustainability and food security (Chandini , et al., 2019), genetically modified crops seem to be an ideal choice because it can mediate the use of chemicals, increase crop yields, and maintain or even promote the current dominant industry agricultural system, and the establishment of a global seed market.

The food system view is not an attempt to provide a static and comprehensive understanding of the world's food system. On the contrary, it recognizes that social movements can play a key role in the current food system dynamics (McMichael 2009). The dual movement and political nature of social movements and capitalism are important factors that affect the depth, scope and political nature of social changes in the food system (Friedmann, H., 2005).). These food campaigns usually focus on the problems caused by the company's food system, ranging from social, economic and environmental. In the past few decades, we have witnessed more and more emerging food movements and advocated alternative agricultural practices such as organic agriculture, slow food, fair trade, localized food production and (Grauerholz, L. Owens, N., 2015). At the same time, they questioned and strongly criticized the neoliberal approach, in which genetically modified organisms are one of the main areas of opposition.

(Clark, J.K., *et al.* 2020) Recognized that trends in the global food movement, namely, gradual and radical. The gradual trend adopts a discourse of food justice, aiming to give disadvantaged farmers the right to food through community building and citizen participation. Most of the alternatives to industrial agriculture, such as sustainable, agro-ecological and organic agriculture, and direct networks between farmers and consumers, are basically within the political and economic framework of the current food system (Cerrada-Serra, P. *et al.* 2018). The radical trend believes that the current international framework for food production and consumption leads to uneven distribution of food, and strongly opposes the destructive neoliberal process that promotes company-driven agriculture. In addition, it defends people's rights to food, calls for small-scale and localized food production and consumption, and constructs the concept of "food sovereignty". It advocates that the poor have equal access to and control of natural and productive resources, which is defined as "people's enjoyment, the right to healthy and culturally appropriate food produced through sustainable methods, and the right to define one's own food and agricultural systems" (Patel, 2009). Both trends seek to establish a more sustainable, fair and healthy food system (Roger Merino. 2020), and their doubts about industrial food are also reflected in ecological and health issues

China's biotechnology policy: from promotion to prevention

Vigorous promotion: from the 1980s to the 1990s

Since the early 1980s, China has followed the example of countries with advanced genetic engineering, especially the United States, to vigorously promote the development of modern biotechnology. Being the first country to grow genetically modified crops on a commercial scale (Falkner 2006), China has a great influence on biotechnology advocacy in the company's food system.

Biotechnology advocacy in the corporate food sector

In the past three decades, neoliberalism has been the dominant trend in the food regime, and the discourse of its food companies has defended the expansion of the global free food market and the reproduction of systems through technological innovation (Sharma, P. Daugbjerg, C, 2020) Genetically modified organisms are essential. Like the neoliberal trend, reformists also encourage the reproduction of the company's food system, but require moderate reforms (Roger

Merino, 2020). They put forward the concept of "food security", which was originally defined by FAO. Its purpose is to promote adequate food supply by stabilizing the expansion of food consumption and production prices (Patel 2009), without intending to change the existing market structure Therefore, genetically modified crops are considered as suitable options (Qaim, M., & Kouser, S., 2013).

Generally, proponents of biotechnology argue for the following reasons. First, genetic engineering technology can promote the increase of overall yield. Using transgenes, specific genes can be inserted into crops to make plants have insect resistance, drought tolerance, less breeding time or other required feathers. Increased productivity can provide more food, lower prices, and help alleviate poverty (Bailey-Serres, J., 2019). Second, genetically modified crops can reduce the use of agricultural chemicals, especially pesticides, by transforming plants that are resistant to insects. By removing chemicals that have been shown to have serious health effects, GMO can promote the sustainable development of agriculture (Oliver M. J. 2014). Third, the development of GMOs provides consumers with nutritious foods, such as iron and vitamin A, which may help in curing some important health disorders (Buiatti, M., et al., 2013).

China's policy to promote the development of biotechnology

Biotechnology advocates believe that GMOs are the key to expanding the global food market and improving food security in developing countries. Under the influence of the dominant food system, China has put forward the viewpoint of biotechnology, and set the goal of "establishing a modern, market-sensitive, and internationally competitive biotechnology research and development system" (Huang and Wang 2003).

In accordance with these goals, the Chinese government has established a sound public funding research system and provided a large amount of funds for biotechnology research projects. At the beginning of the "Seventh Five-Year Plan" (1986-1990), the first comprehensive national biotechnology development policy outline (SSTC 1990) was issued. After the mid-1980s, many high-profile research programs and institutions for GMOs were established according to the outline, including some iconic programs, such as the "863" Program, the "973" Program, and the National Biotechnology Key Laboratory Initiative. (Huang and Wang, 2003). The state's support for biotechnology is constantly increasing. In the Tenth Five-Year Plan (2001-2005), the budget for the development of biotechnology exceeded all previous budgets in the past 15 years. By 2003, more than 150 laboratories were devoted to genetic research on crops, animals and humans (Zhang and Zhou 2003), and an estimated 2,690 scientists were working in the field of plant genetically modified organisms (Falkner 2006).

With continuous support, China's biotechnology has made great progress. From 1991 to 2002, approximately six GMOs in tomato, sweet pepper, cotton, tobacco, and petunia have been approved for commercial use (Zhang and Zhou 2003). Among them, Bt cotton is the most successful genetically modified crop in China. In order to develop cotton bollworm-resistant cotton, the Bt gene has been identified, transferred and modified into the main cotton variety. The first successful variety was produced in 1993. Four years later, it was approved for commercial use and was available for purchase by farmers. Bt cotton has successfully covered a quarter of China's total cotton production.

Chinese policymakers regard biotechnology as a strategic tool to promote national food security and enhance competitiveness in the global food market under the current food system. However, it also recognizes the negative effects of external genetically modified technology controlled by multinational companies and institutions, and with continuous support, its biotechnology has been developed to a large extent. China has not had any important biotechnology regulations for the development of GMOs until the early 1990s, and most leading countries/regions have established comprehensive governance systems.

More preventive measures: from the late 1990s to the present

In the past few decades, with the emergence of alternative agri-food movements, people’s suspicions about biotechnology have become stronger. These movements have criticized the major food systems for large-scale industrial agricultural production in the global market and called for the identification of small, organic and local market food production. The vitality of social movements has affected the current food system, empowered opponents of GMOs, and promoted policy changes. At the end of 1998, the European Union suspended the production of GMOs, and China actually suspended the production of new GMOs in 1999 (Falkner 2006). It signifies that China has reassessed its biotechnology policy and shifted it to a more preventive approach in the context of the growing global anti-gene movement and trade restrictions.

Criticism of biotechnology in the food movement

Generally speaking, the emerging food movement advocates re-differentiation and diversification of food production and shifts to “high-quality” food (Scrinis 2007), in contrast to cheap and standardized food produced by industry under the dominant food system. Although high-quality foods are often associated with alternative practices such as organic agriculture and conventional agricultural methods, GMOs are clearly regarded as "substandard" foods and may have an impact on biosecurity and human health. Concerns about biosafety believe that the impact of biotechnology on environmental sustainability and biodiversity is unknown. Proponents of genetic modification claim that biotechnology can reduce the use of chemical substances. However, critics point out that GMOs are used to adapt crops to the requirements of the chemical industry and the evolution of the agricultural production system. They legalize and expand environmentally unfriendly agricultural methods instead of shifting to more ecologically sustainable systems (Brodt, S., et al., 2011).

In addition, the food movement strives for the right to food of disadvantaged groups, especially farmers controlled by multinational corporations. They believe that these companies impose their products on smallholder farmers and force them to buy patented genetically modified seeds, which is a serious violation of food justice and food sovereignty. Therefore, the promotion of GMOs has also promoted the further concentration of seed ownership in agricultural companies (Bonny, S., 2017), and the extensive control of farmers has exacerbated the unbalanced power relations in agriculture, rather than reduced them.

China preventive biotechnology development policy

China issued the first biosafety regulation "Genetic Engineering Safety Management and Regulations" in 1993, covering mostly general principles. In 1999 moratorium was recognized as a turning point in China's biotechnology policy change (Huang, J., and Q. Wang, 2002) In 2000, when the State Council took over the approval of all new genetically modified crops, changes in the government's internal regulatory agencies paid more attention to environmental sustainability. The redistribution of regulation has led to a more centralized regulatory system and demonstrates the state's emphasis on biological-related decision-making (National Academies of Sciences, 2016).

In the next few years, the State Council issued more stringent biosafety regulations, which shows that people are paying more attention to biosafety and ecology. In 2001, it issued the "Regulations on the Safety Management of Agricultural Genetically Modified Organisms", followed by the Ministry of Agriculture in 2002 issued three management measures on safety assessment, trade imports and GMO labels (Huang, J., and Q. Wang, 2002).

Subsequently, more budgets were allocated to biosafety research. Since 1990/2000, the issue of biosafety has been extended to almost all biotechnology research programs. Many research institutions have launched various biosafety programs, ranging from capacity building and risk assessment to detection technology for GMOs (Huang and Wang 2003).

The above overview introduces important changes in China's GMO policy since the late 1990s, but how does the regime change promoted by social movements reflect the change in China's position? First of all, the increasing concern of the international community on the sustainable development of food has caused the rise of domestic environmentalism. With the spread of public media, critics of biotechnology, although slow and small in scale, have gradually attracted public attention. However, Polanyi's "dual movement" argument shows that social pressure may even bring substantial regulatory policy changes to the most reluctant liberal regimes (Jessop, B. 2008), thereby increasing environmentalism. Second, the close ties with the international community make the ties between each other closer.

Conclusion

Food regime analysis is of vital importance to understand the foundational divide between environmentally catastrophic large-scale industrial agriculture and the alternative eco-friendly food movements and agricultural practices. This divide generated a change in food regime, from the dominant neoliberal system to the incorporation of reformist trend and the global food movements. The rising concern of potential ecological and health risks of industrial agriculture has initiated a general shift towards regulation of GMOs and take the voices of smallholders on the stage.

As a developing country striving to improve its food security, China adopted a strong stateled promotion approach to facilitate the development of biotechnology, under the influence of corporate food regime on Second Green Revolution. However, the regime change, characterized by the various food movements, has also reflected in China's biotechnology policy change. The Chinese government now still strives to promote the biotechnology, but in a more precautionary perspective, as China's former Chairman Jiang

Zemin stated when answering Science Editor Ellis's Robenstein's question about GMOs and biotechnology, "it is important to uphold the principle of freedom of science. But advances in science must serve, not harm humankind. The Chinese government is now mulling over new rules and regulations to guide, promote, and guarantee a healthy development of science. I believe biotechnology – especially gene research – will bring good to humanity (Rubenstein 2000, in Huang and Wang, 2003)".

Moreover, an impression of the development of biotechnology in China in regarding agriculture and food production are undergoing another revolution, the current technology of transferring individual genes through biotechnology-genetic engineering. Plants and animals have been improved to resist pests and diseases. Although agricultural biotechnology has been rapidly improved, there are still some controversies about its deployment and impact. In China, genetic engineering is considered a possible way to enhance China's food security and reduce the impact of industrialization, thereby reducing the supply of agricultural land. Nevertheless, the food safety of genetically modified organisms, the impact of genetically modified plants on the environment, and the social ethics of using the technology have also attracted criticism and attention. Critics of biotechnology say that plant biotechnology is not required, which poses a threat to consumer health, will only increase the profits of companies. This controversy is especially important for China as a developing country that has not yet decided whether to allow the widespread use of genetically modified organisms. In fact, China has allowed the widespread cultivation of Bt cotton that is not an edible plant.

Evidently, more use of pesticides will help China increase production. It also produced many adverse consequences. Pesticides pose a serious threat to soil and water quality and agricultural ecosystems. In some cases, the negative impact and social costs may exceed the cost of purchasing pesticides. Since the 1970s, the Chinese government has realized the negative effects of excessive use of pesticides and has been working hard to regulate the production, sales and use of pesticides. Among them, Bt cotton is the most widely grown genetically modified crop in China today: Bt cotton accounts for a quarter of China's total cotton production. As early as 1991, the Center for Biotechnology Research of the Chinese Academy of Agricultural Sciences (CAAS) launched a research program to develop cotton varieties resistant to cotton bollworm.

Although many articles point out that there is no evidence that genetically modified foods are not safe to eat, it also means that there is no evidence that genetically modified foods are safe to eat.

The main concerns are potential toxicity, sensitization, lack of nutrients and the safety of newly introduced proteins. To provide reasonable certainty to ensure that no damage is caused, multiple types of data and long-term research are required. Some simple experiments and tests have tried to prove that the proteins in genetically modified foods are broken down into small peptides or amino acids during in vitro digestion. However, these tests did not provide information about toxicity and the results of exposure to aggregation of these proteins.

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