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Food Safety Concerns and Biotechnology: Consumers' Attitudes to Genetically Modified Products in Urban China

Peter Ho
Centre for Development Studies, University of Groningen

Eduard B. Vermeer
Leiden University

This article is based on a survey of consumer awareness and acceptance of genetically modified (GM) food products in China. In recent years, the Chinese government has grown more cautious about the risks of transgenic food crops and publicity about these crops and risks. The state plays a critical role in biotech politics and does not allow GM food to become a prominent public issue. Our survey, which polled the opinions of approximately 1,000 urban respondents, showed that only one fifth of consumers had a limited understanding of genes and GM products. In the absence of adequate information on GMOs, the overall majority of the respondents (60%) were neutral or even unwilling to consume GM food. More importantly, when given both positive and negative information about potential GM food allergenicity, the willingness to buy dropped sharply. This might point to future scenarios of Chinese consumer resistance against GM food products.

Key words: biosafety, consumer resistance, genetically modified food, labeling, risk.

Introduction

Studies have been conducted in many countries on the public acceptance of genetically modified (GM) food products. International comparisons are complicated by differences in adoption rates of GM crops and their processed products, differences in national legislation about their admissibility, and differences in labeling requirements. In most countries, public awareness and acceptance have been shaped primarily by mixed messages from action groups and the industry. On one side, concerned biologists, organic farmers, and environmental nongovernmental organizations (NGOs) have linked up with concerned consumers. On the other side, agricultural specialists and biotech industry representatives highlight the benefits of GM crops to farmers and consumers (Wansink & Kim, 2002). Evidence from biological studies is interpreted in such different ways that one should not expect any convergence of opinions in the near future (e.g., Royal Society of London, 2003). The Chinese government has become more cautious about food safety and the potential risks of transgenic food crops in recent years and tries to keep all options open. Basic consumer understanding of genetically modified organisms (GMOs) is very low, mainly because genetic modification is not allowed to become a widely debated issue in the media.

In September 2003, two months after the Beijing government had implemented regulations on labeling genetically modified soybean oil, we conducted a survey of consumer awareness and acceptance of GM food products in four supermarkets in different districts (three in Beijing and one in Shijiazhuang city). We interviewed almost 1,000 customers about their personal backgrounds, attitudes towards various types of food, and opinions on food safety. The overall majority of respondents (71%) said they had heard of transgenic food products. However, only one fifth of the customers showed understanding of genes and GM products. Most consumers (60%) were neutral or even unwilling to consume GM food. We also tested consumers' reactions to information about reduced pesticide use and the possibility of GM food allergies. Additional positive and negative information about GM food had a great impact, driving down the willingness to buy GM food. Additional information also substantially narrowed the difference between those initially in favor of GM food and those against it.

This paper is divided into four sections. We begin with an overview of China's biotech and biosafety policies, based on recent literature, official Chinese sources, and interviews with GMO experts and supermarket managers. In the subsequent two sections, we provide more detailed information on soybeans, GM food labeling, and the state of Chinese public opinion on GM food before the new labeling regulations. The final section presents a detailed analysis of the survey data regarding questions on food safety in general, biosafety and human health, the necessity of labeling, and the willingness to consume and buy GM products.

The Political Economy of China's Biotech Policies

All over the globe, farmers, governments, and food retailers have to find an adequate response to the new challenges of biotechnology. In the United States, GM crops have received the benefit of the doubt, as long as they have "substantial equivalence" and give no evidence of negative impact on health and the environment; GM labeling is voluntary. The United States has been the world leader in the cultivation of GM crops for years and currently accounts for the majority (59%) of the total world acreage of GM crops (International Service for the Acquisition of Agri-Biotech Applications, 2004). The European Union (EU), on the other hand, has taken a more cautious course by instituting a five-year moratorium in 1998. This moratorium was lifted in July 2003, when legislation was passed to meet environmental and health safety concerns, to protect the interests of producers of traditional and organic crops (through zoning requirements to be worked out by the member states), and to uphold consumers' "right to know" through labeling. Under the new rules, the food industry is obliged to transmit and retain relevant information at each stage from the farm to the consumer for five years, even if the final product has no more DNA or protein of GM origin (Prakash & Kollman, 2003).

By comparison, China has generally adopted a positive position towards GM crops. China has more farmers and more consumers than any other country in the world. Over the past decade, China has invested heavily in agricultural technologies that improve quality and increase output of grain, cotton, oil crops, fruit, vegetables, and other crops. Biotechnology is one instrument.

At present, China has become the fourth largest grower of GM crops (after the United States, Argentina, and Canada). China presently accounts for the world's largest acreage in pest-resistant Bt cotton.[1] In 2003, Chinese and Monsanto Bt cotton varieties covered 51% of China's total cotton area (Huang, Rozelle, Pray, & Wang, 2002; Huang & Wang, 2003). However, Chinese and foreign biotech and seed companies have found it hard to muster sufficient capital to invest and grow because of illegal copying of GM cottonseed by farmers themselves. Monsanto has frequently complained about "fake" seeds being sold under its name. China does not want to become dependent on foreign (particularly US) seed companies for cotton or grain seed. Therefore, while allowing joint ventures with foreign companies such as Monsanto, the Chinese government has supported setting up Chinese biotech companies (such as Weiming and Biocentury) that develop GM seeds and supply them more inexpensively. Moreover, there is a self-propelled development pushed by Chinese bioscientists at research institutes and universities and subsidized by the Ministry of Science and Technology. There has been a shift in research funding away from qualities that are useful in poverty reduction (such as drought resistance) to areas that offer higher returns: disease and insect resistance, protein enhancement, and golden rice. Many GMOs have been approved for field trials or environmental release in China. Between 1996 and 2000, China approved 45 GM plant applications for field trials, 65 for commercial release, and 31 for commercialization. By January 2003, trials had been approved for wheat, maize, potatoes, soybeans, rape, peanuts, cabbages, potatoes, and rice (Huang et al., 2002).

A confidential study prepared for China's State Council in 2001 was quite straightforward: "GM organisms do not pose a higher risk than varieties bred through ordinary breeding. The greater risk lies in a state that neglects to use these powerful techniques in order to solve the daily increase in food demand.... China should not accept being controlled by others" (Ma & Wang, 2002). The study recommended a dual strategy for imports. With crops for which China was temporarily unable to achieve commercial production (such as transgenic wheat and beans), China could use a high threshold for biosafety techniques in order to delay import of foreign products. In the meantime, China could strengthen its research and development (R&D): "Once our independently developed products are ripe, we could open our markets again. For crops that have rather great risks of safety and ecology or in cases where we may occupy the world market with nontransgenic crops, such as rice and vegetables, we may stop imports of foreign products for a certain period, and give as a reason that within China R&D of these crops is forbidden." In fact, Monsanto claims that its Bollgard cotton has been subjected to much more severe biosafety testing and geographical limitations than domestic Bt strains. The authors of the report also warned against false publicity: "The problem of GMOs is sensitive, and we should keep reports about transgenic crops strictly in check, in order to prevent unsuitable news and stirred-up (*chaozuo*) reports, and reduce negative impacts. We should not engage in too much media reporting" (Ma & Wang, 2002).

1. *Bt cotton contains genes from the bacterium Bacillus thuringiensis that produce toxins against bollworm in the plant.*

In a 2002 policy statement, the government mentioned a number of reasons for its support for agricultural biotechnology. China needed to increase its unit grain yield by over 40% by 2030 in order to feed its growing population. Bt cotton had been quite successful and already brought over five billion yuan[2] in farmers' benefits. Agricultural production costs should be lowered in order to compete with foreign imports after China's entry into the World Trade Organization (WTO). Farm incomes should be increased. Biotechnology was the future battleground for international competition. Therefore, during 2001–2005, China's investment in biotechnological R&D and commercialization should triple over the previous five years to more than ten billion yuan.

The Chinese developments have caused concern among critical foreign and domestic observers. Some even predicted a "genetic Bhopal," because "regulatory arrangements may be weaker in less developed countries, more difficult to manage or more easily subverted, leading to lower standards for food safety and environmental protection" (Kydd, Haddock, Mansfield, Ainsworth & Buckwell, 2000, p. 1137). However, a recent study demonstrates that current biotech politics in China actually feature complex dynamics with various checks and balances, and the state displays a deeply contradictory position towards biotechnology (Zhao & Ho, in press). In fact, China's biotech policies are strongly wavering between concerns over biosafety and developmental goals such as economic development, food security, and poverty reduction. In particular, after the 2000 US StarLink corn crisis affected international marketing prospects, China has grown more cautious. With food crops, China has been careful in allowing field experiments and has not permitted commercial releases to date (with the exception of delayed-ripening and virus-resistant tomatoes and MV-resistant sweet peppers in 1998/9). In addition, the Cartagena Protocol on Biosafety has been signed by China (unlike the United States) and now awaits ratification.

China qualifies its GM policy as "positive in research, careful in popularization, strengthening management, and safe promotion" (*Nongmin Ribao*, Aug. 6, 2003). However, it should be noted that different sections within the Chinese government represent and defend different interests. The Ministry of Agriculture (MAGR) is the leading agency for regulations on agricultural biotechnology, to the regret of those that believe that the State Environmental Protection Agency (SEPA) should play a greater role (which it might get under the new Biosafety Law that the Ministry of Science and Technology and SEPA have drafted; Cao, 2003; SEPA official, personal communication, Nov. 5, 2003) as well as those who favor a greater role for the Food Industry Bureaus.

China's scientific community is deeply divided between those who are enthusiastic about biotechnological progress and its future economic benefits, those who are concerned about the irreversible impact of escaped GM crops on wild and domesticated varieties, and (somewhere in the middle) those who believe it is only a matter of years before insect resistance will become ineffective. Despite this, the Chinese government has promoted the study of environmental and health effects of GM crops.[3] The various interests and views come together in the Safety Evaluation Committee of GM Agriculture, which makes recommendations to the Minister of Agriculture about trials, release, and commercialization of biotech crops.

As with the EU (but on a much larger scale), China is considering zoning. Entire provinces should grow either GM or GM-free crops. For instance, MAGR considers that for export and environmental reasons, Xinjiang province should grow only GM-free Bt cotton and tomatoes and Yunnan province only GM-free rice, according to a Genescan advisor (Nao, 2002). In the interest of exports, the Northeast should maintain its GM-free status for soybeans and rice. In 2002, MAGR made a revival plan for soybean production in the Northeast and designated 23 high-fat non-GM superior soybean varieties for popularization (*Nongmin Ribao*, Aug. 20 & 21, 2003). Zoning will facilitate inspection and control and ensure the separation of trade flows and provision of GM-free certificates demanded by EU and other foreign importers.[4]

China's entry into the WTO gave an impetus to the adoption of protective measures against foreign imports

2. *The yuan is pegged to the US dollar at approximately 8:1.*

3. *Research on allergenicity and corresponding evaluation methods, standards, and rules were established in 2000. A blood data bank of allergic incidents has not yet been established, and evaluation standards do not conform to international standards (Lu & Liu, 2003).*

4. *It will also help protect China's organic food crops that now grow on more than 700,000 hectares and account for US$25 million in annual exports. In 2002, Jiangsu province adopted rules to protect designated organic food zones from sowing, cultivating, or processing GMOs within a one-kilometer zone (State Environmental Protection Agency, 2002, p. 861).*

of GMOs. In May 2001, the State Council issued Safety Regulations on GM Crops, and two months later (under pressure from premier Zhu Rongji) the Ministry of Agriculture passed Regulations on Labeling Agricultural Transgenic Organisms. In April 2002, the Ministry of Health issued Health Regulations on GM Food, which also demanded labeling and added the requirement that if transgenic food products originated from potentially allergenic food, they should have a label saying that people who were allergic to GM food should be careful. These sets of regulations have drawn criticisms from Chinese industry representatives as having been adopted too hastily without regard to costs and the lack of low-cost testing equipment for GMO detection.[5] The haste has been attributed to China's wish to have trade regulations in place before WTO entry. Even though the MAGR regulations demanded that five categories of GM food products be labeled by March 20, 2002 (soybeans, corn, rapeseed, tomatoes and their derived products, and cottonseed), it was not until July 2003 that these regulations began to be implemented domestically—and then only for the single category of soybean oil.

During that time, foreign imports of agricultural products in these five categories were subject to administrative approval, which required that they be certified not to cause harm to humans, animals, or the environment, be for sale in the country of origin, and contain labeling noting the use of GM ingredients (Foreign Agricultural Service, 2002). One reason for the delay in the implementation of food product labeling was that the organization of inspection and verification had not been completed yet. Another reason was that China's food industry needed more time. However, with China's weak civil society (Ho, 2001), the environmental and socioeconomic risks of biotechnology receive only limited attention in the public media. According to *The New York Times*: "Enthusiasm for the new science abounds. There is no public debate to stir up the opposition that has brought the development of genetically modified crops to a near standstill in India," and "with no independent news coverage..., consumers are unaware that they are eating modified food" (Smith, 2000, p. 1). Against this backdrop, it is important to assess the current level of awareness of Chinese consumers and their perception of the risks of GM food.

Before turning to the analysis of our survey data, we will first discuss China's labeling regulations with particular reference to the production of soybeans and the sale of soybean products.

Soybeans and Labeling of GM Food in Chinese Stores

China has a huge demand for soybeans and has become the world's largest importer of soybeans, most of which are genetically modified. The beans are crushed in coastal factories. Because of their high fat content (22%), imported beans are more suitable for making oil than domestic beans, which have a fat content of 19–20%; partly because of US subsidies, imported soybeans are cheaper as well.[6] The demand for soybean dregs and soy protein for animal feed is also increasing. Under pressure from the US Department of Commerce, domestic traders, and the food industry, interim rules were adopted to ease restrictions; these rules shortened inspection terms for imported GM crops from 270 days to 30 days, and normal imports of GM-labeled soybeans were restored. In February 2004, the Chinese MAGR approved three- and five-year import safety certificates for Monsanto's Roundup Ready soybeans and a few other Monsanto products.[7]

After the MAGR GM labeling rules had been promulgated for some time, some Chinese media started to wonder why they were not implemented, saying that consumers had the right to know and choose under the Cartagena protocol. In July 2003, the Beijing Municipal authorities fined manufacturers of 14 brands of soybean oil for not labeling GM ingredients. Local TV and newspapers publicized the labeling requirement for soybean oil. Later that month, supermarkets received faxes from the Agricultural Bureau ordering them to stop selling nonlabeled GM soybean oils. In some supermarkets, the suppliers of cooking and salad oil withdrew their stock and substituted it for labeled products. In other super-

5. *The rules have a labeling threshold of 0%, which would make them the world's strictest, but an expert of the MAGR Supervision and Testing Center for Agricultural Product Quality stated that a subsequent technical attachment mentions a 1% threshold (personal communication, Nov. 11, 2003).*

6. *Imports were 14 million tons in 2001, fell to 11.3 million tons in 2002 because of the administrative barriers of the new import regulations, and jumped to 20.7 million tons in 2003 (Nongmin Ribao, Aug. 6 & Aug. 20, 2003).*

7. *These products included one version of Roundup Ready corn (which allows growers to use glyphosate-based herbicides that have a favorable environmental profile), YieldGard Corn Borer and Bollgard cotton (which protect themselves from certain insect pests), and Roundup Ready cotton.*

markets (e.g., Carrefour), local staff stamped their stocks with a temporary notice indicating its GM origin. In early August, inspectors found a high compliance rate at Beijing's markets and supermarkets. Offenders had their products confiscated and were fined 10,000–50,000 yuan.

Some companies apparently had prepared better than others. Almost all labels said that the product originally had used transgenic ingredients but no longer contained transgenic elements. They used the least explicit of the three types of labels prescribed by the MAGR labeling regulations: Labels of products containing GMOs should read "transgenic ___;" products containing directly processed GM products should be labeled "product made from transgenic ___" or "the processed materials are transgenic ___." Products that have used GMOs (or processed products containing GMO elements), but no longer have detectable transgenic elements in the final product, should be labeled "the materials used for this product had [or were] transgenic materials, but the final product does no longer contain transgenic elements." This last label was almost universally adopted.

Some interviewees felt that such labels were designed to minimize consumer concern. An official said its wording was chosen by industry itself, "which should not have happened because it is not reliable" (MAGR Supervision and Testing Centre official, personal communication, Nov. 5, 2003). One biologist said it was inaccurate, because even if heating destroys the original proteins, soy oil still contains broken strings of genetically modified DNA. Moreover, regulations said the labels should be well visible and designed and printed together with the packaging and branding. The Ministry of Agriculture has complained that the food industry has designed the GM labels in a very "bashful" manner, making them difficult to read for consumers.

Greenpeace has kept up its propaganda offensive by sponsoring a Chinese plaintiff to sue Nestlé in Switzerland (under the Chinese Law on Protection of Consumers' Rights and Interests) for its sale of non-GM-labeled Nesquik in China. This consumer claim has been given some publicity in the Chinese media (Yao, 2004). Greenpeace Hong Kong (2003) offered a dual-language *Greenpeace Shoppers' Guide to Avoiding GE Food 2003* on its website that put brands of food and drink products from 140 companies into green, yellow, and red categories. Red indicates the company's failure to respond or to promise the product was GM-free. The listing reflects mainly US versus EU brands and is of little use to mainland Chinese consumers, as it lists Hong Kong brands but not those available in the People's Republic of China.

Our consumer survey was conducted two months after the implementation of the labeling rules. Memories of the introduction of GM labels were still fresh. Some Beijing supermarkets we visited had run out of stocks of soybean oil, because residents had been hoarding soybean oil in response to the rapid price increases of soybean oil following the interruption of imports. Wherever we went, we found that all brands carried GM labels, with the single exception of a leftover old bottle. The most popular brands were *Jinlongyu* (Arawana), *Fulinmen* (Fortune), *Luhua*, *Yuanbao* (Gold Ingots), *Hongdeng* (Red Lantern), and *Jinxiang* (King Elephant). Although the labeling campaign was meant to be national, not local, Shanghai followed the labeling rules, as did Tianjin two months later. In other cities, such as Xi'an, some well-known national brands (including also rape oil, e.g., *Liyu* [Golden Carp] and *Jiaoshu* [Bagus]) had followed suit,[8] but others did not; in particular, local oil trading companies and their brands continued to sell their products without GM labels. Industry representatives have pointed out that local suppliers might need more time but would comply eventually.

Prelabeling Consumer Surveys and Imputed Preferences

A recent poll of 600 consumers in China found that 62% had a favorable opinion about biotechnology, while only 9% had a negative opinion. At the same time, however, the overall majority of the respondents (99%) had no or little knowledge of biotechnology (Li, Curtis, McCluskey, & Wahl, 2002). A similarly low awareness of GM food issues was found in a Chinese mail survey in 2002. However, in contrast to the first survey, a much higher percentage of respondents in this survey believed GM foods were harmful to human health or the environment in the long run (respectively 37% and 29%; Zhong, Marchant, Ding, & Lu, 2002).

From the results from these surveys, we might reach two conclusions. First, the overall majority of polled Chinese consumers have little or no knowledge of GM food. Second, in the absence of sufficient understanding of biotechnology, Chinese consumers' attitudes towards food safety can be manipulated easily towards either positive or negative attitudes. A similar picture arises

8. *Fortune Fulinmen used transgenic labeling since June 2002, according to its producer, Beihai Grain and Oil Industry (China Youth Daily, Jan. 24, 2003).*

from the surveys of urban consumer attitudes to GM food prior to the implementation of the GM labeling requirements in July 2003.[9] For these reasons, interview methodology should be designed with care; one should also take Chinese cultural and linguistic characteristics into account. In our survey, we have taken the very limited awareness of GM and GM food of Chinese urban consumers as a starting point and subsequently tested the effects of information supplied to them on their attitudes. This comes close to a simulation of the future reaction of Chinese consumers to GM food once their awareness has been raised. It should be noted that Chinese consumers' awareness had already been raised by the government's labeling campaign in the months before our survey.

Predictions about how Chinese consumers would react to labeling have differed. GMO proponents feared that "GMO products would be considered aliens in the market, and people naturally avoid buying such products because they do not know much about GMOs," as stated by Chen Zhanliang, president of the Chinese Agricultural University, director of the National Laboratory of Genetic Engineering, and founder of several biotech companies. Chen has also been quoted as saying: "The public has a right to know the truth about GM foods, but another truth about human nature is that the more you learn, the less safe you feel." Most scientists expected a negative reaction from Chinese customers. Part of the reason lies with inaccurate media coverage (Sheng, 2001). Others said that if GM foods really pose no harm, people would finally accept them (Yao, 2004). One of our interviewees, a supermarket manager, felt that a GM label meant an official approval of its safety. According to our interviewed managers, few if any customers had asked questions about the GM labels. Apparently, no problems had been expected, because staff and employees of the visited supermarkets (including Carrefour) had not received particular instructions about GM food products.

Greenpeace believes—contrary to the 2003 findings of Hu and Chen about the effects of positive information—that better understanding of GM and labeling will lead the consumer to demand GM-free or organic products. Their survey found that 56% would choose non-GM food over GM food if given the choice; 44% would choose non-GM food even if it costs 10% more than a GM counterpart. The same survey showed that 60% of consumers would not buy GM food even at a discount of 10%. Because almost 60% of respondents did not know about GM food, it is likely that these answers have been influenced by the line of questioning (Hepeng, 2003). Greenpeace collected supportive statements from a few dozen food companies in China and concluded that companies and consumers were "pushing GM food off the shelves" (Greenpeace International, 2003; Phillips, 2003). This may have been wishful thinking. Other surveys (including ours) show that this claim is largely overstated.

However, this does not imply that such a scenario might not occur in the future. The overall picture that arises from our data is that the average consumer has little comprehension of general scientific principles of GM food and its production. In the absence of this understanding, a majority of the respondents are uncertain whether they would consume GM food products. Strikingly, when we provided—through carefully designed questions—neutrally worded background information on the scientific debates on biotechnology, we found a substantial drop in the willingness to buy GM food products.

Survey Results: Attitudes to Food Safety and GM Products

Recent Chinese food scandals surrounding contaminated rice, the illegal recycling of moon-cake fillings, and the outbreak of chicken influenza in Hong Kong and Guangzhou have damaged consumers' trust in food safety. This is also confirmed by our study. The survey data reveal that food safety was positively graded by fewer than half of the respondents. Only 17% and 31% of the respondents deemed food safety to be "excellent" or "good," respectively (Table 1). An almost equal number found it was "not so good" (*yiban*); 6% said it was simply "bad" (*cha*).[10]

Indeed, China's food safety system leaves much to be desired. Standards are incomplete, inspection is weak, and regulations are not sufficiently followed. The

9. *A Greenpeace survey of a thousand Guangzhou consumers found that 64% did not know that their supermarkets sold GM food products and that 87% felt they should be labeled (Greenpeace International, 2003). A 2002 survey of 289 customers in Tianjin found no link between food safety concerns and attitude towards GM food (Wang, 2003). The lack of awareness is also shown by Xuan and Zhou (2002). A survey of 600 consumers in China, the Philippines, and Indonesia found a highly positive attitude towards biotechnology and GM food. When asked about food concerns, consumers did not mention biotechnology spontaneously even once (Asian Food Information Center, 2003).*

Table 1. General attitude towards food—total and by educational group (% of valid answers).

Question	Response	Total	Lower educated	Higher educated
A. How do you grade the safety of Chinese food products? (*n* = 962)	Excellent	17.2	22	15
	Good	30.9	28	32
	Not so good	41.6	38	40
	Bad	5.9	5	10
	Hard to say	4.5	7	4
B. Do you buy "green" food products? (*n* = 958)	Yes	86.1	76	90
	Rarely	6.4	10	4
	No	7.5	14	6
C. Are you willing to pay more for ecological food products, produced with less chemical fertilizers and pesticides? (*n* = 934)	Yes	39.9	34	43
	No	44.2	49	42
	Only nonprocessed	15.8	17	15
D. Are you willing to pay more for organic food products, produced without any chemical fertilizers or pesticides? (*n* = 929)	Yes	66.1	53	73
	No	23.0	33	17
	Only nonprocessed	10.9	14	10

market for "green" food is chaotic, and many products are not tested for safety. Moreover, departmental responsibilities are not clear, and there is a shortage of qualified inspectors (Zhou & Yang, 2002). The relatively negative opinion of food safety in China, although undoubtedly based on actual consumer experiences, may also have been fueled by repeated government warnings against bad food products in recent years. Laws, regulations, and standards on food safety have been tightened recently—also due to the newly established Food and Drugs Administration in 2004—and monitoring procedures are being strengthened.

Our survey showed that a large majority of the respondents had bought green food products; only 14% never or only rarely did so. It should be noted that the standards for such a denomination are lower in China than in the West. Negative answers were more frequent among those under 25 and those over 54 and twice as frequent in the lower education and income groups as in the highest education and income group. Gender made no difference.

The self-professed willingness to pay (WTP) extra for products guaranteed to be from organic agriculture was high. Only 23% said they were unwilling, and 11% chose the qualified answer "only for nonprocessed products." The WTP for products from ecological agriculture was substantially lower at 40% and 16% for nonprocessed products only. One might infer from these responses that many respondents (rightly or wrongly) thought that they did not pay extra for green food products. In the following four subsections, we will look into more detail into the respondents' answers to questions on (a) GM food and its production; (b) biosafety and human health; (c) labeling; and (d) the willingness to buy and consume GM products.

GM Food and Biotech Farming

It is important to note that the overall majority of respondents (71%) said they had heard of transgenic food products (Table 2). This high awareness compared to earlier surveys might be attributed to the government campaign (conducted only two months earlier) for labeling cooking and salad oils based on GM soybeans.

However, as we noted in the introduction, the self-reported awareness of GM does not imply an equally high understanding of the meaning of genetic modification. For instance, most respondents were unable to name any GM crop at all. Of the 32% that could, one half mentioned one GM crop, while few (11%) could mention more than one. It is interesting to note that few people mentioned the "wrong" crops (i.e., crops that have not been commercialized yet or are still at an experimental/field trial stage in China). The crop most frequently mentioned was soybeans (49%) and soy or vegetable oil (13%).[11] The frequent answer of GM soybeans (which China imports in huge quantities from the United States but does not grow yet), contrasts ironically with the infrequent answer of GM cotton, of which China is the absolute world leader in production. Appar-

10. The "bad" judgment was given by 9% of men and 5% of women, but otherwise there was little gender or age difference in the answers.

Table 2. Awareness and understanding of GM crops and food products (% of valid answers).

Question	Yes			No	Don't know/ unsure
	Total	Lower educated	Higher educated		
Have you heard of transgenic (GM) food products?	71	55	82	18	11
Can you mention some GM crops? Which?	32	26	38	68	
Can you mention reasons for their cultivation? Which?	19	24	22	73	8
Have you eaten GM products and food based on them?	37	30	40	32	31
Have you worn clothes made from GM cotton?	15	20	10	36	49
Is it false to say that non-GM soybeans do not have genes?	27	17	35	19	55
Is it false to say that eating GM food may change one's genes?	37	30	45	15	48

ently, government propaganda about GMOs and labeling has not been well understood by most consumers. For instance, a small percentage of respondents (15%) were actually aware of the fact that at least some of their cotton clothing must have been made from GM cotton. In fact, few people have been able to link the GM soybean message with GM crops in general.

Our study also tried to probe into Chinese consumers' understanding of some aspects of biotechnological farming. Recent studies found that farmers have little comprehension of biotechnology in general—let alone of the potential biosafety issues of the GM crops they grow.[12] So, what would consumers understand of biotechnological farming? According to our survey, disappointingly little: Only 19% of respondents could mention one or two reasons why farmers grow GM crops.[13] Even worse, of those giving a second reason, almost half gave a wrong answer (such as "improving the structure of production"). The lack of understanding of the benefits for farmers should be attributed to the reluctance of the Chinese government and media to report on issues related to genetic modification. As we saw above, the Chinese Communist Party (CCP) and government's position is that such reporting might upset the general population and could be detrimental to a policy of keeping all options open.

Less than one fifth (18%) of our sample population gave correct answers to both our questions testing knowledge about the presence of genes and the capacity of modified genes in animal feed for altering human genes. The first question had a lower score (27%) than the second one (37%). The questions "Nontransgenic soybeans do not contain genes, but transgenic soybeans do; true or false?" and "Eating transgenic food may change a person's genes; true or false?" were taken from a recent survey.[14]

Biosafety, Human Health, and the Environment

Initially, most respondents did not seem very concerned about the potential risks of GM food to human health: 82% thought the cooked or processed products were safe, while 71% thought the same about meat. However, the views on unprocessed food were negative, with the

11. This answer was followed by the mentioning of tomatoes (9%), then rice, cotton, and maize (5% each). As a second crop, soybeans, maize, or tomatoes were mentioned about 20% each, cotton 12%, and as a third crop, wheat and cotton (27% and 18%, respectively). Tobacco—China's first GM crop, developed in the late 1980s but halted after some years because of foreign buyers—was mentioned only once.

12. When confronted with the question of what government should do to cope with GM safety problems and guarantee a healthy development of transgenic crops, fewer than 10% felt that government should forbid R&D of transgenic crops, more than 30% that it should improve the regulatory framework, and more than 60% that it should increase investment in R&D (Ma & Huang, 2003). In another study on risk perceptions of Bt cotton by farmers, it was found that 71% of the sampled farmers could not explain the principle by which Bt cotton resists the bollworm (Zhang, 2002).

13. One half of these mentioned an "increase in output," which does not prove an understanding of the reasons for adoption of GM crops. Less than half of the reasons were specific, mentioning most often (in order of frequency) positive health effects, reduced pesticide use, lower costs, and environmental effects.

14. Compared to this study (which interviewed only college students), our respondents did better than the Japanese but scored much worse than the Norwegian, US, and Taiwanese students, of whom two thirds or more gave the correct answers (Chern, Rickertsen, Tsuboi, & Fu, 2002). Because respondents were offered the easy answer "hard to say," the number of accidentally correct guesses should have been small.

Table 3. Assessment of safety of GMO-based food products for human consumption and opinion on food safety in general (% of valid answers).

	Response	Total	Lower educated	Higher educated
Unprocessed GM food (*n* = 854)	Safe	26	40	21
	Rather safe	21	19	19
	Rather unsafe	28	17	33
	Unsafe	25	22	26
Processed/ cooked GM products (*n* = 831)[a]	Safe	33	39	26
	Rather safe	49	43	52
	Rather unsafe	15	14	19
	Unsafe	4	2	3
Meat from animals using GM feed (*n* = 818)	Safe	32	36	28
	Rather safe	39	34	38
	Rather unsafe	22	22	27
	Unsafe	8	8	7
Opinion on food safety in general (*n* = 962)	Good	17	22	15
	Rather good	31	28	32
	Not so good	42	38	40
	Bad	6	5	10
	Hard to say	4	7	4

[a] *Of the 831 valid responses for processed/cooked GM products, 16% said "good" and 7% said "bad."*

majority (53%) deeming unprocessed GM products "unsafe" or "rather unsafe" (*bu zemme anquan*; see Table 3).[15]

We hypothesized that the opinion about GM products would be correlated with respondents' views on food safety in general. This was confirmed. Those who thought food safety was "good" or "rather good," compared to the equally large group with the opposite view, more often deemed GMO-based products to be "safe" or "rather safe."[16] Moreover, there is no scientific basis for a greater concern about consuming meat from animals fed with GM feed than concern for consuming processed products based on GM crops. For this reason, we may conclude that the negative appraisal of GM products (nonprocessed or otherwise) reflects respondents' opinions about differences in food safety between nonprocessed, processed, and cooked food, rather than a well-informed opinion about the risks of GM food.

Table 4. Belief that GM crops might damage other crops or the ecology (% of valid answers).

	Yes	Maybe, but minor	No	Hard to say
All respondents	13	29	38	20
Respondents who heard of GM food before	15	27	40	17
Respondents who never heard of GM food	8	32	32	29
Respondents who were not sure	7	28	38	27
Male : female	16 : 12	33 : 27	33 : 40	18 : 21
<25 years old : >54 years old	13 : 13	21 : 36	40 : 38	26 : 13
Low education : high education	12 : 15	28 : 29	41 : 36	19 : 20
Low income : higher middle and high income	12 : 17	30 : 26	39 : 35	20 : 21
Farm experience : no farm experience	16 : 11	32 : 26	35 : 40	17 : 22
Internet users : internet nonusers	15 : 11	26 : 33	40 : 36	20 : 21

Most respondents did not believe GM crops might cause damage to other crops or the ecology, but many were not sure: 38% answered they did not, 29% "maybe, but nothing important" (*meishemme liaobuqi*), and only 13% said they did. Those who had not heard about GM food before, or were not sure they had, least often thought they might do damage. The belief that GM foods might do damage was slightly more prevalent among men, the more highly educated, higher middle and high incomes, and those with farm experience (Table 4). The lack of attention to genetic modification in Chinese education and the media in general may explain why differences between groups are small.[17]

Awareness of and Demand for Labeling

The majority of the respondents (55%) said they did not know the government had promulgated new labeling rules for GM food. Even among the highly educated, a high proportion was not aware of the new regulations (47%). This seems a rather disappointing result for the recent government campaign. After having responded to some questions with positive and negative information

15. *The 11–15% nonrespondents to the questions (which did not allow the answer "hard to say") were higher than the 4% for the question about food safety in general, showing a somewhat greater uncertainty about how to assess GM products.*
16. *For nonprocessed, processed/cooked, and meat products, the difference in positive appraisal was 6–12%, namely 50% vs. 44%, 89% vs. 77%, and 77% vs. 65%, respectively.*

Table 5. Awareness of and demand for labeling GM products (% of valid answers).

Question	Response	Total	Lower educated	Higher educated
Do you know if government made rules for labeling GM food products? (*n* = 958)	Yes	45	31	53
	No	55	68	47
Do you hold there should be such rules? (*n* = 959)	Yes	66	51	82
	No	10	16	5
	Don't know	24	33	13
If yes, for which products? You may choose more than one. (*n* = 941)	Unprocessed	35	39	37
	Cooked	58	49	63
	Feed	37	30	47
	Cotton	19	19	20
Of above, choosing only one (*n* = 654)	Unprocessed	15	26	12
	Cooked	33	29	28
	Feed	13	13	14
	Cotton	8	9	6

about genetic modification, customers were asked whether they felt that the government should make such regulations. Two thirds said "yes," 10% said "no," and 24% were "not sure" (Table 5).[18]

Asked for which out of four given types of products labeling was needed, 58% of the respondents indicated processed and cooked food products, including edible oil and drinks, 37% meat from animals fed with GM feed, 35% nonprocessed food, and 17% cotton. Considering the expressed greater worries about the safety of nonprocessed GM food versus processed or cooked GM food, it may seem strange that nonprocessed products were mentioned less often. However, the high percentage mentioning processed and cooked food products may be attributed to the fact that to date, labeling requirements had been implemented only for edible and cooking oils. Animal feed and cotton had not been included in the 2002 MAGR list, but several fresh products such as peppers and tomatoes had. Another (probably very minor) explanation may be that some customers may have doubted the practicality of labeling fresh products and feed.

Consumption and Purchase of GM Food

In this subsection, we will deal with the willingness to consume and the willingness to purchase GM food. As we saw in a previous subsection, consumers show a very limited understanding of GM food and its production. In the absence of such knowledge, most consumers remain neutral or unwilling to consume GM food. However, positive and negative information about the potential allergenicity of GM food has a great impact on the willingness to buy.

We asked four different questions regarding the willingness to consume GMO-based food products. Due to the limited and recent labeling that so far extends only to soy oil (and sometimes rapeseed oil), the Chinese consumer is not offered a real choice between the same products with or without GMOs. Moreover, GM soybean oil is cheaper than non-GM soybean oil. In September 2003, some imported brands have labeled rapeseed (and canola) oil as based on GMOs, but most domestic brands did not. Since then, the Chinese customer can avoid GM-labeled oils only by purchasing more expensive sunflower and peanut oil. In view of this limited availability and the lack of relevant knowledge with most customers, we decided to ask first about the willingness to consume, then provide positive and negative information about pesticide use, health, the ecology, and government labeling requirements, and only then ask for willingness to pay for slightly more

17. *Those who had heard of genetic modification before had a considerably higher total of yes or no answers than those who had not (55% vs. 40%) and less often answered "hard to say" (17% vs. 29%). To a lesser extent, the former also held true for internet users. These results suggest they had made up their minds more often than others. Of course, this holds true only if one assumes that the answers "yes, but not important" and "hard to say" reflect uncertainty rather than a well-founded opinion. As with studies in other countries, demographic variables had little influence.*

18. *The awareness of labeling rules was positively related to age. People under 25 years old were less often, and those over 54 more often, aware of GM rules (33% and 55%). However, a smaller than average majority of these two age groups (63% and 57%, respectively) felt a need for them.The less educated felt much less need for such rules than the highly educated. Lower-income people also expressed a lesser need (56%). Those who believed they were consuming GM food products knew about government rules more often (67%) and felt more often that labeling was needed than those who thought not or did not know (77% vs. 60% and 61%). Willingness to pay for guaranteed GM-free food was also a related factor. 52% of the willing, as opposed to 37% of the unwilling, had heard of GM regulations, and 75% as opposed to 55% felt such rules were needed. Those willing to pay for organic agricultural products scored highest, 78% feeling there should be GM rules (vs. only 44% of the unwilling).*

Table 6. Willingness to consume GM food products (% of valid answers).

Question	Response[a]	Total	Lower educated	Higher educated	Score[b]
A. Willing to consume food containing GM-based ingredients? (*n* = 946)	1	17	22	12	1.90
	2	23	23	24	
	neutral	51	49	51	
	3	7	5	9	
	4	2	1	4	
B. If with less pesticide use?	1	30	34	24	1.95
	2	48	39	53	
	3	20	23	21	
	4	2	5	2	
C. If some allergic reactions possible?	1	11	13	7	2.33
	2	41	43	46	
	3	43	39	43	
	4	5	6	5	
D. Willing to pay for GM-free food?	Yes	31	31	33	2.62
	No	40	48	36	
D1. Only for nonprocessed products?	Yes	29	21	32	

[a] *1 = very willing; 4 = very unwilling.*

[b] *Based on unrounded figures; yes weighted as 1.5, no as 3.5.*

expensive food products that are guaranteed to be free from transgenic elements (see Table 6). The initial willingness to consume food containing GM-based ingredients was rather high, 40% being "very" or "rather" willing.

On the other hand, the majority of respondents was neutral (51%), or was "rather" to "very" unwilling (a total of 9%) to consume GM food. As was to be expected, willingness to consume was positively associated ($p < 0.01$) with a belief in the safety of food in general ($r = 0.249$) and negatively associated with trust in the safety of GM nonprocessed food, processed food, and meat (r = -0.116, -0.130, and -0.270). Knowledge about genes (r = -0.216 and -0.279) and education (r = -0.109) were negatively correlated. There were less significant ($p < 0.05$) positive correlations with having farming relatives ($r = 0.071$), with not buying green food ($r = 0.066$), and, surprisingly, with the belief that GM crops pose a danger to the ecology or other crops ($r = 0.075$). However, we should not simply conclude from the latter result that consumers did not care about environmental effects. The answers may have been influenced by positive information about the reduced pesticide use required by GM crops. In the light of the limited awareness and information, it is not surprising that one half of respondents adopted a neutral attitude towards the consumption of GM food.

In subsequent questions about the purchase of GM food, we forced respondents to abandon this neutral position, so we cannot directly measure the effect of positive information about reduced pesticide use. After asking, "if GM crops use less pesticides than non-GM crops, how willing would you be to buy GM agricultural products and products based on them?", willingness went up to 78% of respondents. The fact that our calculated unwillingness score went up from 1.90 to 1.95 instead of down (Table 6) suggests that the initial "neutral" answer concealed a less positive attitude than average.

Subsequent negative information contained in our rather cautiously phrased question, "some scientists say that GM food products may give allergic reactions with a few people, but other scientists do not agree; if you knew this debate goes on, would you still buy GM food products?", strongly decreased the willingness to buy GM food. In fact, the average willingness dropped by a quarter, to 52% (Table 6).[19]

Conclusion: Scenarios of Consumer Resistance?

China's unprecedented economic development, industrialization, and urbanization have been accompanied by profound changes in the food chain—with potentially grave implications. Although China's agricultural production chain is different from that of the West,[20] Chinese consumers wrongly assumed that they were safe from food crises, such as bovine spongiform encephalopathy (BSE) in the United Kingdom. This was painfully demonstrated with the severe acute respiratory syndrome (SARS) outbreak in spring 2003. Nobody could have predicted that the consumption of civet cats in South China would have caused such dramatic

19. *The less-educated reacted less strongly to the allergy question, their willingness dropping by 16.5% to 56%. In addition, 31% said they would be willing to pay more for GM-free food, and 40% to be unwilling to do so. More (48%) of the less-educated were unwilling. 29% (and 21% of the less-educated only) limited their willingness to pay more for nonprocessed natural food products, not for processed products and cooked food. Income was not a factor.*

20. *A large proportion of Chinese agriculture is still conducted in a semitraditional manner on small plots with high labor inputs and a low level of mechanization.*

domestic and global consequences. During the following year, Chinese consumers were plagued by news about carcinogenic substances in Lee Kum Kee's oyster sauce and toxic chemicals in Long Kou rice vermicelli. The death of hundreds of infants due to bad-quality baby milk powder in Anhui in 2004 shocked public opinion. From this we might learn that China is not that much different from industrialized societies: The increasing scale, complexity, and diversification of food production and consumption also entail problems of food safety.

In this light, the Chinese government's relatively positive stance towards allowing GMOs into the food chain is remarkable. The critical question asks whether Chinese consumers are sufficiently aware of the potential risks of GM food—particularly so in a semiauthoritarian context with restrained freedom of press and speech. It is against this backdrop that we have conducted a survey on Chinese urban consumers' awareness and acceptance of GM food products. From the survey, which polled approximately 1,000 respondents, we can draw four critical conclusions.

First, the overall majority of respondents (71%) had heard of transgenic food. This high percentage is most likely due to the government campaigns to raise awareness for the new labeling rules. However, it should be noted that a substantial proportion of consumers (55%) said they did not know the government had promulgated new labeling rules for GM food. Even close to half of the highly educated respondents were not aware of the new labeling rules. These results point to a larger underlying problem—citizens' widespread lack of basic understanding of GMOs and their potential risks to the environment and human health.

Our survey data confirm this picture, which brings us to our second conclusion. An absolute majority of urban consumers (over 80%) had no inkling about genes and could not correctly answer whether the statement "nontransgenic soybeans do not contain genes, but transgenic soybeans do" was true or false. The same counted for the question about whether eating transgenic food could alter a person's genes. Furthermore, elementary knowledge about biotech farming was also lacking among our respondents. For instance, most consumers were unable to mention any genetically modified crop at all, and few people could relate GM soybean to GM crops in general.

Third, the survey demonstrates the critical role of the state in China's political economy of biotech. The poor understanding of biotech and its potential risks can in large part be attributed to the state's reluctance to allow the emergence of uninhibited public debates about genetic modification. This reluctance is not just driven by a fear of social unrest, but most likely also by a felt need to protect the domestic biotech industry against potential consumer resistance. According to Xue Dayuan, former deputy director of the Biosafety Office of the State Environmental Protection Agency, in 2004 the State Council had issued a confidential notice to concerned state institutions, which called for a halt to discussions about biotechnology in the media (Xue Dayuan, personal communication, September 2004). However, this is not to say that the Chinese state discourages reporting about biotech altogether. Rather, it is a matter of state-guided, "well-balanced" reporting about biotech. This is demonstrated by China's first article about biosafety of GM crops in the nation's main government newspaper: the *People's Daily*.

This article was written by Mang Keqiang, a reputable professor at the Institute of Microbiology of the Chinese Academy of Sciences. He warned that "once agricultural transgenic plants and microorganisms are released and spread into the environment, they might be difficult to control (*yi shifang tuiguang, ze nanyi kongzhi*)" and hoped that the "involvement of other concerned experts in the discussion will bring these questions to the attention of governmental policy makers and the administrative departments in charge of research funds" (Mang, June 13 & 20, 1996). It is critical to note that Mang Keqiang did not write on a personal title, but had been invited by the central authorities to do so (Mang Keqiang, personal communication, 2002). The proactive and dominant role of the Chinese state in the biotechnological arena is also demonstrated by the fact that no domestic NGOs have made biotechnology a field of activity in Chinese society today. To date, Greenpeace is the only NGO that has worked in this area, and has done so only with great caution due to past confrontations with the government.[21] It is therefore no wonder that information about food safety in relation to biotech almost exclusively comes through government channels. In a recent survey of 1,000 Chinese respondents, it was found that less than 3% had heard about GM food through environmental NGOs.[22]

21. The Greenpeace office was reopened in spring 2002 after being closed down in 1995 because of an incident in August of that year when public security personnel arrested six foreign Greenpeace demonstrators, detained them for one day, and expelled them from China for unfurling an antinuclear banner in Tiananmen Square.

Our fourth and final conclusion is that in the absence of sufficient understanding of GM food, its production, and potential risks, Chinese urban consumers' acceptance of GM food safety can move in quite opposite directions. Initially, our survey shows that a relatively high percentage of respondents are willing to consume GM food (40%). At the same time, it is crucial to realize that a substantial proportion of consumers is actually neutral (51%) or unwilling (9%) to consume GM food. When we provided both positive and negative background information on the scientific discussions on GM food risks (through carefully designed and neutrally worded questions), the willingness to purchase GM food products dropped substantially (by 25%). This is an important result that might point to future scenarios of widespread consumer resistance against GM food, as also occurred in countries in the European Union.

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22. *Of the interviewees, 37.2% had heard about GM food through the media, 12.8% through friends, 12.3% through books and articles, 2.8% through school, 2.0% through the government, and 1.5% through companies (Green Community Research Center, 2002).*

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Appendix A. Demographic Characteristics of the Sample

Our sample population consisted of almost 1,000 customers visiting four supermarkets in Beijing and Shijiazhuang in September 2003 (Table A1). Most were women. Their age distribution did not differ much from the general adult Beijing population, except for a much lower percentage of people over 64 (16% of the Beijing urban population of 15 years and older is over 64; National Bureau of Statistics of China, 2003) and a slightly lower percentage aged 55–64. In the absence of other data, it is hard to say whether the slanted gender distribution and the rather even age distribution in the under-55 age cohorts reflect the general composition of the Chinese shopping population. The gender ratio did not differ significantly between age groups except for a slightly higher male percentage in the 25–34 cohort (34%).

Table A1. Characteristics of the sample population.

Gender	70.5% female; 29.5% male
Age	26.7% under 25; 23.1% 25–34; 20% 35–44; 19.8% 45–54; 8.3% 55–64; 2.1% 65 and over
Education	16.6% primary; 48.4% midddle; 35.1% tertiary
Income	24.1% low; 43.3% lower middle; 30.1% higher middle; 2.5% high
Smokers	19.8% (39.9% of men; 11.3% of women)
Internet users	54.7% (60.1% of men; 52.5% of women)
Farm experience	36% (46.4% of men; 31.6% of women)
Farm relatives	55.4% (57.6% of men; 54.7% of women)

Note. n = 965. Income had 44 missing values; other items had 7–24 missing values.

Most customers (73%) put themselves in the middle-income categories; 24% claimed to have a low income. Men classified themselves less often as low income (19% vs. 26% of women) and more often as high income (6% vs. 1% of women). One third of the youngest group had a low income. Most high incomes were in the 25–35 age group. Otherwise, age did not affect reported income much.

Gender difference in reported education was found only in the highest educational category, with 39% and 33%, respectively, of men and women. Our sample was more highly educated than average for Beijing.[23] The internet was used by almost as many women as men, most often by the young but still by 40% of those aged over 54. Internet use is important, because (more so than the occasional reporting in newspapers and other Chinese media) it offers information on GM food and its safety aspects.[24]

23. About half of this is due to an underrepesentation of elderly people. Of the Beijing population over six years old, 15% have primary school or less, 33% junior middle, 26% senior middle, and 25% tertiary education (National Bureau of Statistics of China, 2003). The percentage of tertiary education among those over 20 years old is about 30%.

More than one third of the respondents had some experience with farming, particularly those in the 45–54 age group (many of whom had been sent down to the country in the 1970s). More than half had relatives who were farmers. Smoking had the greatest gender difference, and was associated with high age, low educational level, farming experience, and farming relatives.

Our sample was taken at different times of the day at three supermarkets in Beijing (a Carrefour in a central residential area, a Hong Kong-Chinese JV in the Jianguomenwai business district, and a Chinese supermarket in a workers' district) and one in the nearby provincial capital of Shijiazhuang. Customers were promised a small gift upon completion of the questionnaire; few refused to participate. Therefore, we are confident that our sample population was an adequate reflection of metropolitan supermarket customers in general.

Appendix B. Separate Groups in the Sample

Based on the respondents' answers, three groups with special characteristics may be distinguished: the knowledgeable, the willing, and those with farm experience. These are discussed in detail below.

Knowledgeable (K) Group

The *Knowledgeable* (K) group consists of those (n = 172) who answered the two questions on genes correctly. The higher-educated people belonged to the K group almost twice as often as the lower-educated ones. The group had more males (34%) and fewer people under 25 (18%) than average. Members of this group were less prone to confess ignorance or uncertainty and more often chose positive or negative answers. More of them had heard of GM food (88% vs. 77%) and indicated they consumed it (48% vs. 37%). However, they were more convinced that their clothes are made from GM-free cotton (49% vs. 36%)—something Chinese consumers cannot possibly know. Also, they were less uncertain about the question of whether GMOs may damage other crops or the ecology, being more often convinced that GMOs do not (46% vs. 38%) or do (17% vs. 13%). The K group was similar to the population in its professed knowledge of government regulations about GM food products but more often said there should be such regulations (81% vs. 66%). As for the types of product that need regulation, the K group answered more often three or all four product types (26% vs. 13%).

The K group had a slightly higher initial willingness to buy GM food (45% vs. 40%). Almost half took a neutral attitude. Their appraisal of GMO-based food products was more negative ("rather unsafe" or "unsafe") with nonprocessed food (62% vs. 52%) but less negative with processed or cooked food (13% vs. 19%) and meat (23% vs. 30%). Their reaction to positive and negative information about GM crops and food was more extreme than average. Positive information about reduced pesticide use pushed up their willingness to buy to 85% (as opposed to a 77% average); subsequent negative information about possible allergic reactions drove it down to 48% (as opposed to a 52% average). However, only few became very unwilling. We conclude that most Chinese consumers—even those with knowledge about genes—have little or no awareness of GMOs and the advantages and risks of GM-based food products; new information makes a great difference to their attitude.

Willing (W) Group

After the respondent's awareness of GMO problems had been raised through reading and responding to various questions, we asked whether they were willing to pay more for GM-free food. The 31% who answered with an unqualified "yes" we refer to as the *Willing* (W) group. Their characteristics of gender, age, education, and income do not differ from the others. That goes also for farm experience, farming relatives, internet use, and smoking. The W group was more ignorant about genes than average. Although similar percentages of the W group, compared to the other groups, gave the correct answers to the two questions about genes (27% and 38%), more gave the wrong answers (30% and 22% against averages of 19% and 15%). Therefore, their willingness to pay for GM-free food was not based on superior knowledge.

The W group had more people who stated they had heard of GMO-based food (76% vs. an average of 71%), had bought "green" food (91% vs. 86%), knew there were government regulations for GMO-based food (52% vs. 45%), felt the need for such rules (75% vs. 66%), believed they had consumed it (43% vs. 37%), and thought GM crops might damage other crops or the ecology (20% vs.13%). Their conviction that GM food was safe was about average, but more believed that safety of food in general was good (28% vs. 11%). The

24. *The most popular website, http://sina.com, points to information on the website of the China Food Industry Association, http://gmfood.cfiin.com.*

question concerning allergic reactions affected their willingness to buy less than average, with 20% (vs. 11%) remaining very willing. The W group had a much higher than average willingness to pay for products from ecological agriculture (66% vs. 40%) and organic agriculture (77% vs. 66%). In conclusion, whether more ignorant in some respects or more knowledgeable in others, the Willing group was more likely to be positive about anything.

Farm Experience (F) Group

36% of our respondents had experience with farming, and 55% had farming relatives. The latter did not influence answers much, but the former did. Our hypothesis was that the *Farm Experience* (F) group would have a greater understanding of GMOs and the reasons for the adoption of GM crops and therefore be more receptive to GM food. Their demographic characteristics differ from the others in that they have more males (38%), fewer people aged 35–44, and more people aged 45–54 (the latter difference reflects the rustication campaigns of the 1970s). They have a lower than average level of formal education and considerably fewer people in the higher income categories (21% vs. 33%).

Our hypothesis was not confirmed. The F group scored slightly lower than average in their understanding of what genes are and can do. Wrong answers to the two related questions were given by 22% (vs. 19%) and 21% (vs. 15%). Only slightly fewer people in the F group were unaware of GMO-based food products (16%). They could not name more GM crops than other people. Even if they gave slightly more reasons why farmers might grow GM crops, there were fewer correct reasons given (22% vs. 19% gave one reason, and 14% vs. 12% gave two, but most frequently mentioned were production increase and improvement of management structure). More than average, yet still a minority (21%), thought they had worn clothes made from GM cotton. Slightly more than average (16%) thought GM crops might harm other crops or the ecology. Slightly more (41%) said they consumed GM food, and their initial willingness to do so was also slightly higher (21% being "very willing"). They had a higher opinion of food safety in China in general (53% deeming it "good" or "rather good") and were more convinced of the safety of GM food in China (32% vs. 26% for unprocessed food, 37% vs. 32% for cooked food, and 35% vs. 32% for meat).

The F group was more willing than average to pay for ecological and organic food (42% and 70% vs. 34% and 66%). Their reaction to information about reduced pesticide use was more positive than average (35% vs. 30% becoming "very willing" to buy). After receiving information about allergies, more of them than average remained very willing or willing to buy (57% vs. 52%). It appears the F group is not better informed about GM but has a more positive attitude than average about all that has to do with agriculture.

Appendix C. Relation with Gender, Age, Smoking, and Income

Gender did not affect the responses much. Men knew more often than women that all soybeans have genes (32% vs. 24%). They were slightly more confident about knowing relevant government regulations (47%) but felt slightly less need for them (64%) and had slightly more trust in the safety of fresh and cooked GMO-based food (44% and 73%, respectively). Positive information about reduced pesticide use had the same impact on men and women. However, there was a substantial gender difference in the effect of information about possible allergic reactions. It drove the willingness of women to buy GM food down to 49%, but 58% of men remained willing, in spite of the fact that more men than women believed GM could damage other crops or the ecology (16% vs. 12%), at least to a minor extent (33% vs. 27%).

The under-25 age group had heard of GM food products least often (62%), was least convinced they ate them (30%), was least aware of labeling regulations (33%), and showed the greatest understanding of what genes are and may do (with 35% and 43% correct answers). They were slightly less confident about the safety of processed or cooked GM-based food (78%) and least influenced by positive information about pesticides (going up from initially 42% willing plus "neutral" to 72% willing). After negative information, they became least willing to consume GM food (46%). Their eventual willingness to pay extra for GM-free food hardly differed from other age groups.

The over-54 age group was most aware of government regulations (55%), least convinced rules were needed (57%), had least understanding of genes (14% and 28% correct answers to the two questions), and was most confident that nonprocessed food products based on GM were safe to eat (63%). Positive and negative information about GM had the least impact, with their willingness to consume dropping by 20%.

The 25–44 age group was initially least willing to consume GM food (35% as opposed to 42% of the oth-

ers). They reacted slightly more strongly to positive and negative information about GM, their willingness to buy dropping from 79% to 52%, as opposed to a drop from 75% to 52% with the other age groups.

The attitudes of smokers differed from nonsmokers in some respects. General characteristics (age, education, income) of male smokers did not differ from nonsmokers, but female smokers were slightly overrepresented in the over-54 age category and underrepresented among below-25 age and higher education categories. Smokers scored lower on knowing that eating GM food will not change a person's genes (27%) and more often thought GM crops might damage other crops or the ecology (20%). Fewer smokers were aware of government regulations (42%) and fewer felt they were needed (62% of male and 42% of female smokers, vs. 70% of nonsmokers). Smokers were slightly more willing to consume GM food (43%) and more positive about its safety for human consumption in its three forms (60%, 84%, and 75%). Positive information about pesticide use brought their willingness up to the same level as that of nonsmokers, but subsequent information about allergies brought it down less, 15% remaining "very willing." One might say that smokers cared less. However, their eventual willingness to pay for organic, ecological, and GM-free food did not differ significantly from that of nonsmokers.

Income was a significant factor in several answers. For valid statistical analysis, we included the small high-income group in the higher-middle-income group. Compared to this combined "higher" group, the low-income group had less often heard of GM food (65% vs. 77%) or of labeling regulations (40% vs. 49%), and a smaller majority felt a need for them (56% vs. 70%). Although their appreciation of GM food product safety was not very different, more often they deemed nonprocessed GM food "unsafe" (33% vs. 22%) rather than "rather unsafe" (21% vs. 32%).

The higher-middle-income group showed less willingness to consume GM food (35% vs. 42% of the others) and more often took a neutral position (55% vs. 50%). A larger minority remained unwilling to buy GM food even when told of reduced pesticide use (26% vs. 21%); information about allergies had slightly smaller impact. More (but still a small minority) thought GM crops might damage other crops or the ecology (17% vs. 10%) and fewer that they did not (35% vs. 39%). 10% (vs. 4% of the others) classified China's food safety as outright bad. For food guaranteed as GM-free, their WTP was similar to others, except that fewer (26% vs. 31%) chose the option "only for nonprocessed prod-

Table D1. Willingness to buy GM-based food products of the initially willing (W), neutral (N), and unwilling (U) customers, and willingness to pay more for GM-free food (% of valid answers).

	Willingness[a]	W	N	U
Initial attitude		1.58	2.50	3.25
If less pesticide	1	47	19	11
	2	39	58	28
	3	12	21	53
	4	1	2	7
	Avg.	1.68	1.96	2.56
If possible allergy	1	19	6	3
	2	50	40	11
	3	30	51	63
	4	1	4	23
	Avg.	2.13	2.53	3.05
WTP for GMO-free	1–2	33	28	31
	3–4	35	44	36
	Avg.	2.53	2.83	2.57
Fresh food only		31	28	33
n		377	481	88

[a] *1 = very willing; 4 = very unwilling.*

Appendix D. Initial WTP—Three Separate Groups

In Table D1, we distinguish three groups based on their initial willingness to buy GM food. Most initially neutral customers (N) swung to "very willing" (19%) or "rather willing" (58%) to pay more after the first (positive) question, with a total average score of 1.96. After the second (negative) question, a slight majority of them swung to "rather unwilling" (51%) or "very unwilling" (4%), with a total average score of 2.53. The initially willing customers (W) responded more positively to the first question, 47% "very willing" and 39% "rather willing," with an average score of 1.68. After negative information, 69% remained willing, but their average score went to 2.13. Their final WTP was slightly higher than average, with 33% saying yes, 35% no, and an average score of 2.53. The rather small group of initially unwilling customers had a similarly large swing. 39% became willing after positive information, but only 14% remained so after negative information.

The lack of willingness to pay more for GM-free food was greatest with those who had been neutral before. It differed little between the initially willing and unwilling. This remarkable result seems to show that additional information—good and bad—narrowed the difference between those initially in favor and those

who were not. However, only part of this should be attributed to our additional information and forcing respondents to choose between either positive or negative answers. The final question asked for willingness to pay *more* for GM-free food, not just readiness to buy food with or without GMO-based ingredients. The ratio between the willing and unwilling to pay more (31:40) was lower than the one for ecological food (40:44) and much lower than the ratio for organic agriculture (66:23). Apparently, GM-free food was not valued as highly as ecological or organic food.

In all three categories (W, N, and U) a high percentage (28–33%) of respondents were willing to pay for GM-free only for nonprocessed natural products. We can not offer a single interpretation. Some may have believed that processing and/or cooking removes all GMOs anyway, so paying for GM-free food is unnecessary. Others may have been attracted by the possibility of adopting an answer between yes and no, so this result should not be taken at face value.

Authors' Note

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