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Consumer Acceptance and Willingness to Pay for Genetically Modified Rice in China: A Double Bounded Dichotomous Choic Contingent Valuation Survey Calibrated by Cheap Talk

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ABSTRACT

Considering population growth, limitations on land and water resources, and contamination to the ecosystem due to agricultural activities, current rice production in China is facing pressure to fulfill national demand. Self-sufficiency of rice has been a long-held political objective of the Chinese government and it is national goal to maintain the equilibrium between the national production and consumption or even achieve a supply surplus in rice. With the developing bio-technology of genetic modification (GM), scientists believe that using genetically modified cultivars may ease the pressure mentioned above. However, both the government and the people are very cautious about large-scale cultivation and commercialization of GM rice and have concerns over public health, environmental safety, economic stability and other diverse impacts. The consumers' acceptance, producers' adoption of these new products, the political environment, and the cost benefit effectiveness of GM rice being commercialized has remained ambiguous within the constantly changing social media and political environment. The main objective of this thesis is to describe the political environment and perspectives of consumers to understand the barriers and controversies to accept and use GM rice by conducting research regarding consumers' attitudes and their willingness to pay (WTP) for GM rice based on different information treatments. The other purpose of this study is to compare the results of this study with previous studies of Chinese consumers' WTP and attitudes on GM rice and perform analyses based on economic, political, and social perspectives to provide contributions on future policy making.

For this study a nation-wide survey was conducted where 1150 consumer respondents were randomly recruited of which 994 provided valid data. Geographically the survey sample pool covered twenty two main rice producing/consuming provinces of mainland China. A double

bounded dichotomous choice contingent valuation method was applied to estimate the consumers' WTP. To reduce the hypothetical bias, cheap talk was applied as a calibration method. Results from the survey are used to develop a welfare analysis based on an econometric model simulation, to determine under different information treatments if there are significant differences in the WTP. This research contributes to the literature and policy decision making in regards to understanding the consumer barriers to and benefits from GM rice commercialization. Our results show that consumers' WTP for GM rice is mainly negative: the total mean WTP for the entire sample was estimated to require an average 47% price discount for GM rice. This is a significant change from earlier studies (Lin, et al 2006). Science-based knowledge about GM rice benefits and risks need to be disseminated to China's consumers to improve acceptance and successful commercialization.

Key word: GM rice, China city consumers' WTP, double bounded dichotomous choice, cheap talk

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DEDICATION

I dedicate this thesis to both sides of my grandparents, who encouraged me so much to be brave and have the confidence to pursue my dream. I also dedicate this thesis to the upcoming researchers who will also dedicate their knowledge, time and passions to study Genetically Modified food related issues.

TABLE OF CONTENTS

ABSTRACT *5*

ACKNOWLEDGEMENTS *7*

DEDICATION *8*

I. INTRODUCTION *1*

The challenges of Chinese agriculture 2

Chinese GMO Developing Situation 4

GM Rice debate 8

II. LITERATURE REVIEW *12*

Global status of GM crops 12

WTP studies about GMOs 16

Consumer attitudes and Information effects 18

Media effects 21

Contingent Valuation Method 22

Calibration method 25

III. METHOD OF ANALYSIS *27*

Hypothesis 27

Survey Design 31

The goods descriptions 32

Sampling procedures 33

Experimental design 34

Demographic, prior knowledge and acceptance 34

Information shocks and Calibration method 35

Double Bounded Dichotomous Choice contingent valuation procedure 37

Statistical testing procedures 40

Testing procedures and software introduction 40

Analytical approach 42

The multinomial logistic regression (M-logit) and marginal effects 42

Double Bounded Dichotomous choice analysis for WTP 44

Data 48

Data merging and sorting 50

IV. RESULTS *51*
Data descriptions 51
Demographic variable descriptions and analysis 51
Objective and subjective knowledge analysis 55
True /False objective knowledge 55
Awareness of the GM related terms 56
Awareness and knowledge of GM rice and 2012 Golden rice deceived case 58
Acceptance of GM related products 59
Percentage Change comparison 59
Tobit models for the acceptances 60
Consumer preferences over rice products without price changes 63
Multinomial logistic model analysis 63
Relative risk ratio and adjust predictions between treatments 66
Marginal effects estimation 68
Double bounded contingent valuation and WTP 70
Lower starting prices DBDC and WTPs 72
Higher starting prices DBDC and WTPs 77
V. SUMMARY AND CONCLUSIONS *82*
References *85*
Appendix *95*
Survey questionnaire *95*
The awareness of GM related terms between our study and 2002 study *101*
The acceptance of different GM products. *102*

I. INTRODUCTION

Rice is a key, staple food in China and much of Asia. Approximately three billion people depend on rice as a basic source of food (Redoña et al. 2004). Sixty percent of the Chinese population relies on rice as their main food grain. Approximately fifty percent of farmers cultivate rice as their main farming activity. Compared with the 1950s, where it was the beginning point of boosting rice production, the cultivated area of rice has grown 12.1%, the yield per hectare has increased by 226% and the total production has risen by 265% (Wang et al. 2006).

Even though China is the largest rice producing and consuming country, it continues to face a gap between national supply and demand. Based on the history of China including the famine of the late 1950s (Ashton et al., 1984), food security has been an important concern for policy making. Even though there are well documented reports which imply that bio-technology has made substantial contributions on rice growers' income growth (Pray et al., 2001), the need for increased rice production is still essential. According to Rosegrant's estimation, "the cereal production in China must keep rising to about 40% to meet the needs of demand of the national population in 2020" (Rosegrant et al. 2001). Meanwhile, the fragmented rice growing patterns, the degradation of soil fertility in cultivated land, the over-applied fertilizers and pesticides, the shortage of water resources and the loss of rural labor due to population urbanization have put pressure on agricultural production as well.

The challenges of Chinese agriculture

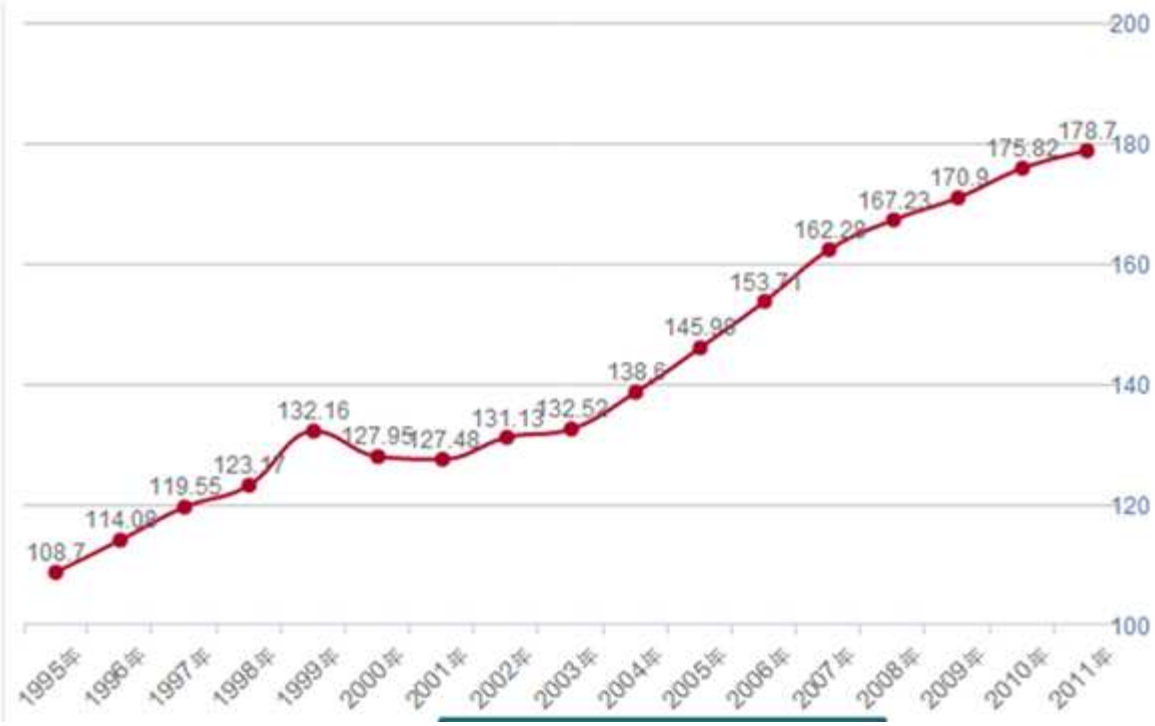
Chinese agriculture is characterized by small farms. Also, with the fragmentation of land ownership, the average size of farms is decreasing throughout the country, and the number of small-size holdings increased significantly. In 1999, the average farm cultivated 0.53 ha, that was spread over 6 separate plots. These small-scale farmers play an important role for food security and poverty alleviation however this fragmented production system could not fulfill the rapidly expanding national demand. (Fan et al., 2005, Tan et al., 2006)

Chinese *Mollisols* (also called Black soils) account for a total area of 7 million ha, and the cultivated area in the region is 4.4 million ha. However, due to intensive cultivation, soil organic matter (SOM) loss, and soil erosion, associated with yield suppression has been a serious problem threatening the future sustainability of Chinese agriculture in the region (Liu et al., 2006). The annual SOM loss rate is 1.8%, the erosion rate is 1.24–2.41 mm/year, and soil loss in 1° to 5° sloping farmlands is 220.5 t/ha/year, respectively.

Compared to world averages of fertilizer and pesticide application levels, excess agrochemicals and chemical fertilizers were applied to rice fields in China. In 2000, the fertilizer usage per hectare in China reached 339 kg which exceeded over 40% of the standard level 225 kg/ha published by FAO; and application rates have continued to increase over time (see Figure 1.1). The amount of fertilizer application in China is 9 times higher than in Russia and 2.4 times higher than the U.S; however, the total utilization (plant uptake) is less than 30%.(Widawsky et al., 1998) In addition, the average amount of pesticide application in China keeps increasing; the annual usage of pesticides in China exceeded 120 million tons in 2004, which is 4 times higher than 2000. The China National Environmental Monitoring Centre reported that there are 430

million tons of wasteful application of pesticides per year, which has brought predictable damage to the ecosystem.

Figure 1 Annual pesticide usage in China (million ton)



Source: “Annual Pesticide Usages in China (mt)” National Bureau of Statistic of China, last modified November 8, 2013,

Water supply and sanitation in China are facing a number of challenges due to water scarcity, contamination, and pollution. Agricultural activities, which account for 62 percent of the country's per capita water usage, exceeds by more than one-quarter of the world average. China's total water consumption also takes a serious toll on China's water supply, where 65% of the total agricultural water usage is applied to rice cultivation. Nevertheless, according to the published records by China National Environmental Monitoring Centre, a large amount of pesticides and herbicides leak out of agricultural fields due to inefficient agricultural activities. Along 92,100 km of waterways, 49.7% have been contaminated with chemicals and the water in 11% of those failed to meet the quality requirement as an irrigation resource. (Sun et al., 2000)

With the expansion of employment in rural enterprises and the urban sector, the labor force available for farming has become scarcer in many areas of the eastern and coastal regions of China; as a result the farming sector has become a part-time job. This transaction has negative impacts on the environment due to the substitution of chemicals for labor. (Huang and Rozelle et al. 1996) Huang stated in his paper that the lack of labor may lead to improper allocation of pesticides.

In conclusion, the conventional rice cultivation patterns bring some negative consequences to the ecosystem and to production costs. The agricultural acreage in China is less than two thirds of the United States, however, the usage of pesticides is many times higher (Huang et al. 2005), which causes water pollution problems and degrades soil quality. The traditional growing patterns of rice still rely on manual labor; the high frequency of pesticide and fertilizer applications drives up the production costs.

Chinese GMO Developing Situation

Some scientists believe that the bio-technological cultivation method can provide increased productivity and ease environmental pressures (Ming et al., 2004). Ming believes that bio-technology could potentially fix the controversy between improved productivity and ecosystem degradation, and accelerate the development cycles of high-quality genes. China has to rely on rising productivity and more environmentally friendly production systems. To increase yield production, reduce water pollution and efficiently allocate land resources, the Chinese government has attached great attention to bio-technological improvements. The development of new GM crops has been listed as one of the 16 major projects in The National Program for Long-

and Medium-Term Scientific and Technological Development 2006-2020 (PRC. State Council, 2006). There is ￥24 billion ($375 million) special funding for GM rice strain research. [1]

Currently China is one of the largest producers of bio-technology enhanced plants and it has dedicated substantial resources to the development of modern bio-technology (Lakhan.et al. 2006). Since 2004, northern and western China where most of Chinese cotton is grown has *Bt* (Bacillus Thuringiensis) cotton cultivated acreage on more than 90% of the total cotton acreage. By 2009 the growing area for *Bt* cotton nationwide had reached 3,800,000 hectares, which occupied 70% of total cotton growing land. With a high adoption rate of 7.5 million small farmers, Huang stated in his paper that Chinese *Bt* cotton cultivation could be marked as the most successful case in terms of productivity, incomes, equity and sustainability. Among all impact factors, the highly developed agricultural research systems has contributed to the lower cost of *Bt* cotton seeds by independently producing two transgenic constructs that confer insect resistance. Lower costs and marginally higher yields drive a large net profit gain in China. The large scale grown *Bt* cotton has brought an economic profit of over ￥59 billion. (Jiang et.al.2011)

The GMO product available for food processing in the greatest quantity is GM soybeans, of which over 50 million tons were imported during 2011. Imported GM soybeans are mainly used in food processing to make food oil and for livestock feed. (Tan et. al. 2013). The Chinese Ministry of Agriculture has issued import safety certificates for five varieties of GM soybeans, all of which have passed through strict environmental and food safety assessments, allowing

[1] The State Council of the People's Republic of China. (2006). The national medium- and long-term program for science and technology development (2006-2020).

them to be approved and imported. These safety assessments indicate that the five GMOs approved for import have the same level of safety as their non-GMO counterparts.

There has been almost no commercialization of GM rice. Only a small set of countries have extended GM food crops and most of these have done so in a relatively minor way (James et al. 2002). James reported that at present bio-technology is primarily used for industry. Because of government indecision, biosafety regulations, consumer resistance and trade concerns, Iran and the United States are the only countries that have approved the commercialization of GM rice. However, due to consumer resistance to GM products and the rising cost of commercializing new products, no commercialization has occurred and most of the private research sector is cutting back on development as well; such as Monsanto, Syngenta and Bayer (Rozelle et al.2005).

Currently, there is an active debate on when and how China should commercialize its *Bt* rice. The latest released policy from the Ministry Agriculture of PRC indicated that *Bt* rice is forbidden to be commercialized within the short term. However, the trial research for GM rice has shown positive economic and health results. (Huang et. al. 2010)

In the past 20 years in China, numerous *Bt* rice lines have been developed and the first field tests took place in 1998. By the record of the Ministry of Environmental Protection of the PRC, the main institutes for the development of *Bt* rice in China are public institutions: Institute of Genetics and Developmental Biology, Chinese Academy of Science, Fujian Academy of Agricultural Science, Huazhong Agricultural University, and Zhejiang University. Public research expenditures on GM rice in China increased from 8 million Yuan (US$1.18 million) in 1986 to 195 million Yuan (US$28.68 million) in 2003. In 2008 the National Science and

Technology Major Project of the China announced the development of GM crop strains to be one of the long term projects.

On October 22, 2009, China's Ministry of Agriculture issued two biosafety certificates for commercial production of *Bt* rice lines Huahui No.1 and Shanyu 63 in Hubei province. A Chinese Academy of Sciences (CAS)trial research indicated that the two new varieties of GM rice, *Bt* Xianyou 63 and Huahui No.1, have made considerable progress in lowering input costs, reducing labor intensity, reducing the need for insecticides and their harmful effects on beneficial insects (Huang et al.2010). It is been reported that based on the filed data in Hunan and Fujian provinces, the *Bt* Xianyou 63 varieties could save up to 60% of pesticide input application per hectare and release nine working days of pesticide application (Huang et al., 2005).

The second generation of Golden rice was developed with health attributes desired by consumers rather than producers (Rousu et al. 2005). Golden rice is known as containing more vitamin A than conventional rice. It is designed to produce beta-carotene which is known as a precursor of vitamin A. Using a gene that produces beta carotene, results in the milled rice having a golden color. This variety was genetically modified to combat the vitamin A deficiency (VAD) in countries where rice is the main staple food. VAD can cause temporary or permanent blindness, increase the rate of child night blindness, also children and pregnant or lactating woman with VAD tend to have a higher mortality. During the past decade, government and medical agencies have invested considerable effort on various policies to reduce VAD. Scientists have a high expectation that Golden rice will be a useful approach to address vitamin A intervention in Asia. Golden rice could be easily adopted in the existing rice growing areas and it could sustainably address VAD with minimum additional expense. Anderson et al (2005)

estimate the welfare gains from the introduction of Golden rice, with a 45% market share in Asia, its introduction would lead to $17.4 billion annual welfare gain.

GM Rice debate

The controversy in China of whether GM rice should be commercialized is large. Public opinion is characterized by anxiety due to a lack of GM rice knowledge, and the asymmetric information delivered by social media not based on scientific information or simply just the fear of the unknown. Twardowski et al. (2010) noted that the expansion of the new insect resistance gene may interrupt the ecosystem by raising the chance of modified gene transfer during pollination. However, scientists hold the opposite views and believe that GM rice systematically cultivated has not yet reached a 1% escape level which is the threshold of "Gene Contamination" determined by international cereal trade. (Shelton et al., 2002; Messeguer et al., 2004; Chen et al., 2004). The low frequency of gene flow of GM rice at this point makes it difficult to evaluate if gene escape will be unpredictable or irreversible into the ecosystem.

Based on the lessons from the case that Mexico GM maize contaminated the native varieties in 2004, some scientists suspect that low frequency gene flow through outcrossing are inevitable, and it is yet to be decided whether large scale production of GM rice would further harm the gene diversity (Lu et al., 2003; Chen *et al.* 2004; High et al., 2004). The fast self-renewal and rapid adaption of the Bt protease inhibitors would trigger target insects resistance to the *Bt* gene. Whereas in the long term perspective, more harmful insecticides would have been used instead. (Benbrook et al., 2004; Snow et al., 2004) The non-target organisms including beneficial species may potentially be killed by the Bt protease (Losey et al., 1999, Hilbeck et al., 2001). Some scientists suggest that long tern impact of GM crops on biodiversity and soil

microbial population should be more adequately researched (Saxena et al., 2002, Wu et al., 2004).

For the economic impact, Fu et al. (2012) in his paper did a risk-return analysis of each stakeholder of the rice trading system. He indicated that as long as short-term profit exists, farmers will hold a positive attitude to adopt GM rice; from the perspective of consumers, due to the low price elasticity of rice demand and safety concerns, it may be difficult to determine their attitude. For both seed companies and domestic rice dealers, the attractive return on investment will trigger great interest for them to enter the GM market if it exists. However, due to diversity of food safety standards and labeling policies, the international rice dealers should be concerned about the high upfront investment issue.

Yang and Li (2006) estimated that *Bt* rice commercialization would bring $3 billion welfare improvement to both producers and consumers in China. With 70% and 50% adoption rate of GM rice, the total welfare will be raised to $2.65 billion and $1.98 billion in 2015. The European Union, Japan and other countries have already issued trade barriers against GM rice, therefore the welfare gains to the world rice market are not significantly influenced. It is worth noting that with higher productivities through lower input cost, wide production of GM crops may precipitate the reallocation of land and other resources for other alternative agricultural products to expand profit.

To provide assistance, protection and to regulate the market, the government of China has attached great attention to GMO development over the past 30 years. During the 1980s, 130 projects were focused on GMOs, 90% of the current field trials are targeted on pest resistance or virus resistance (Zhang et al. 2003). Along with the growing number of research projects, the

government of China released a series of regulations and policies to provide rules and bio-safety regulations for the market. The first biosafety regulation for GMOs in China was issued in 1993 by the Chinese Ministry of Science and Technology. Since then, regulations have been updated and revised, with the latest version issued in 2006, followed by six other regulations issued by other political sectors. In 2009, "The provisions on the administration of food labeling" was issued by the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (AQSIQ). This labeling policy clearly stipulates that any product which contains GMO or related GMO materials must be labeled before transfer to the market. The latest 12th five year plan on national economic and social development in China (2011-2015) has attached great attention on innovation and application of biotechnology breeding. Based on the 12th five year plan and other plans, the Ministry of Agriculture (MOA) released annually transgenic major project regulation to supervise and assist on the development of biotechnology breeding and application. Although the current regulations on agricultural GMOs in China are comprehensive and elaborate, criticisms and challenges exist.

On the other hand, a series of studies have shown neutral or opposed attitudes of China's consumers for GMOs. Zhong et al. 2002 even stated that due to the lack of information, Chinese consumers' attitudes toward GMO is very vulnerable and they are easily influenced by the media environment. The Chinese Center for Disease Control and Prevention (China CDC) under orders from the Ministry of Health of Children in central Hunan province found that dozens of children were used in 2008 as test subjects in a US-China joint research project that included GM Golden rice in 2012. The China CDC reported on Dec 7, 2012, that a scientist and an official from the Zhejiang Academy of Medical Sciences used the academy's stamp to renew the ethical review which had expired due to the fact that information was withheld from parents of the children fed

golden rice while signing the papers permitting their children to take part in the tests. The media defined this research as “a typical case of a scientific experiment conducted by unethical means with illegal procedures. (China Daily, Dec 27 2012)”. This debate lasted for over three months, and it has likely given Chinese rice consumers a relatively aggressive and negative attitude toward GMO.

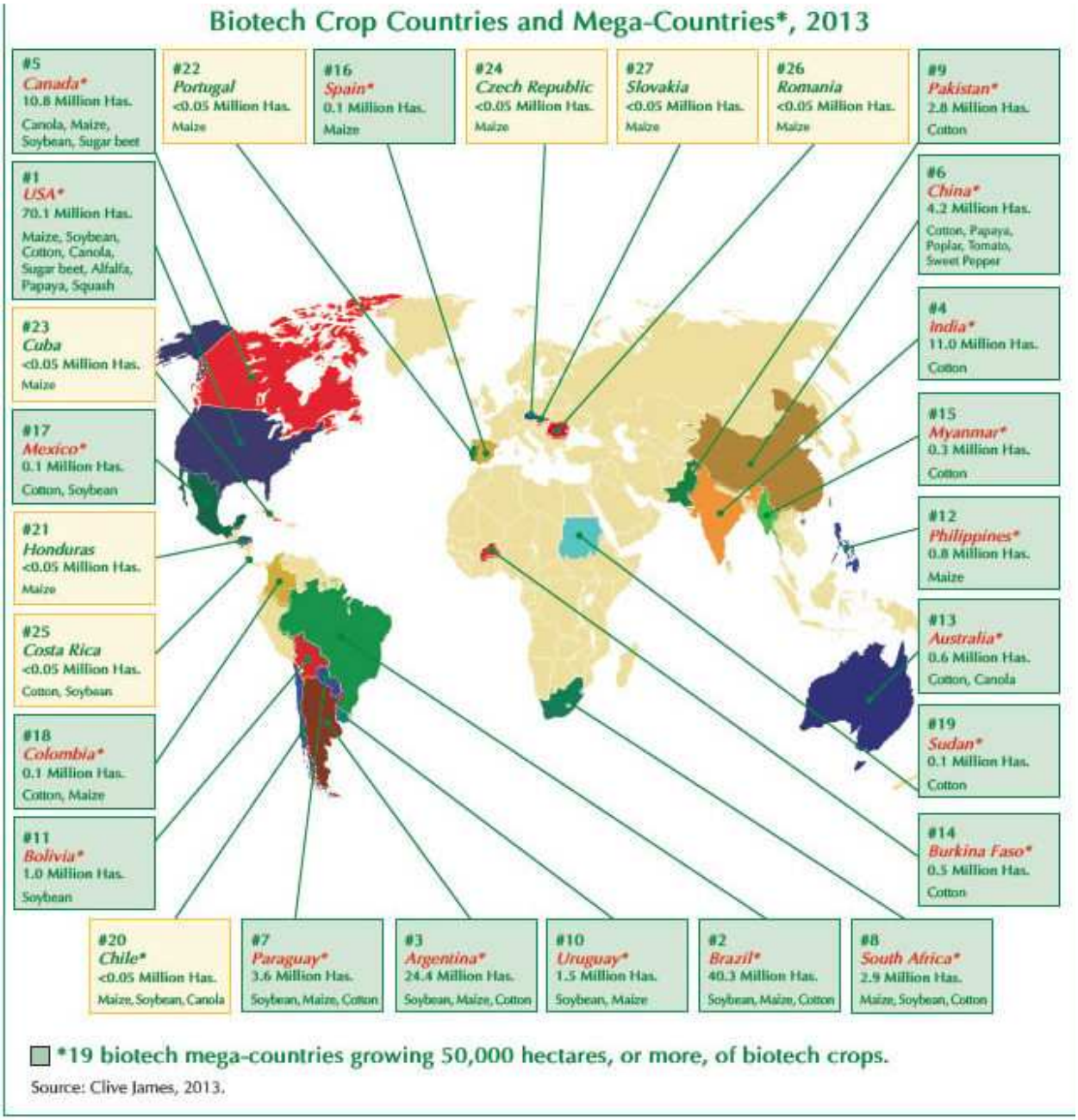
Because of the above controversies, it is necessary to conduct research regarding consumers’ attitudes and their willingness to pay for GM rice based on different information shocks. The purpose of this thesis is to measure consumers’ willingness to pay (WTP) for GM rice. The study also includes a comparison of the results with previous studies of Chinese consumers’ WTP and attitudes. The analysis is based on cost benefit and social perspectives to better understand the barriers to GM rice commercialization in China. The following sections provide a review of the previous studies on both consumers’ willingness to pay for GM rice and the methodological use of choice experiment. Because GM rice has not been released for commercial production in the survey area, double bounded dichotomous choice contingent valuation was chosen as the hypothetical bidding method to obtain the willingness to pay of the rice consumers. To avoid hypothetical bias that might occur during the auction, the value of a cheap talk text was evaluated.

II. LITERATURE REVIEW

Global status of GM crops

It has been two decades since genetically modified crops were first sold commercially globally. In terms of cultivated area, GM soybeans are the most widely grown GM crop, according to the ISAAA report (James, 2012). Seventy-nine percent of global soybeans cultivated hectares were planted to GM soybeans. GM soybean varieties had impressive economic benefits ($32.6 billion) for the soybean growers for the past decades. GM cotton also is widely adopted and contributes to higher profits from production as well. In 2013, seventy percent of the world's cotton cultivated area was GM cotton cultivars that were insect resistant and herbicide resistant, covering over twenty-four million hectares. Most of the GM cotton is grown in India, the US and China (James, 2012). GM maize and canola are the other two GM crops which dominate the global market. Seventeen countries planted GM maize in 2012, the total acreage has reached fifty seven million hectares. Based on Clive James' annual report of the status of global GM products and the analysis released by the GMO Compass, it is very clear that the total acreage of GMO cultivation has consistently increased since 1996 when it was first introduced onto the market. Figure 3 shows the global status of commercial GM crops.

Figure 2 Global Status of commercial GM crops.



Impressed by the economic benefit generated from *Bt* cotton cultivation, the Chinese government has given great attention to other genetically modified crops. Starting from the late 1980s, rice scientists were provided with two to three million dollars per year. Huang stated in his paper that by 2003 there were nearly 24 million dollars allocated to rice institutions (Huang et al 2006). *Bt* rice was characterized as resistant to several rice pests and diseases such as stem borer. In addition to constant investments in the research projects to stimulate development of variety innovations, the Ministry of Agriculture of China also ratified and provided field trials for further producing rice varieties with pest resistance. The bio-safety certifications for trial production were issued in 2009; however, because of the public concerns of food safety, and the contentious social media environment, so far there has been no authorization for commercialization of any GM rice variety.

A significant body of literature provides estimates of the economic impacts of GM crops adoption and the literature implies that wide adoption of GM rice will boost farmers' welfare. (Zhong et al.2003;Yang et al 2006; Huang et al 2008; Qiam et al 2009; Fu et al 2012). Based on the data collected from the China National Rice Research Institute 2008, Tan et al. (2011) pointed out that there are significant decreases for input costs, and direct health advantages for farmers of *Bt* rice cultivation. Rice grower's acceptance of Bt rice are primarily affected by the profitability, and commercial production of GM rice should be easy to popularize among smallholder farmers. The implications of the commercialization of GM rice could far exceed the effect on its own producers and consumers. Zhu et al. (2011) determined the factors affecting cognition of transgenic technology and adoption of GM rice by farmers in her research in 2011. She divided the factors into endogenous and exogenous groups. Among all the factors, the farmers' age and a having a second job were factors estimated with negative effects on the

farmers' willingness to adopt GM varieties. However, educational level, years of producing rice, family income, total acreages of their arable land, and the number of family members were estimated to be positively associated with GM rice adoption.

Huang et al. (2003) analyzed the economic impacts of GM crops using the GTAP (Global Trade Analysis Project) model. Their framework estimated different scenarios with regards to domestic production of *Bt* crops and international trade with specific attention on import trades and labeling issues. They assumed that with respect to the same adoption rate as *Bt* cotton, the supply price for rice will decrease by about 12% due to cost reduction, and the total welfare will increase by 4155 million USD.

To test the producers' favorability towards adoption the new varieties of *Bt* crops, some scholars have conducted research from the perspective of obtaining higher yields and lower costs. Qaim et al (2003) concluded in their paper that the main factor for *Bt* crops was the cost reduction through less pesticide application, less labor expenditure and less capital expenditure on equipment. Their paper also provided experimental evidence about responses to potential yields improvements, insecticide use reduction and higher income margins based on previous research on *Bt* cotton and *Bt* maize over different countries. The environmental release field trials showed that under the presence of natural and induced attacks of leaf roller and yellow stem borer without pesticides application, the production from the *Bt* variety Xianyou 63 trait was 28.9 percent higher yielding than the non *Bt* variety (Tu et al., 2000). Huang et al. investigated the impacts of GM rice on rice farmers in 2007. They used data collected from rice trial farmers from 2002 to 2004 and indicated that in regards to different variables, there are significant differences in pesticide usage and farmers' perception on yield loss between GM and non-GM cultivation. The data showed that the pesticide application of *Bt* rice trials is

14.42kg/hectare whereas the usage of pesticide in non *Bt* rice trials is 23.5kg/hectare. *Bt* rice adoption could not only save up to 61% of pesticide use but also increase yields by 9-11%. They claimed that Bt rice cultivation would save input costs for farmers; along with Fu's conclusion they assumed that farmers will have positive attitude toward the new varieties as long as there are economic benefits.

WTP studies about GMOs

From the perspective of consumers' acceptance, very little research has been done on *Bt* rice; however, many scholars have studied the WTP of consumers with regards to other GMO traits. Huffman et al. (2001) first researched WTPs for three transgenic foods with different information provided in two cities in the US. Their research showed a 15% negative price difference between food produced by genetic modification methods and conventional food. A study in France by Noussair et el. (2004) estimated an approximate 30-37% lower price difference for GM biscuit and chocolate bars compared to non-GM products. They also analyzed the labeling effect on GM; when emphasizing the GM label, the WTP displayed a decrease of up to more than 20%. In subsequent research by Huffman and Rousu (2007) focused on consumers' behavior, they reported a 14% price premium for non-GMO food and a higher reduction of the WTP for the GM products (35%) if the bidders are only informed by environmental organizations. Huffman and Rousu (2007) declared the results varied significantly with the information received by the respondents. They also suggested that uninformed consumers are affected more than informed consumers by information treatment.

Li, Curtis, McCluskey, and Wahl (2003) concluded that Chinese consumers, on average, were willing to pay a 38% premium for GM rice over the non-GM alternatives. They found that the price elasticity of demand for GM rice is relatively low. For the high-income group in China,

the ratio of rice consumed to the total diet is relatively small compared to other income groups; therefore compared to the low-income population, there is little effect on the high-income group's welfare by using bio-technology to reduce input cost and lower the market price of rice. Conversely, most survey respondents were willing to try genetically modified foods, and the willingness to purchase genetically modified foods was higher among those who felt they did not have adequate or high quality foods available at home.

Curtis, McCluskey, and Wahl (2004) have identified three main factors affecting risk perceptions: government regulation, media coverage and attitude toward science. They conclude that government-controlled media coverage in China concerning genetically modified crops has been very positive. Fifty-four percent of their subjects claimed to have no knowledge of genetically modified products at all, and only 7.8% associated high risk with genetically modified foods. Additionally, 64.6% of the respondents considered advertising in their food choice decisions. However, recent studies in China found that the consumer acceptance of GM food has declined from 80% of 2005 to 40% in 2010 (Fu et.al, 2012).

There have been an increasing number of studies on consumer attitudes toward bio-technology foods in China. Previous surveys suggested that the majority of Chinese consumers have favorable or neutral opinions about bio-technology. Li et al. (2003) conducted a small survey to obtain the WTP for bio-technology in Beijing, China. Product-enhancing bio-technology would be more likely to gain a price premium of 43.9%. Zhong et al. (2003) stated that Chinese people know little about GM food. Regardless of their knowledge, forty percent will buy GM food without dramatic reports of disasters. Ho et al. (2006) demonstrate that most Chinese consumers lack the most basic understanding of bio-technology and its potential risks. The majority of the respondents (60%) were either unwilling to consume GM food or were

neutral about the idea, but when given "neutrally-worded" information about potential GM food allergenicity, the willingness to purchase dropped sharply. Huang et al. (2008) estimated the labeling effect for GM product and found the same result as Li et al., for 60% or higher of respondents, bio-technology and non-bio-technology foods are perfectly substitutable, 20% of the respondents would not buy any bio-tech food and 20% would buy it with a price discount. Using the same survey data set Huang collected in 2002-2003, Lin et al. surveyed consumers' attitudes about *Bt* rice. They found that the acceptance towards GMO rice is relatively high. Lin et al. (2006) also found that the majority of survey subjects had little knowledge of GM food. De Steur et al. (2010) did a semi- hypothetical experimental auction about folate enhanced GM rice in Shanxi province, specific to female consumers, and found they would pay a premium of 33.7% for nutrient enhanced GM rice.

In general, the previous studies indicated that commercialization of GM rice in China is relatively easy to carry out and the rice grower will be benefit from this with respect to higher profit and health improvement. Many studies showed that China consumers lacked GM knowledge but held a positive attitude toward GM rice. However, the literature over time has discerned less favorable acceptance and increased knowledge on GM rice.

Consumer attitudes and Information effects

Besides the willingness to pay, some scientists are also curious about what are the factors that determine consumer attitudes toward GM food. Costa-Font et al. (2008) summarized an extensive amount of literature about consumers purchasing decisions of GM food and provided a systematical logic framework to understand the underlying process of consumer behavior when introduced to GM food. They divided factors into three dimensions which would affect consumer's attitude when they are making the purchase decisions. These dimensions include 1)

risk and benefit perceptions of consumers and how they were weighted while making purchase determinations; 2) individual belief, perceptions and attributes such as environmentalism; and 3) knowledge of products and how consumer value the information sources. It is not surprising that geographic region, the social media environment and demographic characteristics play important roles for decision making. For instance, the majority of the studies which were conducted in Europe show a general negative attitude to GM products, whereas Lin's study in China found that 46-47% of all respondents were supportive of bio-technology food; in contrast 5-15% of urban consumers in the survey were opposed to bio-technology food. (Lin et al. 2006) In addition, education, income, moral considerations, age, gender and other socio-economic characteristics were found to have direct relationships with consumer's acceptance of GM food as well. (Costan-Font et al.2005; Loureiro et al.2004; Veeman et al.2005; Siegrist et al. 2000)

Information provided to consumers when they were first introduced to GM products can have an impact on their purchasing decision making. Tegene et al. (2003) introduced biotechnology information to survey respondents in negative, positive, and combined (both negative and positive) perspectives. They found that consumers whom received only negative information about biotech modified food offered 35 percent lower bids compared with conventional food; those who had combined negative and positive treatment offered 16 to 29 percent lower price with regards to regular food and when the respondents were only given positive information, they bid higher. They found their results to be consistent with Fox, Hayes, and Shogren et al (2002) that consumers place a greater weight on negative information than on positive. Lusk et al. (2004) conducted a survey which covered three states in US and two countries in Europe. Their subjects were provided information about GM food with environmental benefits, health benefits, and benefits to the third world, and the consumer

reactions varied with regards to type of information and locations. They found that positive information about GM food significantly affects the demand of consumers in all of the locations but France; they also found that objective knowledge and prior attitudes of consumers have significant effects on their willingness to pay. Rousu et al. (2005) conducted research on market information and labeling information effects on consumers' WTP for genetically modified tobacco. With market information provided, the absence of a GM labeling has no impact; without market information provided, tobacco with GM labeling leads to a lower WTP. Their result indicated that positive information reduces the discount consumers placed on genetic modification. Huffman et al. (2007) studied how prior knowledge would affect the interpretation of new information. They found that participants with prior knowledge of GM discounted GM-labeled food products more heavily than without prior beliefs. With negative information provided, participants discounted most heavily for GM-labeled products, however, with positive or two-sided information provided, there was no statistically significant difference between the bidding behaviors.

More recently Corrigan and Nayga et al. tested information effects on Golden rice in 2009 by providing four types of information: negative, positive, two-tail and no information. Their findings showed inconsistency with regards to Tegene et al. They declared that the subjects whom have been provided with positive information have the highest mean WTP, followed by those who received no information; the mean WTP for two-tail information treatment took the third place, and the lowest mean WTP belongs to respondents given the negative information treatment.

The format of the benefit and risk information provided has an ambiguous effect on consumers' willingness to pay estimate. Crowley et al. (1994), encouraged subsequent scholars

to use the two-sided format for the information shock (i.e. positive and negative information). They asserted that to offer two-sided information would enhance credibility, reduce counter-arguing and generate attitudinal resistance to attack. The two-tailed information format is more persuasive than only one-sided information. However, Fox et al. (2002) reported in his study that the two-sided information treatment unexpectedly generated lower mean and median WTP than the no information treatment. They explained this phenomenon as when participants were faced conflicting information, the negative one dominated the positive one, and led to a consequential decrease in the willingness to pay values due to loss aversion type behavior.

Media effects

Besides the information effect, some scholars believe that social media discourse and level of trust in government are both factors which affect the purchase decision making of consumers. Curtis et al. (2004) stated that if people have trust in government their new food acquisition and food consumption will be regulated in a very positive way. Chou et al (2007) found that government-controlled media coverage in China has been very positive towards GM food. Only 7.85 % of respondents indicated they felt high risk related with GM technology. The Chinese government has a great ability to influence people's attitudes toward GM food by their widespread and dominant role in the media. Chou et al. (2007) estimated the effect of a trust barometer of government controlled media on consumer behavior by using data collected over 11 cities from China in 2002. Their results showed that most of the urban consumers have relatively strong faith in government controlled media, and only thirteen percent of their consumer sample presented a doubtful attitude toward government administration when it announced information about agricultural bio-technology. They believed that the confidence level of government public management capacity will significantly improve consumer

acceptance of genetically modified food. Chou's result was consistent along with a previous study by Qui et al (2006), who reported that about 25 % to 40% of the consumers were found to have either neutral or undetermined attitudes towards GM food, and the trust of government influenced the acceptance of GMO in a positive way. Qui et al (2006) considered this finding as an important factor for future GM market. They concluded that with more government effort on pursuing the development of GMO, consumers' perception of GMO can be potentially altered.

Contingent Valuation Method

No current policy in China has provided for the commercialization of GM rice. Therefore to avoid deceiving auctions and to obtain a more precise result compared to several previous studies, an elicitation mechanism which allows researchers to create a hypothetical market has been applied to acquire the willingness to pay from the subjects in previous studies. Unlike the experimental auction procedure where actual products are demonstrated to subjects and each individual makes a consequential economic commitment, the contingent valuation mechanism estimates reflect hypothetical transactions with respect to whether people are willing to pay if the given situation was presented in a real, well-functioning market. It is more of a situation associated with building a hypothetical market which the bidding process does not provide incentives for respondents to make their valuation decisions; it involves people hypothetically rating, ranking, or choosing between competing products or alternatives. The approach was first introduced by Ciriacy-Wantrup et al. (1947): to estimate the monetary value for externality benefits generated from soil erosion prevention. They came up with the idea that one could elicit an individual's WTP for public good benefit through surveys. However, Davis et al.(1963) was the first one who put the CVM into practice. They applied a CVM survey on goose hunters to appraise the benefit of goose hunting. Because CVM is a simple, flexible and non-

market elicitation, it has been widely used in cost benefit analysis and environmental assessment and a large number of refinements have taken place ever since. (Hanemman et al. (1991), Smith et al. (1992), Cameron et al. (1994) Carson et al. (2000), Hausman (2012) and Haab et al. (2013) have published papers that discuss the controversies and evidence for and against contingent valuation including hypothetical bias, willingness-to-pay and willingness-to-accept gap. Haab et al. point out that useful CV analysis depends heavily on careful survey design and implementation. Arrow et al. (2003) provide a case study NOAA panel has made its reputation as the guide light of how to conduct more precise contingent valuation surveys.

According to the contingent valuation literature, to estimate the economic value of public amenities or hypothetical commodities, use of dichotomous choice models has become a standard practice. A random sample of individuals are asked if they will pay a certain amount of dollars for a hypothetical good or an assumed change in the availability of a particular public good. The yes/no answer of each subject along with the bid amount reveal whether the consumer's maximum WTP is greater or less than the bid amount. To improve precision, the double-bounded approach was developed by researchers as one of the elicitation formats. (Carson et al., 1985). This procedure asks respondents whether they are willing to pay some initial bid amount, and then a follow up question with a higher or lower bid amount will be asked based on the response to the first bid (a higher bid for a yes response and a lower bid for a no response). With this procedure, each participant bids twice, and it is easier to put the subjects' responses into four categories: Yes Yes; Yes No; No No; and No Yes. Hanemann et al. (1991) and Kanninen et al. (1993) both stated that the double bounded procedure has more statistical efficiency and is more reliable when explaining the consumer's preferences and market type. The double-bounded dichotomous choice model has become more and more popular in the

contingent valuation research. However, a number of projects have suggested disadvantages of using this approach. Tversky et al. (1974) pointed out in their paper that using the double bounded format would easily trigger bias, namely starting point bias known as an anchoring effect. From a psychological perspective, when people are unconfident about their valuation decision for a hypothetical good, they might anchor their assessment to the available information provided. Therefore during the survey, there is the chance that subjects will value the good based on the initial bid, subsequent payment questions or fixed reference prices.

Generally speaking, the fixed initial bid amount provides a crucial point for the uncertain respondents to alter their original bids, and therefore provides the researcher with deviate WTP information. Ignoring the starting bid bias, the estimated mean WTP will potentially be drawn to the initial bid amount, and the dispersion of the WTP of the sample population will be narrowed due to the redefined WTPs from the confined boundaries of bidding format. To avoid starting point bias, Arrow et al.(1993) suggest using different prices or references to start the first bid, and then follow up with compiled second bid prices.

The majority of studies suggest that hypothetical bias is a significant problem in contingent valuation estimates. Hypothetical bias arises due to the hypothetical nature of the market in CVM surveys which can render respondents' answers meaningless if their declared intentions cannot be taken as accurate guides of their actual behavior. List and Gallet et al. (2001) conducted a meta-analysis of 29 studies containing 58 valuations and found that average subjects overstated their preferences by a factor about 3 times higher in hypothetical settings. Cummings, Harrison and Rutstrom et al. (1995) conducted research to study the percentage of yes responses to purchase questions for three products with and without CV methods. They found that with the hypothetical framework, the yes responses were generally higher compared to actual market

framework. This provides strong evidence of the existence of hypothetical bias. For lessen the impact of such bias, it is essential to use a technique that relies on the assumption that although responses to hypothetical CV questions may be biased, consumer responses provide useful information about true economic values. To correct for hypothetical bias several calibration procedures have emerged in the literature.

Calibration method

There are several ways to calibrate hypothetical bias in contingent valuation. A statistical function can be used to calibrate the data. Shogren et al. (1993) introduced a calibrated process which compiled a statistical function which related to hypothetical values for a product via a CV survey and the real value of the product through a lab section via an auction. They suggested that by using this function, one can correct the values of the survey respondents that did not participate in the auction. Another way of calibration is to include "no answer" or "don't know" as an explicit option, this is known as the uncertainty adjustment method. (Murphy et al. 2005). Oath taking is also a calibration method, where participants were asked to sign an agreement which requires them to admit that all of their answers are honest (Carlsson et al. 2013). Recently scientists have developed a technique called "honesty priming" that implicitly stimulates certain behaviors unconsciously which allows people incidentally exposed to some cues or words in an unrelated subsequent choice task. These stimuli can activate actual buying goals, thereby influencing the participant's subsequent decision in a non-conscious manner. Magistris, Gracia, Nayga (2012) studied the effectiveness of honesty priming in Spain; they confirmed that the honesty priming task reduces the hypothetical bias in the CV method. The most popular calibration method is called cheap talk. There is a solid background of literature (Carlson et

al.2011; Mahieu et al .2012; Tonsor et al, 2011) which applied cheap talk scripts in their surveys, however, the robustness of this calibration method remains ambiguous.

Cheap talk was first introduced by Cummings and Taylor (1999), and subsequently used by Lusk (2003). Cheap talk is an ex-ante calibration technique in which the researcher attempts to elicit unbiased responses by reading a script that draws respondents' attention to the hypothetical bias. It illustrates the importance of not only establishing that a calibration technique works, but also developing an understanding of *why* it works. By demonstrating a paragraph before the bidding process, participants were asked to simulate their actual purchasing behavior if the product was available in real market and evaluate the product value. Blummenschein et al. (2008) found that cheap talk is most effective only for certain types of respondents. Lusk et al. (2003) claimed that cheap talk had no effect on experienced subjects but reduced WTP for inexperienced subjects. Aadland et al. (2006) documented how cheap talk reduced WTP most for those stating relatively high WTP, members of an environmental organization, and those with graduate degrees.

The evidence of the robustness of cheap talk is very mixed. Taylor et al. (1995) found it helpful in their study, but Cummings et al..(1999) found that a shortened version of the script was not effective, but a lengthier script similar to that used by Cummings and Taylor in 1995 was successful. Similarly, Poe, et al. 2002) found that decisions were not changed significantly by a short script. List et al. (2001) reported that the long script was only effective with inexperienced participants but not experienced ones; both Lusk (2003) and Aadland and Caplan (2003) report similar results. Brown, et al. *(*2003) found that high WTP payment amounts are significantly affected by the long cheap talk script. Brummett, Nayga, and Wu (2006) reported no evidence of cheap talk effect on WTP study for irradiated mangoes.

An increasing number of researches have been conducted to study consumer acceptance, valuation and willingness to pay towards GM food. Hypothetical bidding method (contingent valuation) was widely used due to the limitation of market authorizing .For Europeans, there is a reluctance of GM food acceptance, same situation were inspected in China as well. Previous literature has shown that the majority of Chinese consumers do not hold an opposing attitude for GM rice, however, only a slight percentage of consumers had showed interest in consuming GM rice. The relationship between consumer's willingness to pay and the information when first introduced to GM rice has not been extensively studied. We are particularly interested in determining the effect on acceptance and WTP of science-based information on benefits and risks of two genetically modified rice traits that are available for future commercialization: *Bt* rice and Golden rice. This study measures the current attitudes and willingness to pay for *Bt* and Golden rice by China's urban consumers. The study also includes a comparison of results with previous studies of Chinese consumers' WTP and attitudes. The following section will discuss how this survey was conducted and introduce the theoretical framework used to justify the statistical results.

III. METHOD OF ANALYSIS

Hypothesis

The question of whether GM rice should be commercialized in China is an active debate among NGO, and government organizations. As a result this study expects that consumer attitudes towards GM rice are becoming more ambiguous. We assumed that the information about GM rice delivered to the public might be both inadequate and asymmetric, therefore, this study provides the participants with scientifically based, two-tailed information (both benefit and risk attributes) and examine the purchasing behavior in response to different GM rice traits

compared to conventional non-GM rice. Consumer's willingness to pay and attitudes towards products can be elicited in different ways. As mentioned in the previous chapter, no GM rice variety has been authorized to be commercially produced and consumed in China. Therefore the best way to obtain the Chinese consumer's WTP for GM rice without resorting to deception is to conduct a stated preferences test, where a hypothetical market is created for participants to express purchase behavior. In our particular study we create four conjectural scenarios where three of them provide two-tailed benefit and risk information about particular GM rice products and the other one only presents neutral information about GM rice in general. By doing this we estimate whether the consumers' willingness to pay is influenced by distinctive GM attributes/traits and the information on benefits and risks. There are five rice products involved in this survey: 1) Conventional rice which is the reference product; 2) GM rice which has no special attributes and benefit/risk information; 3) GM rice with an environmental impact factor, in this case Bt rice; 4) GM rice with health impact factors, in this case Golden rice; and 5) a stacked GM rice with both an environmental impact and a health impact, in this case Bt plus Golden rice. Because the literature discussed in the previous chapter suggests that the order of information about benefits and risks influences consumer responses, the four GM information treatments are multiplied by a factor of 2 to be able to test the ordering effect of the benefits and risk information. By presenting survey participants with seven information treatments about GM rice products of varying GM attributes and ordering of benefits and risks, we can test if the consumers' willingness to pay changes as a function of the order of information reception.

Ho_1: $WTP_{GN.\ Rice} = WTP_{Btrice} = WTP_{Golden\ rice} = WTP_{s.rice}$ = *Reference price for conventional rice*

Where: $WTP_{GN.\ Rice}$ stands for the WTP for a non-specific GM rice product.

$WTP_{Bt\ rice}$ stands for the WTP for Bt rice with an environmental impact factor.

$WTP_{Golden\ rice}$ stands for the WTP for Golden rice with a health impact factor.

$WTP_{s.\ rice}$ stands for the WTP for stacked GM rice with combined impact factors.

We assume respondents will value the good depending on how they value sequences of information when presented. It is important to test whether the ordering of information influences behavior. Benefit first or risk first could alter the respondents' WTP. In our survey, participants were asked to value one particular GM rice product compared to a reference conventional rice product with both positive and negative information provided. We arranged the information sheet in two different formats: as benefits first followed by risks and as risks followed by benefits. For the general GM rice information treatment, only general and neutral descriptive information about what GM rice was provided, so we could have it as our control. The second hypothesis is to test whether the arrangement of information delivered has an effect on the consumer's willingness to pay and whether the ordering effect of information will have an interaction effect by the four information treatments.

$$Ho_2:\ WTP_{Btrice\ o1} = WTP_{Btrice\ o2;}$$

$$WTP_{Golden\ rice\ 01} = WTP_{Golden\ rice\ 02;}$$

$$WTP_{s.\ rice\ o1} = WTP_{s.\ rice\ o2.}$$

$$Ho_{2\ sub:}\ WTP_{Btrice\ o1} / WTP_{Btrice\ o2} = WTP_{Golden\ rice\ 01} / WTP_{Golden\ rice\ 02} = WTP_{s.\ rice\ o1} / WTP_{s.\ rice\ o2}$$

Where: *O1* stands for the presentation of benefits first followed by risks.

O2 stands for the presentation of risks followed by benefits

$Ho_{2\ sub}$ stands for the hypothesis that the ordering effect is indifferent to the GM traits

The most popular stated preference method which has been used to value hypothetical products is known as the contingent behavior questions or contingent valuation; where individuals are asked how they would change the level of purchasing activity in response to a change in a characteristic (price) of a product**.** Among all of the approaches to conduct a contingent valuation, the double- bounded dichotomous choice (DBDC) experiment has gained a broad acceptance by scholars. It permits the estimation of how changes in individual prices across the choice alternatives alter the respondents' purchase choice. However, due to the hypothetical nature of the market in CVM (contingent valuation method) surveys, hypothetical bias will arise. Hypothetical bias can render respondents' answers meaningless if their declared intentions cannot be taken as accurate guides of their actual behavior. To avoid hypothetical bias, calibration methods as discussed in the previous chapter must be employed. To analyze the effectiveness of calibration, two methods were originally used for our survey: cheap talk script and oath taking. After a pretest, we found that the Oath Taking method conflicted with the orthodox local Chinese culture and it was excluded from our final survey design. The incorporation of a cheap talk script by including one-half of the sample in our survey allows us to elicit the existence of hypothetical bias.

$$Ho_3: \ WTP_{\ mean\ nct} = WTP_{\ mean\ ct}$$

Where: $WTP_{\ mean\ nct}$ stands for the mean willingness to pay for GM rice without cheap talk calibration.

$WTP_{\ mean\ ct}$ stands for the mean willingness to pay for GM rice with Cheap Talk calibration.

Survey Design

In this study we conduct a survey to estimate the WTP of Chinese consumers for GM rice using conventional white rice as a reference. We examine the responses of consumers in the context of objective and subjective prior knowledge of the respondents. Furthermore we test if the WTP estimates are different by different GM rice traits, and the effect of information treatments that provide science-based expressions of potential benefits and risks associated with each GM trait and the order for which benefits and risks are presented to the respondents. Finally, we evaluate the variation in WTP relative to socio-economic variables that are hypothesized to influence consumer acceptance. Because GM rice is not commercialized in China, the use of a hypothetical contingent valuation method is used in the form of a double-bounded dichotomous choice. To test for and calibrate hypothetical bias we provide half of the sample with a cheap talk text. We also compare the results with previous studies to see if there are differences in consumers' acceptance and awareness toward GM products for the past twelve years.

The basic structure of the survey is presented here. First, each participant is requested to sign a consent form. Then they are asked about their objective and subjective awareness of genetically modified organisms. A cheap talk script is then administered followed by an information sheet which gives pertinent knowledge about particular GM rice trait. The respondent is carefully guided through this information sheet to make sure they fully understand. A reference price question is asked after the information treatment. This question operates as a filter, which eliminates respondents who never purchase rice and then segregates those who do purchase rice into two groups. Those who prefer to purchase non-GM rice compared to GM rice given both are at the same price will be presented with lower bound price choices. Those who are

neutral between equally price GM rice and non-GM rice and those who prefer GM rice are then presented with upper bound price choices.

The goods descriptions

There are four different GM rice products involved in the constructed hypothetical market for this survey: 1) GM rice with no specific trait, 2) *Bt* Xianyou 63 rice; 3) Golden rice, and a 4) a stacked GM rice with both Bt and Golden rice traits.

The *Bt* Xianyou 63 rice variety has received the bio-safety certification for trial research from the Ministry of Agriculture in China in 2009. It was genetically modified to express the cryIA (b) gene of a bacillus thuringiensis bacterium, which confers resistance to a variety of leaf-eating pests (Fujimoto et al. 1993). The literature on the benefits of *Bt* rice notes that farmers do not need to spray their crops with insecticides as much as on conventional rice to control insect (Lepidoptera) damage. Huang et al (2005) provide estimates that *Bt* rice cultivation reduces pesticide input costs by as much as 80%, boosts yields by less than 10% and reduces poor health outcomes associated with exposure to toxic chemicals.

Golden rice is designed to biosynthesize beta-carotene a precursor of Vitamin A to enhance its bioavailability in rice intensive diets which are typically vitamin A deficient (VAD). This genetic transformation was achieved by inserting two genes, a plant phytoene synthase (psy) and a bacterial phytoene desaturase (crtI) (Ye et al, 2000). This first generation demonstrated that it was possible to produce pro-vitamin A in rice but the bioavailability was low. Thus a second generation changed the source of the psy gene from daffodil to maize with a resulting increase in bioavailability of the carotenoids from 1.6 μg/g to 37 μg/g (Al-Babili and Beyer, 2005) At this higher carotenoid level it has been estimated that to meet the recommended dietary allowance of

Vitamin A only 144 g of rice would be needed (Tang et al., 2009). VAD is known as one of the main causes of temporary or permanent vision impairment and is known to increase mortality among children and lactating women. Golden rice, reflecting its name, has a visual color difference from conventional rice; the milled rice is golden. Although golden rice is designed to be a humanitarian tool, there is significant opposition to it, including loss of biodiversity (Shiva), enhancing market power of multinational bioscience companies (Greenpeace, 2005) and diversion from other strategies to enhance Vitamin A in diets through supplements, consumption of carrots and certain leafy vegetables (Enserink 2008). Wessseler and Ziblerman (2013) have estimated that annual perceived costs of adopting Golden rice in India have to be greater than US$199 million per year over the past 10 years to explain the delay in commercialization.

Sampling procedures

Based on Lin et al. (2006) the survey sample for this study was selected to cover the major rice growing areas in China. In our particular sample we included thirteen provinces and three municipalities. Our target population is aimed towards the main rice consumers between the ages of sixteen to eighty years. Cluster sampling was applied to be our basic sampling method, so we could sample economically while retaining the characteristics of a probability sample. After a pretest we trained students at China Agricultural University in Beijing to conduct the survey during their next subsequent trip to their home cities. These student enumerators were carefully selected based on their hometown location, to make sure each province had an equal chance to include possible respondents. To ensure sampling representativeness, all enumerators were recruited from the population of undergraduate students in the Economics Department of Chinese Agricultural University. The samples were collected during the summer break (July 1st to July 22nd) of 2013.

Thirty-five enumerators were recruited and received extensive training from the research committee chaired by Professor Zheng Zhihao to guarantee professional, unbiased sampling. A stipend of 500 Yuan was provided upon return of the questionnaires to each student enumerator to ensure successful completion. Each enumerator was requested to obtain and use random sampling rule to ensure that each person in their territory population had an equal chance of being included in the sample. Potential survey respondents were asked if they would participate in this study which would take approximately 15-20 minutes, and as compensation, each subject who signed a consent form received 10 Yuan or an equally priced store coupon. To ensure sample quality, each enumerator was responsible for surveying only 30 respondents; in total this survey covered 1050 people for the total sample pool.

Experimental design

Demographic, prior knowledge and acceptance

This survey instrument included questions to measure the antecedent knowledge of each participant. First, all subjects responded to a set of socioeconomic characteristics questions which included geographic and administrative division information, age, gender, education level, household number, career status, monthly annual income, etc. Then a set of questions were asked to identify the rice consuming conditions of each respondent. This included questions about the number of meals with rice per day, frequency of rice purchasing, and current rice stock amount. The prior knowledge question set was arranged as the second part of our survey. In this section, we introduced a true/false table to obtain the basic objective and subjective knowledge of genetically modified organisms. The six true false questions were extracted from IRNA (International Research Association) research conducted in 2000 by Bai et al (2003) to see if the objective knowledge will affect consumers' responses to willingness to pay.

Another set of questions was then presented to procure subjects' recognition of GM with a special emphasis focusing on their source of information. They were asked where they get GMO information and how often they hear this kind of information. With these questions, we obtain the respondents' awareness of genetically modified technology and the media coverage rate of different media sources. This set of questions was consistent with a survey conducted by Lin et al. in 2006.

This section of the survey also included three multiple choice questions which are designed to collect the respondents' objective and subjective assessment of their own knowledge of GM products (subjective knowledge); whether they heard about the 2012 Golden rice leaking out case that happened in Hunan province which was discussed above in the literature review proportion (objective knowledge); and how they weight their reliance on diverse media sources when food sector related news were reported (subjective question).

The third section of the survey questionnaire was a set of questions which scaled participants' acceptance toward GM products. The first two products were actually available on the market (GM soybean oil and GM maize fed livestock), and the last two products were not, (pest resistant GM rice and health enhanced GM rice). Participants were asked to presume that the all of the products are obtainable in the market and weight their acceptance for each product.

Information shocks and Calibration method

In our survey, we created a 1*2 +3*2*2 factorial design to test the information effect, calibration effect and ordering /formatting effect as discussed above.

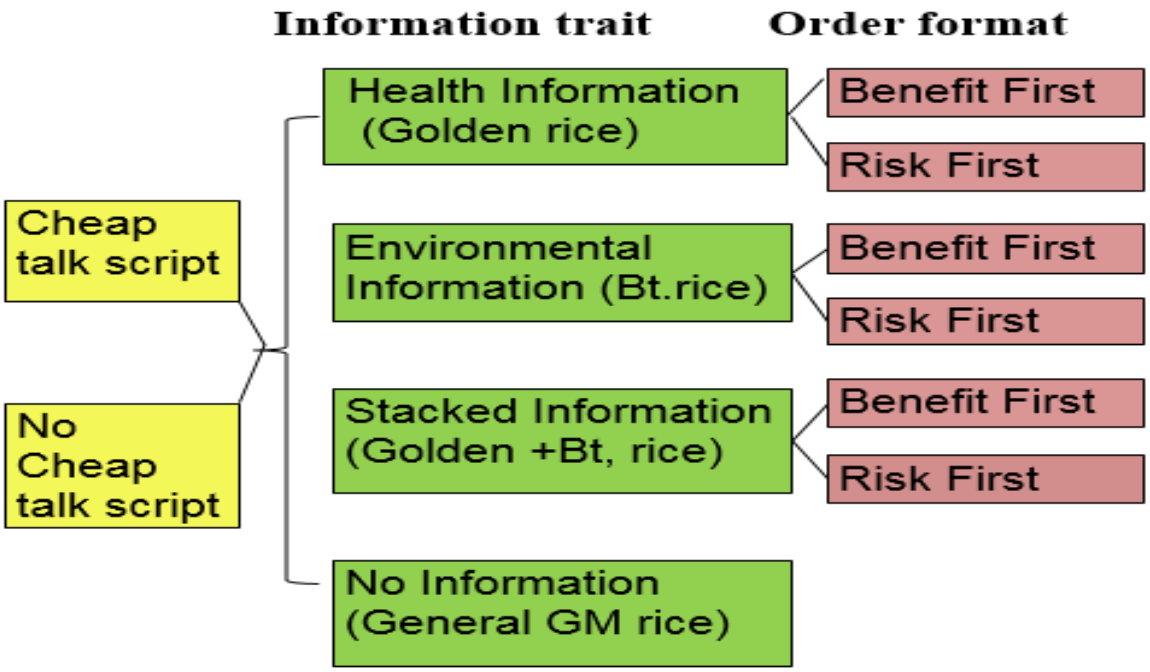
We followed Crowley's (1994) approach and provided both positive (benefits) and negative (risk) information in our treatments. Four different information treatments were applied

to test the information effect on consumers' valuations towards GM rice: 1) No information or neutral information treatment, 2) Health information treatment, 3) Environmental information treatment, and 4) combined Health and Environmental information treatment. For no/neutral information treatment, a neutral introduction about *GM.* Technology was introduced; no specific benefit or risk factors of GM rice product were mentioned in this treatment. For the environmental treatment, scientific based information about *Bt* rice which contains both benefits and risks was provided. For the health treatment, both benefits and risks about Golden rice were provided. For the combined environmental + health information treatment, the hypothetical rice product which contains both attributes from *Bt* and Golden rice was presented, with benefits and risks. To avoid loss aversion behavior we also arranged our information sheet in different formats: benefit information provided first or risk information provided first. Two ordering/formatting treatments were used on the three kinds of information treatments with two tailed characteristics to test the information format effect. In this estimation, sub-sample subjects who received Health information, Environmental information, and Aggregated/ combined information treatments were equally divided. The information sheets were prearranged into two different kinds of formatting, with either the benefit attributes presented first or the risk factors were introduced first. The information on benefits and risks that were provided to the respondents was based on scientific literature, cited above.

Two calibration treatments were employed in this survey. The respondents were divided into two equally numbered groups, with 50% of the respondents guided to read through a cheap talk script which not only described the existence of hypothetical bias in contingent valuation surveys but also required them to bid as they were in an actual monetary buying situation. The other 50% of the sample did not have a cheap talk script. The control group (no calibration

treatment) was given directly the semi-DBDC contingent valuation question set. The other group was provided with a paragraph of cheap talk script as a calibration method before the semi-DBDC WTP questions were asked. Figure 3 presents a flow chart of all the treatments.

Figure 3. The treatments flow chart



Double Bounded Dichotomous Choice contingent valuation procedure

After the respondent was guided through the information sheet and the cheap talk treatment (if provided), a set of questions was asked to obtain the respondents' willingness to pay of GM rice. The WTP questions started with a reference price of 5 Yuan/ kg for conventional rice and asked the subjects if they were willing to pay the identical price for GM rice. There are four options for the reference price question which elicited the basic preferences of the

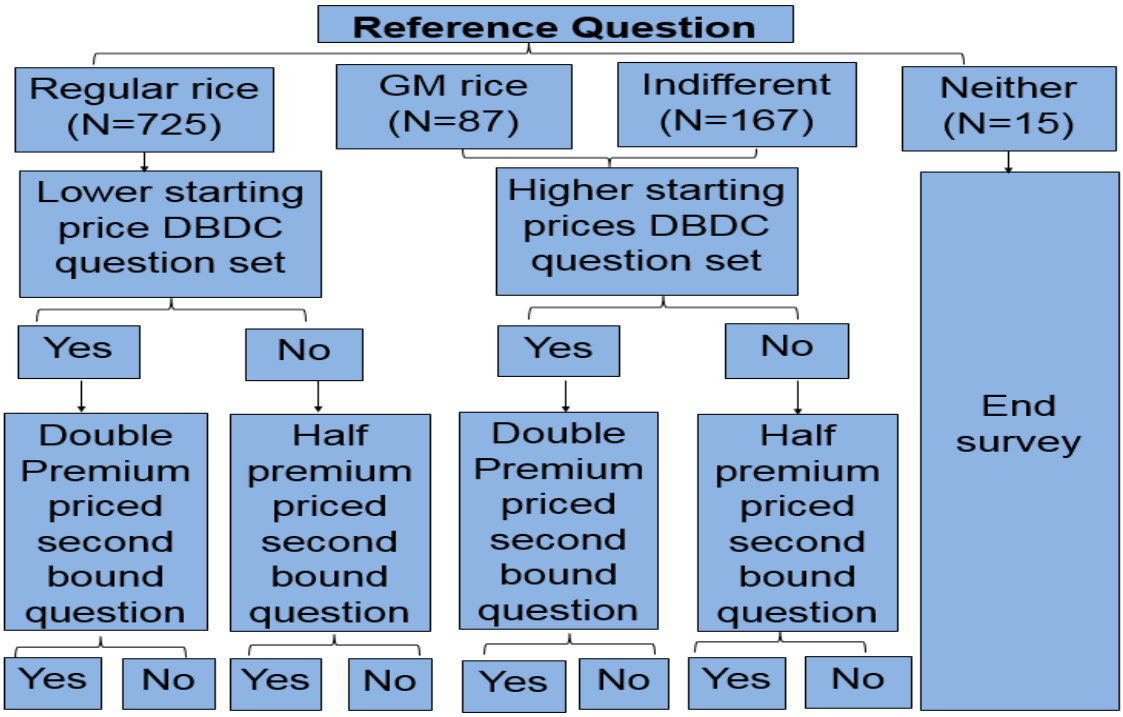
consumers about GM rice: 1) they prefer to buy GM rice, 2) they prefer to buy conventional rice, 3) they have an equal preference on GM rice and conventional rice, and 4) they chose not to buy rice. Based on their answers, participants who prefer GM rice or those who have an indifferent attitude towards GM and conventional rice were then randomly assigned to answer a parallel first bounded dichotomous choice question which holds the price for conventional rice consistent as reference point but with higher starting prices for GM rice; those who showed their preference on conventional rice were asked a paired first bounded dichotomous choices question which also held the reference price for conventional rice at 5 Yuan/kg but set a lower starting prices bid for GM rice; those who expressed no interest in buying rice were automatically finished with the survey.

For example, subjects who preferred GM rice or who were indifferent were asked if they were willing to pay a randomly assigned starting price from the price range of 5.25 Yuan/kg to 7.5 Yuan/kg for GM rice, the exact value is generated randomly in 25 cent intervals. If they choose to buy conventional rice, they were then asked if they are willing to pay a randomly assigned price from the price range of 4.75 Yuan/kg to 2.5Yuang/kg (with a 25 cent interval) for GM rice. Participants are then asked a follow-up question to the first bounded question set that either doubles or halves the premium or discount on the amount they are willing to pay for the GM rice. This set of questions is called the second bounded questions.

According to the subjects' answers to the first bounded question, the second bounded question would halve or double the price premium that they had in the first bounded question. A "No" response to this first question would have the premium halved and a "yes" response would double the premium. For instance, if the subject picks "yes" to the first bounded question with a higher price range and agrees to pay 5.5 Yuan/kg for GM rice, the premium will be 0.50 Yuan,

the second bounded question would double the premium and ask if they are willing to pay 6.00 Yuan/kg for GM rice. If the subjects chose "no" to the first bound question at a price of 5.5 Yuan/kg for GM rice, the second bounded question will half the premium and ask if they are willing to pay 5.25 Yuan/kg for GM rice. A flowchart explaining the DBDC procedure is provided in Figure 4.

Figure 4 Flowchart of the Semi-Double Bounded Dichotomous Choice Method



A pretest of the questionnaire was arranged in Beijing and Guangzhou two weeks before the start of the data collection. The first pretest was conducted at the China Agricultural University using 50 undergrad students as a sample size to improve the quality of the questionnaire; then a few pretests were applied in a randomly selected apartment complex in Guangzhou called Biguiyuan. The enumerators were required to enter into each representative's

home to conduct the survey. By doing so, we acquire the best procedure of applying the survey. Step 1: The respondent was asked for her/his consent to take the survey and given an ID number and the participant compensation fee. Step 2: A brief discussion about the purpose of this study was provided followed the series of questions outlined above. Step 3: When enumerators were reading the information sheets and the cheap talk scripts, participants were required to read them as well to improve their understanding. After the reading, participants were carefully guided through the bidding procedures. Step 4: After the survey, participants were asked not discuss the study with anyone to avoid interaction among participants.

Statistical testing procedures

Testing procedures and software introduction

After presenting a summary of the basic statistical results for the entire sample of the demographic, awareness, acceptance and objective and subjective knowledge questions presented, the entire sample is divided according to their response to the reference question and differences between these two sub-samples are evaluated for the demographic, awareness, acceptance and objective/subjective knowledge questions.

The next step in the analysis estimates a multinomial logistic (M-logit) regression to analyze the relationship between the respondent's characteristics captured by the questionnaire and the response to the reference question. This M-logit regression is estimated using the entire sample. The marginal effects of every variable are then calculated and compared holding other variables constant. The reference question set up a reference price at 5 Yuan/kg for both non-GM and GM rice and asks the subjects to reveal their preference. In the M-logit regression, the categorical responses to this question are the dependent variable.

The WTP analysis using the double bounded dichotomous choice method involves the assignment of respondents to three groups, 1) the respondents to the reference question who prefer to buy GM rice or who were indifferent to non-GM are assigned to the higher price WTP estimation; , 2) the respondents to the reference question who prefer to purchase conventional non-GM rice are assigned to the lower price WTP estimation; and 3) those who indicated that they do not purchase rice were discarded from any WTP analyses. The discussion of the WTP model concludes with an assessment of change in response to similar WTP questions and estimates from previous studies.

Microsoft Excel (Data Analysis) and Statistical Software (STATA 13.1) were used to obtain statistical results. First we estimate the multinomial logistic regression parameters (via maximum likelihood) and their corresponding marginal effects to test the relationships between respondent's characteristics and rice product preferences. STATA software was used. Before we estimated the logit model we checked the correlation of each variable by using the *correlate* command in STATA and to display the matrix; then the *pwcorr,obs sig* command is used to display all pairwise correlations. Then we conducted the WTP analyses, STATA command created by Lopez-Feldman et al. (2012) were used following the econometric model explained in functions (1) to (14). This Double-B module allows direct estimation of β and and gets the double bounded dichotomous choice contingent valuation regression. The STATA command of the regression is *doubleb*.

Analytical approach

The multinomial logistic regression (M-logit) and marginal effects

For the M-logit, the related statistical functions are listed and explained below. According to the reference question in our survey, we regressed the categorical response, *Y*, against explanatory variables in *X*. The dependent variable *Y* is distributed categorically.

$$Pr\ (Y=1) = \frac{eX\beta(1)}{(eX\beta(1)+eX\beta(2)+eX\beta(3)+eX\beta(4)}$$

$$Pr\ (Y=2) = \frac{eX\beta(2)}{(eX\beta(1)+eX\beta(2)+eX\beta(3)+eX\beta(4)}$$

$$Pr\ (Y=3) = \frac{eX\beta(3)}{(eX\beta(1)+eX\beta(2)+eX\beta(3)+eX\beta(4)}$$

$$Pr\ (Y=4) = \frac{eX\beta(4)}{(eX\beta(1)+eX\beta(2)+eX\beta(3)+eX\beta(4)} \quad (15)$$

Where $\beta(1)$ represents the set of coefficients of people who choose to buy conventional non-GM rice; $\beta(2)$ represents the set of coefficients of people who choose to buy GM rice; $\beta(3)$ represents the set of coefficients of people who held indifferent attitudes in purchasing GM or conventional non-GM rice, and$\beta(4)$ represents the set of coefficients of people who choose to buy neither of the rice products; *Y as* the dependent categorical variable and *X as* a *1*K* vector of explanatory variables.

To identify our model, we set $\beta(2) = 0$ as the base outcome, the remaining coefficients $\beta_{(1)}, \beta_{(3)}, \beta_{(4)}$ measure the change relative to the *Y=2* group, where we can acquire the unit change in the corresponding variable compared to the base outcome of the group of people who choose

GM rice in the reference question. The altered equations when $\beta(2)$ was set to zero and relative probability of *Y=1, Y=3, Y=4* to the base outcome line are:

$$Pr\ (Y=1) = \frac{eX\beta(1)}{(eX\beta(1)+1+eX\beta(3)+eX\beta(4)}$$

$$Pr\ (Y=2) = \frac{1}{(eX\beta(1)+1+eX\beta(3)+eX\beta(4)}$$

$$Pr\ (Y=3) = \frac{eX\beta(3)}{(eX\beta(1)+1+eX\beta(3)+eX\beta(4)}$$

$$Pr\ (Y=4) = \frac{eX\beta(4)}{(eX\beta(1)+1+eX\beta(3)+eX\beta(4)} \qquad (16)$$

Relative probabilities are $\frac{\Pr(Y=i)}{\Pr(Y=2)} = e^{X\beta(i)}$ where *i*= 1,3,4 (17)

The ratio of the relative risk of a one unit change in $X_{j\ when}$ *Y=1, Y=3, Y= 4* are then:

When *Y=1*: $\frac{e^{\beta 1(1)X1+\cdots+\beta j(1)(Xj+1)+\cdots+\beta k(1)Xk}}{e^{\beta 1(1)X1+\cdots+\beta j(1)Xj+\cdots+\beta k(1)Xk}} = e^{\beta j(1)}$

Y=3: $\frac{e^{\beta 1(3)X1+\cdots+\beta j(3)(Xj+1)+\cdots+\beta k(3)Xk}}{e^{\beta 1(3)X1+\cdots+\beta j(3)Xj+\cdots+\beta k(3)Xk}} = e^{\beta j(3)}$

Y=4: $\frac{e^{\beta 1(4)X1+\cdots+\beta j(4)(Xj+1)+\cdots+\beta k(4)Xk}}{e^{\beta 1(4)X1+\cdots+\beta j(4)Xj+\cdots+\beta k(4)Xk}} = e^{\beta j(4)}$ (18)

Where the *j* represents the *j*th explanatory variable where we assume that we have in total *k* variables contained in our regression.

In STATA the *mlogit* command estimates the regression parameters and the marginal effect of each explanatory variable we use the *margin dydx* command to calculate marginal effects from the estimated model at fixed values of each covariate of variables in the variable list and average or otherwise integrate over the remaining covariates. After the multinomial logistic

regression, we conduct the Hausman test (Hausman et al .1981) to check the level of significance of predicted vs. actual values by using *hausman . allcats, alleqs constant* command in STATA. By doing so, we can test of our statistical model corresponds to our data. The test statistic for the Hausman test is:

$$H = (b_1 - b_0)'\left(\mathrm{Var}(b_0) - \mathrm{Var}(b_1)\right)^{\dagger}(b_1 - b_0),$$

Double Bounded Dichotomous choice analysis for WTP

We estimate a semi-double bounded dichotomous choice model to measure the respondents' willingness to pay for GM rice. Each participant is presented with two bids. The first bid is contingent upon the respondents answer to their choice between conventional and GM rice priced equally at 5 Yuan/kg. If the response to the reference question is prefer GM or indifferent then the first bid price for GM rice is randomly assigned in the range of 5.25 Yuan/kg to 7.5 Yuan/kg with intervals of 0.25 Yuan/kg. If the response to the reference question is prefer non-GM then the first bid price for GM rice is randomly assigned in the range of 2.5 Yuan/kg to 4.75/Yuan/kg with intervals of 0.25 Yuan/kg. The level of the second bid is conditional on the answer of the first bid. If the respondent agrees to purchase the product at the first bid and answers "yes", the second bid (B_{i2}) sets a bid value higher than the first bid ($B_i < B_{i2}$) , and if the answer is "no" then the second bid is at a lower value($B_i > B_{i2}$) . Here we specify the second bid with a higher value than the first bid as B_{i2}^h, and with lower value as B_{i2}^l. Therefore following the mechanism, there are four discrete outcomes of the price bidding process for GM rice that are observable:

1. "yes, yes", a yes to the initial bid and a yes to the second bid
2. "yes no", a yes to the initial bid and a no to the second bid

3. “no yes”, a no to the initial bid and a yes to the second bid

4. “no, no”, a no to the initial bid and a no to the second bid

We define the likelihood of the four outcomes as: P^{yy}, P^{yn}, P^{ny}, P^{nn}. According to the assumption for the principle of bidding, consumers will choose the bid which is most likely their ideal willingness to pay to maximize their utilities. When a subject’s WTP is higher than the bid, it is expected that the individual will answer yes. Therefore, if we define the willingness to pay for a certain respondent *i* as $WTP_{i.}$,we note the probability of observing a positive / negative response for the first bound question at given values as:

$$Pr\ (\text{Answer1=1}) = Pr\ (WTP_{i.} > B_{i,}) \quad (1)$$

$$Pr\ (\text{Answer1=0}) = Pr\ (WTP_{i.} < B_{i,}) \quad (2)$$

where B_i is the bid price offered to the respondent for purchasing biotech rice, and $WTP_{i.}$ is the respondents’ acceptable price for purchasing biotech rice.

where the Answer1 is a binary valued indicator for the response “yes” for the first bounded question.

The likelihood functions of the four outcomes (P^{yy}, P^{yn}, P^{nn}, P^{ny}) for the double bounded question set are generated from (1) and (2). Under the first situation, when the respondent answers “ yes” for the first bound question, and “yes” for the second bound question, then $B_i < B_{i2}^{h}$.

$$\begin{aligned} P^{yy}(B_{i,}\ B_{i2}^{h}) &= Pr\ (B_i < WTP_{i.} \text{ and } B_{i2}^{h} \leq WTP_{i.}) \\ &= Pr\ (B_i < WTP_{i.} \mid B_{i2}^{h} \leq WTP_{i.})\ Pr\ (B_{i2}^{h} \leq WTP_{i.}) \\ &= Pr\ (B_{i2}^{h} \leq WTP_{i.}) \end{aligned} \quad (3)$$

Under the second condition, where a “yes” is followed by a “no”, we have $B_i < B_{i2}^{h}$

$$P^{yn}(B_{i,}\, B_{i2}^{h}) = Pr\,(B_i \leq WTP_{i.} < B_{i2}^{h})$$

(4)

Under the third condition, where a "no is followed by a "no", we have $B_{i2}^{l} < B_i$,

$$\begin{aligned} P^{nn}(B_{i,}\, B_{i2}^{l}) &= Pr\,(B_i > WTP_{i.} \text{ and } B_{i2}^{l} \geq WTP_i) \\ &= Pr\,(B_i > WTP_{i.} \mid B_{i2}^{l} \geq WTP_i)\; Pr\,(B_{i2}^{l} \geq WTP_{i.}) \\ &= Pr\,(B_{i2}^{l} \geq WTP_{i.}) \end{aligned}$$

(5)

Finally, under the fourth condition, where a "no" is followed by a "yes", we have $B_{i2}^{l} < B_{i.}$

$$P^{ny}(B_{i,}\, B_{i2}^{l}) = Pr\,(B_{i2}^{l} \leq WTP_{i.} < B_i)$$

(6)

If we model the WTP for an individual with relevant information and characteristics, we can elicit the willingness to pay as follows:

$$WTP_i = \alpha + X_i\beta + \mu_{i,} \quad \mu_i \sim N\,(0, \sigma^2)$$

where the parameters β, α, σ^2 are a *K*1* vector and two scalars, X_i is a *1*K* vector of explanatory variables. The total sample size is n, and the error term is μ. We can modify the above probability functions as:

$$\begin{aligned} Pr\,(\text{Answer1=1}) &= Pr\,(WTP_{i.} > B_{i,}) \\ &= Pr\,(X_i\beta + \mu_{i.} > B_{i,}) \\ &= Pr\,(\mu_{i.} > B_i - X_i\beta) \\ &= Pr\,(v_{i.} > -\frac{Xi\prime\beta - Bi}{\sigma}) \\ &= 1 - \square\,(\frac{Xi\prime\beta - Bi}{\sigma}) \end{aligned}$$

(7)

$$\begin{aligned} Pr\,(\text{Answer1=0}) &= Pr\,(WTP_{i.} < B_{i,}) \\ &= \square\,(\frac{Xi\prime\beta - Bi}{\sigma}) \end{aligned}$$

(8)

$$\begin{aligned} P^{yy}(B_{i,}\, B_{i2}^{h}) &= Pr\,(B_{i2}^{h} \leq WTP_{i.}) \\ &= Pr\,(X_i\beta + \mu_{i.} \geq B_{i2}^{h}) \\ &= 1 - \square\,(\frac{Xi'\beta - Bi2h}{\sigma}) \end{aligned}$$

(9)

$$P^{yn}(B_{i,}\ B_{i2}{}^{h}) = Pr\ (B_i \leq WTP_{i.} < B_{i2}{}^{h})$$
$$= Pr\ (B_{i,} \leq X_i\beta + \mu_{i.} < B_{i2}{}^{h})$$
$$= \Phi\ (\frac{Xi'\beta - Bi2h}{\sigma}) - \Phi\ (\frac{Xi\prime\beta - Bi}{\sigma})$$

(10)

$$P^{nn}(B_{i,}\ B_{i2}{}^{l}) = Pr\ (B_{i2}{}^{l} \geq WTP_{i.})$$
$$= Pr\ (B_{i2}{}^{l} \geq X_i\beta + \mu_i)$$
$$= \Phi\ (\frac{Xi\prime\beta - Bi2l}{\sigma})$$

(11)

$$P^{ny}(B_{i,}\ B_{i2}{}^{l}) = Pr\ (B_{i2}{}^{l} \leq WTP_{i.} < B_i)$$
$$= Pr\ (B_{i2}{}^{l} \leq X_i\beta + \mu_{i.} < B_i)$$
$$= \Phi\ (\frac{Xi\prime\beta - Bi}{\sigma}) - \Phi\ (\frac{Xi\prime\beta - Bi2l}{\sigma})$$

(12)

Where v_i is the standard deviation and distributes normally, $v_i \sim N\ (0,\ 1)$ and $\Phi(x)$ is the standard cumulative normal.

Given a sample with N respondents, where $B_{i,}\ B_{i2}{}^{l}, B_{i2}{}^{h}$ are the bids used for the *i*th respondent, based on the above functions (7) to (12) , we can then define the log-likelihood function as

$$lnL() = \sum_{i=1}^{N} [\ D_i^{yy}\ ln\ P^{yy}(B_{i,}\ B_{i2}{}^{h}) + D_i^{yn}\ ln\ P^{yn}(B_{i,}\ B_{i2}{}^{h}) + D_i^{nn}\ ln\ P^{nn}(B_{i,}\ B_{i2}{}^{l})$$
$$+ D_i^{ny}\ ln\ P^{ny}(B_{i,}B_{i2}{}^{l})]$$

(13)

$$lnL() = \sum_{i=1}^{N} [\ D_i^{yy}\ ln(1 - \Phi\ (\frac{Xi'\beta - Bi2h}{\sigma})) + D_i^{yn}\ ln\ (\Phi\ (\frac{Xi'\beta - Bi2h}{\sigma}) - \Phi\ (\frac{Xi\prime\beta - Bi}{\sigma}))$$
$$+ D_i^{nn}\ ln\ (\Phi\ (\frac{Xi\prime\beta - Bi2l}{\sigma})) + D_i^{ny}\ ln\ (\Phi\ (\frac{Xi\prime\beta - Bi}{\sigma}) - \Phi\ (\frac{Xi\prime\beta - Bi2l}{\sigma}))$$

(14)

Where D_i^{yy}, D_i^{yn}, D_i^{nn} ,D_i^{ny} are indicator variables that take the value of 1 if the associated action was taken or 0 if not taken by the ith individual.

For the two WTP analyses, we used the STATA command created by Lopez-Feldman et al. (2012) following the econometric model explained in equations (1) to (14). This Double-B

module estimates β and □.. The STATA command is *doubleb*. Where the probability four outcomes altered by symmetry are:

$$P^{yy}(B_{i,}\ B_{i2}{}^{h}) = 1 - \square\left(\frac{Xi'\beta - Bi2h}{\sigma}\right) = \square\left(Xi' * \frac{\beta}{\sigma} - \frac{Bi2h}{\sigma}\right) \quad (19)$$

$$P^{yn}(B_{i,}\ B_{i2}{}^{h}) = \left(Xi' * \frac{\beta}{\sigma} - \frac{Bi2l}{\sigma}\right) - \left(Xi' * \frac{\beta}{\sigma} - \frac{Bi2h}{\sigma}\right) \quad (20)$$

$$P^{nn}(B_{i,}\ B_{i2}{}^{l}) = 1 - \left(Xi' * \frac{\beta}{\sigma} - \frac{Bi2h}{\sigma}\right) \quad (21)$$

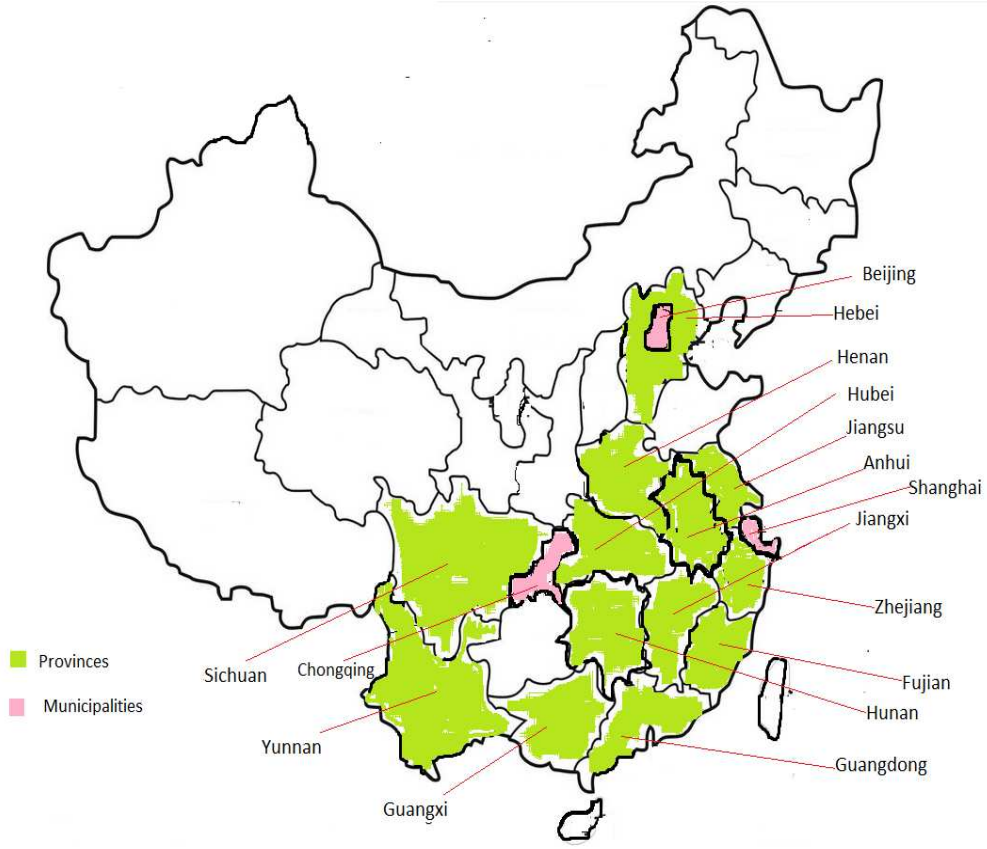
$$P^{ny}(B_{i,}\ B_{i2}{}^{l}) = \left(Xi' * \frac{\beta}{\sigma} - \frac{Bi2h}{\sigma}\right) - \left(Xi' * \frac{\beta}{\sigma} - \frac{Bi2l}{\sigma}\right) \quad (22)$$

Data

The survey data was collected in 2013 from May to July. All of the enumerators were carefully trained to make sure that every subject understands the survey procedure so they could collect reliable data. This survey covered thirteen provinces and three municipalities; under the administrative division of provinces, fifty five cities were included; and under the municipalities division data were collected in eleven districts. Based on the nature of Chinese administration division, we defined the three municipalities parallel to provinces, and the provincial districts were parallel to cities. Figure 5 shows the geographically distribution of our survey.

Thirty-five enumerators were recruited for our survey, each of them were expected to conduct face to face interviews at each respondent's house. Thirty copies of questionnaires were assigned to each enumerator, to insure survey quality. In total we had 1050 copies of surveys. After review, 994 out of the 1050 copies of questionnaires were determined to contain valid observations.

Figure 5 The surveyed provinces in China



Data merging and sorting

To improve the explanatory power of the models, some of the variables were aggregated and redefined. For example, the provinces were redefined by regions: western China, central China and eastern China; cities were redefined as large, mid-sized and small by population density. With regard for career status, a binary variable was created to describe whether the job provided a monthly salary or not. Respondents who described their jobs as a federal employee, company employee, individual business owner and workers were defined as having stable monthly working status; those whose jobs did not belong to these categories were then defined as non-salaried.

The income level variable was originally distributed into ten categories. As such this variable was treated as a continuous variable. The middle values of each designated income category were divided by 1000. The highest amount category which originally was more than 40,000 Yuan/month was rescaled to 60 and the other categories were reset as: 0.5, 2, 4, 6, 8, 10, 15.5, 25, and 35. The education level attained variable also had many categories, so a new dummy variable which merged education as whether the participant had a bachelor degree or not was created.

Seven binary variables were created to describe the combination of information shocks and ordering effects of this particular study: No information, health information with benefit first, health information with risks first, environmental information with benefits first, environmental information with risks first, stacked health + environmental information with benefits first, and stacked health + environmental information with risks first. The media sources variable was redefined as whether the participants considered TV or News as reliable media sources when they reported food related news or not reliable.

IV. RESULTS

Data descriptions

Table 1 summarizes the sample distribution between information, cheap talk, and ordering treatments.

Table 1 Data distribution by factorial treatments

	Cheap talk script			No cheap talk script		
	No ordering	benefit-risk	risk - benefit	No ordering	benefit-risk	risk - benefit
No information trait	74			67		
Health information trait		65	71		74	74
Environmental information trait		71	63		69	81
Staked information trait		71	68		73	73

Demographic variable descriptions and analysis

For this particular survey, 51% of our respondents were males and 49% were females. The ages of respondents were concentrated situated in the range from 22 to 50 with total age range started from 16 years old to 78 years old and the mean age of 37. For educational level, more than 85% of our sample participants acquired their diplomas from junior high school to bachelor degree, 71% respondents claimed that they had high school or higher diploma. The fact that the majority of our subjects have higher level of education certified the respondents' abilities of acquiring new delivered information. In respect of subjects' career distribution, government related institution employees accounted for 12.27% of the whole sample, students had the same ratio as government officers; ordinary companies' employees represented 21.73% of total sample size; individual business owners accounted for 16.9%. Over 50% of respondents sorted their career status into one of three categories: Federal employees, company employees and individual business owners. When asked about average monthly income, only 57% out of the total sample subjects indicated their income level exceeded the national average of 7,000 Yuan/month. However, considering the specific culture in mainland China, where people feel uncomfortable talking about their salary and are accustomed to minimizing their actual total income level; a specious perspective should be held to these data.

Based on the record of the Sixth National Census of Population in China (2011), the national gender ratio was 51.27% vs. 48.73 %(male vs. female), the average household number was 3.1. 70.14% of the Chinese population was aged in the range between fifteen and fifty-nine and 9% of the population had a bachelor's degree. Compared with these population data, our sample represented higher education levels, bigger household size Chinese consumers. Taking consideration into geographic factors, this survey covered the major rice grown provinces along Yangzi River, east coast, and Pearl River Delta. These locations assumed to be representative of

future consuming trend, therefore, the sample was capable of representing current and future trends for the majority of Chinese consumers for rice. Table 2 summarizes socioeconomic characteristics for the 994 survey participants.

Table 2 Socioeconomic characteristics for the whole sample

Variables	Max	Min	Mean	Std. Err
Age	79	16	37.7	12.2
Household size	1	11	3.5	1.2
Income level(1000 Yuan)	60	0.5	7.26	7.84
Meals containing rice per day	5	0	2.2	0.6
Objective knowledge accuracy	100%	0%	36%	16%
GM soybean oil acceptance	100%	0%	64%	48%
GM corn fed livestock acceptance	100%	0%	65%	48%
GM pest resistance rice acceptance	100%	0%	57%	50%
Health enhanced GM rice acceptance	100%	0%	67%	47%
Heard of term “Hybridization”	Yes(1)	No(0)	0.79	0.41
Heard of term “Gene”	Yes(1)	No(0)	0.86	0.36
Heard of term “Biotechnology”	Yes(1)	No(0)	0.69	0.46
Heard of term “GMO”	Yes(1)	No(0)	0.86	0.35
Subjective knowledge evaluation	3	1	2.73	0.9
Variables	Category		Percentage	
Gender	Male		51.11%	
	Female		49.52%	
Have Bachelor’s degree or not?	Yes		47.69%	
	No		52.31%	
Working status	With salary		58.15%	
	Without salary		41.85%	
Governmental	Capital city		17.61%	
Administrative divisions	Secondary city		22.84%	
	Town		41.95%	
	Village		17.61%	
Frequency of purchasing rice	More than once		27.57%	

	Once per month	43.86%
	Less than once	28.57%
Current household rice stock(kg)	Less than 5kg	24.95%
	5kg or10 kg	37.42%
	More than 10kg	37.63%

The sample was then divided into two groups based on their answer to the reference question. A total of 725 participants indicated a preference for non-GM rice in the reference question, while 254 indicated no difference or a preference for GM rice. To see if the two sub-samples differed significantly in terms of demographic characteristics and other variables, t-tests were conducted with the results reported in Table 3.

Table 3 Socioeconomics Characteristics descriptions under different samples

		Prefer Non-GM rice (n=725)		Prefer GM rice or indifferent(n=254)	
Variable	Category	Mean	Std.Dev.	Mean	Std.Dev.
Age		37.9	12.2	36.6	11.9
Household size *		3.5	1.2	3.3	1.2
Income level(1000Yuan)		7.04	6.95	7.88	9.98
Meals containing rice per day		2.2	0.6	2.1	0.6
Objective knowledge accuracy		36%	16%	36%	16%
GM soybean oil acceptance*		58%	49%	86%	35%
GM corn fed livestock acceptance*		50%	50%	86%	35%
GM pest resistance rice acceptance*		59%	49%	80%	40%
Health enhanced GM rice acceptance*		61%	49%	88%	33%
Heard of term “Hybridization”		0.79	0.4	0.78	0.41
Heard of term “Gene”		0.85	0.35	0.84	0.36
Heard of term “Biotechnology”		0.7	0.46	0.67	0.47
Heard of term “GMO”*		0.87	0.33	0.83	0.37
Subjective knowledge evaluation		2.7	0.87	2.79	0.93
Gender	Male		50.48%		53.54%
	Female		49.52%		46.46%
Bachelor’s degree or	Yes		49.10%		43.70%
higher	No		50.90%		56.30%
Working status	With salary		58.21%		59.45%
	Without salary		41.79%		40.55%
Residence	Capital city*		19.86%		11.81%
	Secondary city*		20.69%		27.56%
	Town		42.48%		42.13%

	Village	16.97%	18.50%
Frequency of purchasing rice	More than once	26.76%	30.31%
	Once per month	45.24%	40.94%
	Less than once	28.00%	28.74%
Current household rice stock(kg)	Less than 5kg	25.52%	22.83%
	5kg or10 kg	37.66%	37.01%
	More than 10kg	36.82%	40.16%

*Statistically significant at 5% level between two sub-samples.

The results show that the two sub-samples are significantly different in terms of household size, acceptance of GM products, GM related terms awareness and governmental administrative division. Participants who preferred non-GM had a larger household size and were more likely to live in a capital city. This sub-sample also had lower acceptance for GM products and was less aware of the term 'GMO'.

Objective and subjective knowledge analysis

True /False objective knowledge

Table 4 summarizes the objective knowledge responses with respect to the True/False questions in the survey. Along the question set, question 5 and 6 were designed as indicators to measure the objective basic understanding of trans-genetic technology. The results showed that 95% of our sample had the first question right, followed by the third question and second question with 72% and 62% accuracy rates. Only 47% and 41% of our sample had the transgenic knowledge indicator-questions answered correctly. (Question 5, Question 6) Compared with three other previous studies conducted in 2003 by Bai et al.in China and the related reports in US and European studies (Hallman et al. 2002; IRNA 2000), our results indicate that Chinese consumers' objective knowledge about bio-technology has increased in general, however, respondents are still very limited in the understanding of transgenic.

For this study the average percent accuracy across all questions was 67%, which is comparable with the results obtained in the US (2001), higher than the results from China (2002) and Europe (1999).Compared to Bai's China study, the accuracy response rate was particularly better with a substantial increase for questions 3, 5 and 6. This suggests that Chinese consumers have become better informed on bio-technology related issues for the past decade.

Table 4 Comparisons of the T/F questions answering situation with percent correct.

	Correct Answer	This study 2013	China 2002	U.S 2001	EU 1999
1. There are some bacteria which live on wastewater	True	95	93	94	83
2. Father's gene determines the gender of the child.	True	62	59	73	44
3. Ordinary food does not contain genes, while genetically modified food do.	False	72	43	57	35
4. By eating a genetically modified food, a person's genes could also become modified.	False	59	53	69	42
5. It is impossible to transfer genes between animals and plants.	False	47	26	48	26
6. Product genetically modified with genes from fish would probably taste "fishy."	False	41	29	48	NA

Source: China 2003, Bai et al.; U.S. 2002, (Hallman et al FPI); EU 2000, (INRA)

Awareness of the GM related terms

By asking the consumers whether they have heard of GM related terms, we considered their answers as an index vector to show the objective prior awareness about bio-technology. In

this study, the greatest familiarity was for the terms “genetics” and “GMO” .When asked about the awareness of genetically modified organisms, 86.12% of our respondents indicated that they had heard this term before, among this group 35% of them stated that they had regularly heard this term, and 40% indicated that they heard this term occasionally.

Contracted with the 2002 China (Bai et al) index with the awareness rate of 66.5%, this result showed an obvious growth of the population’s objective knowlede about genetically modified related information. The awareness level of GMO was found consistent with previous research conducted in 2000 in Japan by Macer and Ng et al. and in Europe by the Angus Reid Group. Hallman et al (2002) had found that the awareness ratio of GMO in U.S. was approximately 77%, which was slightly lower than our sample. To further study the relationship between the awareness of the terminology “GMO” with demographic characteristic variables, a logistic model was estimated with the dependent variable set equal to 1 if the respondents had heard of “GMO”, otherwise equal to zero. With setting “age” and “household size” at their mean values, we computed the marginal effect for other variables. The results are presented in Table 5 as odds ratios and marginal effects at mean values and the associated statistical significance.

Table 5 The Odds ratio and MEMs (Marginal effects at mean values) of awareness of GMO

Variables	Categories	Odds	P	MEM	P
Age		0.99	0.58	Mean =37.6	
Male*		1.55	0.04	4.1%	0.04
Education* (primary school base)	Jr. High or Equal Tech school***	2.38	0.01	14.1%	0.01
	Sr. High or Equal Tech school***	4.59	0.00	21.6%	0.00
	Bachelors or equal***	10	0.00	27.1%	0.00
	>= Master’s degree***	17.96	0.01	29.5%	0.00
Career (Federal employee base)	Ordinary company employee	0.26	0.21	-4.9%	0.09
	Individual business owner***	0.07	0.01	-16.1%	0.00
	Laborer or worker**	0.08	0.02	-15.3%	0.00
	Farmer***	0.04	0.01	-23.3%	0.00
	Unemployed	0.3	0.32	-4.1%	0.29
	Retired**	0.1	0.04	-13.2%	0.01
	Student*	0.13	0.06	-10.3%	0.02
	Freelance or self-employee**	0.12	0.05	-11.0%	0.01

	Other*	0.13	0.07	-9.7%	0.02
Income level (less than 1000RMB base)	1,000-2,999 RMB*	2.91	0.05	13.2%	0.09
	3,000-4,999 RMB*	2.7	0.07	12.5%	0.11
	5,000-6,999 RMB	2.32	0.13	10.9%	0.18
	7,000-8,999 RMB***	6.05	0.01	19.1%	0.02
	9,000-10,000 RMB**	4.77	0.03	17.5%	0.04
	11,000-19,999 RMB**	7.15	0.02	20.1%	0.02
	20,000-29,999 RMB	4.63	0.20	17.2%	0.13
	30,000-39,999 RMB	4.11	0.31	16.3%	0.21
	<= 40,000 RMB	1.96	0.45	8.9%	0.44
Household size		0.97	0.68	Mean=3.5	
Residence (capital city base)	Secondary city**	2.09	0.06	6.4%	0.06
	Town	1.03	0.92	0.3%	0.92
	Village	1.37	0.37	3.0%	0.38

***statistically significant at 1% level, ** at 5% level, * at 10% level.

According to the results, the odds are that male respondents were 1.55 times more aware of the term “GMO” than female respondents. Holding age and household size at their mean values, compared to those who had only primary school diploma, the possibilities of being aware of GMO for respondents who had higher education are significantly higher by different levels (14%, 22%, 27% and 30%). Higher income also increases the probability of awareness of the term “GMO”. Compared with respondents whose monthly incomes were less than 1000 RMB, those whose income were at 7,000 RMB to 20,000 RMB had significantly larger chances to be aware of the term GMO. An opposite phenomenon was observed when discussed by the career classification. Generally, higher education and higher income level increases respondents’ awareness of the term GMO; other career types, however, are less aware of GMO compared to federal employees.

Awareness and knowledge of GM rice and 2012 Golden rice deceived case

Responses to awareness and knowledge of GM rice and 2012 golden rice exposed case following the awareness test for GM related terminologies are given as follows. 33.2% of the respondents indicated that they have a good understanding about GM rice, 45.4% of respondents

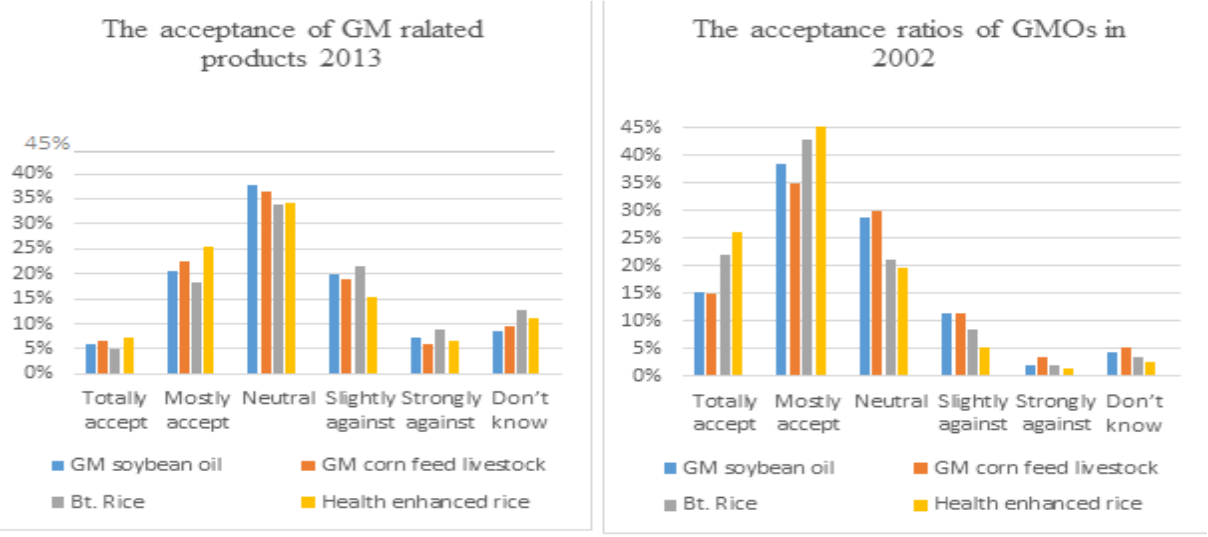
thought their knowledge about GM rice was ordinary, and 21.5% of the respondents considered their understanding of GM rice as limited. The awareness of the 2012 golden rice exposé reported by Chinese Center for Disease Control and Prevention (detail present at the introduction part) was then asked, to test if this particular case would affect the acceptance and WTP for consumers. 13.6% of respondents claimed that they knew extensively how this case had happened; 39.5% of respondents indicated that they had only heard of this news yet did not know exactly what had happened and 46.9% of respondents said they had no awareness of this news.

Acceptance of GM related products

Percentage Change comparison

This study asked respondents to rank their acceptance of a set of GM products (Question 3.1). Figure 6 shows the acceptance of four different GM related products which were listed on the questionnaire. Regardless of product type, 34% to 38% out of the total sample size were neutral in acceptance, 5% to 10% of participants showed either a complete acceptance or strongly against attitude, and approximately 10% indicated their attitude about GM products was unclear. By defining the "potential acceptance rate" as people who rank their acceptance rate neutral or more accepting, among the four products, Bt rice was found to have the lowest potential acceptance rate of 57%; followed by GM soybean oil and the other two of 65% and 66%. Our results indicate that regardless of products, more than 50% of the total sample had a neutral or positive acceptance towards GMOs. A similar study which was conducted in 2001 by Bai et al. assessed acceptance for the same GM products. Figure 6 presents our results and Bai et al.'s results from 2002.

Figure 6 Consumers' acceptance towards different GMOs



A clear decline was observed in acceptance of all GM products in 2013 particularly for *Bt* rice and health enhanced rice compared to Bai et al's research (29% and 15% changes). Less than 66% of sample respondents had a neutral or positive acceptance regardless of the product, however; more than 80% neutral or positive acceptance of any GM products was found in the previous research. Compared to Bai's study. our results seem to have more respondents ranking their attitude about GMO products as neutral instead of "Mostly accept" and more revealed against attitude toward GM products for this study. Even though acceptance of GM products has declined, the majority (57%-66%) of the respondents were neutral or accepting.

Tobit models for the acceptances

The relationship between acceptance rates of each product and socio-demographic variables were examined using a Tobit regression model. Four regressions were estimated where the acceptance rate of each of the GM products were set as censored dependent variables with the upper and lower thresholds censored at 0 and 100 percent. Generally age and gender were found significant across all GM products. A one year increase in age decreased the acceptance of

health enhanced rice by 0.4%, and decreased the other three products by 3%. Male respondents are 8% more likely to accept Bt rice and 6% more likely to pick the other three products compared to females. Tables 6 and 7 summarize the results for Bt rice and health enhanced rice because they are the main products that we used for the WTP analysis later.

Table 6 Tobit model for BT rice acceptance and socio-demographic variables.

		Bt rice	
Variables	Categories	Coef.	P>t
Age***		-0.29	0.01
Male***		7.99	0.00
Household size		-1.49	0.14
Education (Base : primary school diploma)	Junior High	-5.40	0.32
	Senior High	-3.92	0.49
	Bachelor's degree	-2.65	0.64
	Master's degree	-5.58	0.45
Income (Base : monthly salary less than 500 RMB)	1,000-2,999	-10.25	0.20
	3,000-4,999 *	-13.36	0.09
	5,000-6,999	-6.28	0.43
	7,000-8,999 ***	-17.94	0.03
	9,000-10,000 ***	-18.31	0.04
	11,000-19,999 **	-15.71	0.07
	20,000-29,999	-10.15	0.38
	30,000-39,999	-11.08	0.48
	<= 40,000	-3.39	0.79
Residence (Base: Capital city)	Second level city***	10.58	0.01
	Town***	8.01	0.02
	Village ***	9.81	0.02
True false questions	Question 2.1.1	11.05	0.07
	Question 2.1.2	-3.18	0.21
	Question 2.1.3	0.74	0.82
	Question 2.1.4***	9.74	0.00
	Question 2.1.5	-1.44	0.58
	Question 2.1.6	1.18	0.65

Prior Knowledge (base: Very good)	Good***	19.06	0.01
	Neutral	7.50	0.29
	Bad	2.30	0.76
	Don't know	-14.61	0.16

***statistically significant at 1% level, ** at 5% level, * at 10% level.

The results show that higher income will decrease the acceptance rate significantly when income range from 7,000 to 19,999 RMB. People who live in suburban areas or the countryside have significantly higher acceptance for Bt rice compared to those who live in capital cities. Better prior knowledge of GM rice and the accuracy of true false-question, “By eating a genetically modified food, a person’s genes could also become modified?” also increases the acceptance of Bt rice significantly by 19% and 10%.

Table 7 Tobit model of health enhanced rice acceptance and socio-demographic variables.

	Health enhanced rice		
Variables	Categories	Coef.	P>t
Age***		-0.39	0.00
Male***		5.68	0.02
Household size***		-2.25	0.03
Education (Base : primary school diploma)	Junior High	-6.33	0.25
	Senior High	-5.19	0.38
	Bachelor’s degree	-3.52	0.55
	Master’s degree	-5.11	0.50
Income (Base : monthly salary less than 500 RMB)	1,000-2,999	-14.06	0.09
	3,000-4,999 *	-8.42	0.30
	5,000-6,999	-7.06	0.39
	7,000-8,999	-11.27	0.18
	9,000-10,000	-10.38	0.25
	11,000-19,999	-6.81	0.45
	20,000-29,999	-0.62	0.96
	30,000-39,999	-2.50	0.88
	<= 40,000	10.52	0.41
Administration Division (Base: Capital city)	Second level city	1.49	0.70
	Town	1.74	0.62
	Village	4.35	0.31
True false questions	Question 2.1.1	6.84	0.26
	Question 2.1.2*	-4.35	0.10
	Question 2.1.3	-0.33	0.92

	Question 2.1.4***	10.66	0.00
	Question 2.1.5	-1.70	0.52
	Question 2.1.6	1.19	0.66
Prior Knowledge (base: Very good)	Good***	15.44	0.03
	Neutral	8.73	0.23
	Bad	9.52	0.22
	Don't know	-3.68	0.73

***statistically significant at 1% level, ** at 5% level, * at 10% level.

For the acceptance of health enhanced rice, generally we observe a negative relationship with income level. For those whose monthly income is between 3,000 to 4,999 RMB, the acceptance rate is 8% lower than those who earned less than 1,000 RMB. Respondents who got the fourth true false question correct were significantly 11% more likely to accept health enhanced rice compared to those who did not. Better prior knowledge of GM rice also increased the acceptance significantly by 15%.

Consumer preferences over rice products without price changes

Multinomial logistic model analysis

A general question referred to as the reference question was asked to measure the respondents' preferences over rice products with an equal price of 5 Yuan/kg. Respondents were asked to pick one out of four choices to represent their preferences: conventional rice, GM rice, indifferent with conventional rice and GM rice, and neither. Our results showed that after information treatments, 725 participants chose to purchase conventional rice, 87 preferred GM rice, 167 of indifferent and 15 showed no interest in purchasing any kind of rice.

A multinomial logistic regression model was estimated to test for significant differences among the four choice responses to the reference question. The dependent and independent variables are described in Table 8. The estimated regression coefficients are provided in Table 9,

using the response of 'prefer GM rice' as a base. For this model, there were three replicates of the predictor variables representing the three models that were estimated: "Non-GM rice vs. GM rice", "Indifferent vs. GM rice" and "Neither conventional nor.GM rice". To evaluate whether the multinomial-logistic model corresponds to the data, a predicted vs. actual test is essential. Based on the assumption that the outcome categories of the M-logit model have the property of independence of irrelevant alternatives (IIA), a Hausman test was computed.(Hausman et al. 1981) After excluding the outcomes of the model one by one, the results showed no systematic change in the coefficients but a negative $\chi 2$ when "Indifferent" was taken out, however, due to the relatively small number of observations and the $\chi 2$ value from the original regression, this would not be problem for confirming the power of our model since there is some precedent for not rejecting the null for negative values of the test statistic (Hausman and Taylor, 1981)

Table 8 Descriptions of multinomial logit model variables

Variables	Description
Dependent variable	Non GM rice, GM rice, Indifferent between GM and non GM rice, Neither
Age	Continuous variable
Male	Male=1; Female=0
Bachelor's degree	Bachelor's degree or higher=1; Less than bachelor's degree=0
Household size	The house hold number
Salary Status	Salaried income=1, No monthly salary=0
Meals	Number of Meals including rice per day
Income	The median value /1000 of each category
Objective knowledge accuracy	The accuracy rate of six objective knowledge true/false questions
Cheap talk	Cheap talk script=1; No cheap talk=0
Information treatments	No specific trait information Health trait br (Golden rice) information, benefits first then risks Health trait rb (Golden rice) information, risks first then benefits Environment trait br (Bt rice) information, benefits first then risks Environment trait rb (Bt rice) information, risks first then benefits Stacked br health+environment information, benefits first then risks Stacked rb health+environment information, risks first then benefits
City size	Variable City was recorded by urban population density: Large population , median population ,small population
Residence	Governmental administrative divisions: Capital city, Secondary city, town, village

Media reliability	Respondents think that food related information from TV or Newspaper media were more reliable=1; If not =0

Table 9 Multinomial regression results to the reference question responses

Choice preferences	Prefer non GM rice		Prefer Indifferent		Prefer Neither	
	Coef.	P	Coef.	P	Coef.	P
Male	-0.36	0.13	-0.25	0.37	-0.54	0.39
Age	0.02	0.142	0.00	0.918	-0.01	0.657
Bachelor's degree	0.51	**0.04	0.14	0.63	0.55	0.42
Household size	0.05	0.59	-0.25	**0.04	-0.72	***0.01
Salary status	0.34	0.15	0.52	0.06	-0.48	0.45
Meals	0.11	0.6	0.11	0.63	-0.27	0.6
Income continuous	0.00	0.28	0.00	0.98	0.00	0.72
True false accuracy	-0.44	0.54	-0.46	0.59	-3.14	0.13
Cheap talk	0.30	0.21	0.06	0.83	0.46	0.45
Information and order(No information as base)						
Health trait br	0.86	*0.08	0.58	0.29	-0.27	0.83
Health trait rb	-0.03	0.94	-0.26	0.59	-1.15	0.35
Environmental br	0.25	0.56	0.21	0.68	0.78	0.4
Environmental rb	0.72	0.13	0.62	0.24	0.55	2.56
Stacked trait br	-0.10	0.81	-0.08	0.86	-0.62	0.55
Stacked trait rb	0.08	0.84	0.04	0.94	-13.61	0.98
City size (Middle base)						
Large	-1.00	***0.01	-1.28	***0.00	-1.56	**0.05
Small	-0.96	***0.00	-1.28	***0.00	-2.99	***0.01
Residence(Capital city base)						
Second level city	-0.97	**0.03	-0.11	0.83	1.13	0.38
Town	-0.99	**0.02	-0.56	0.26	-0.54	0.7
Village	-0.93	*0.06	-0.22	0.71	1.34	0.34
Media reliability	-0.43	*0.07	-0.18	0.52	-0.32	0.61

***statistically significant at 1% level, ** at 5% level, * at 10% level.

The estimated coefficients are not easily interpreted quantitatively due to the nature of multinomial logistic model; alternatively they represent the logs of the odds ratios. For instance, respondents who live in the urban area and are not college educated are significantly less likely to purchase conventional rice over GM rice. Generally, a positive coefficient represents higher probability to choose the conventional rice product over GM rice, and a negative coefficient means a lessening probability to choose the conventional rice compared to the GM rice.

Relative risk ratio and adjust predictions between treatments

The ratio of the probability of choosing an outcome over the base outcome is referred as relative risk ratio. The relative risk ratio yields the regression coefficients as one unit change in the predictor variable. It can be obtained by exponentiating the multinomial logit coefficients. STATA command ***rrr***. was applied and the results are presented at table 10.

Table 10 The relative risk ratio

Choice preferences	Prefer non GM rice		Prefer Indifferent		Prefer Neither	
	RRR	P-value	RRR	P-value	RRR	P-value
Male	0.70	0.13	0.78	0.37	0.58	0.39
Age	1.02	0.14	1.00	0.92	1.00	0.65
Bachelor's degree	1.67	**0.04	1.15	0.48	1.74	0.80
Household size	1.06	0.54	0.78	***0.04	0.49	***0.02
Salary status	1.41	0.15	1.68	*0.06	0.62	0.45
Meals	1.11	0.60	1.12	0.63	0.77	0.59
Income continuous	1.00	0.28	1.00	0.98	1.00	0.72
True false accuracy	0.64	0.55	0.63	0.59	0.04	0.13
Cheap talk	1.34	0.21	1.06	0.83	1.59	0.45
Information and order(No information as base)						
Health trait br	2.37	*0.08	1.79	0.29	0.76	0.83
Health trait rb	0.97	0.94	0.77	0.59	0.32	0.35
Environmental br	1.28	0.56	1.23	0.67	2.18	0.39
Environmental rb	2.06	0.13	1.87	0.24	1.73	0.56

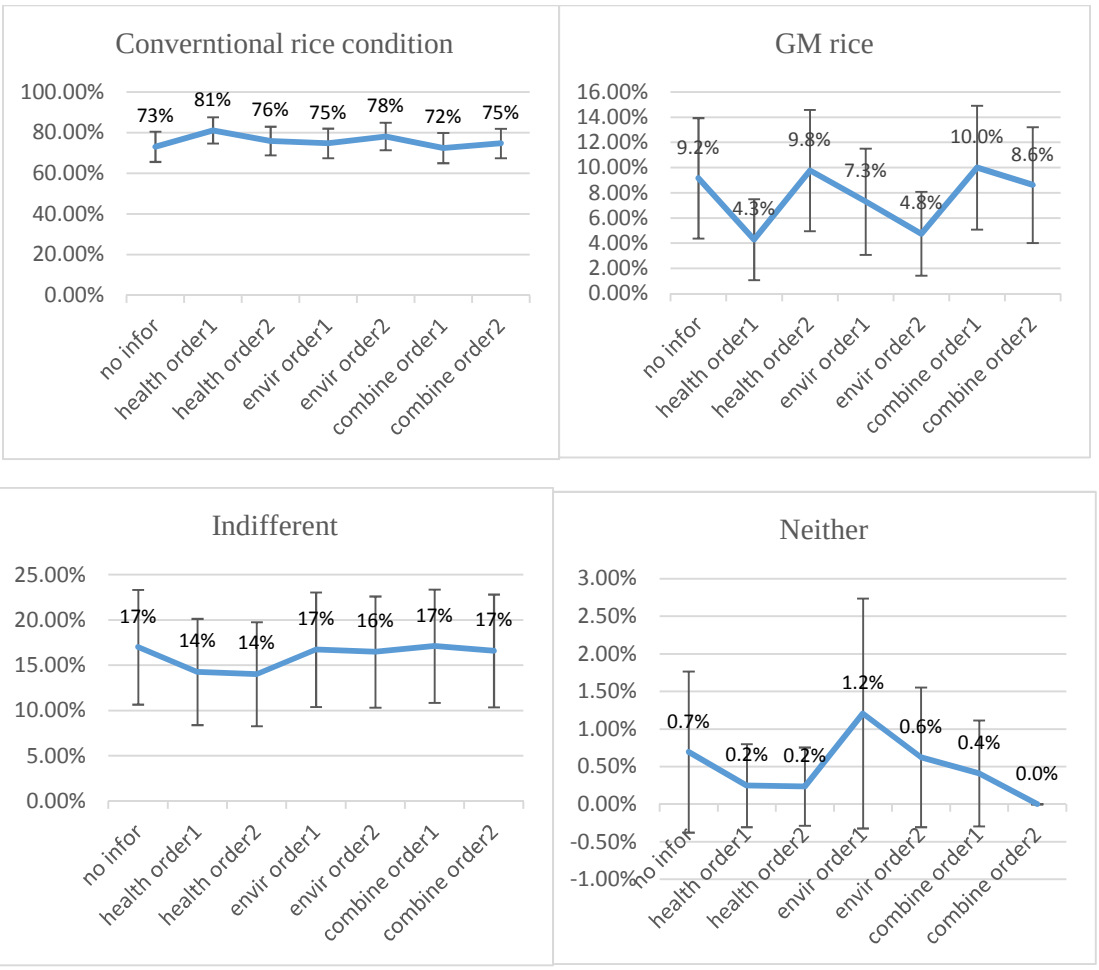
Stacked trait br	0.91	0.80	0.92	0.86	0.54	0.55
Stacked trait rb	1.09	0.84	1.04	0.94	0.00	0.98
City size (Middle base)						
Large	0.37	***0.00	0.28	***0.00	0.21	**0.05
Small	0.38	***0.00	0.28	***0.00	0.05	***0.00
Residence(Capital city base)						
Second level city	0.38	***0.03	0.89	0.83	3.09	0.88
Town	0.37	***0.02	0.57	0.25	0.58	0.69
Village	0.40	*0.06	0.81	0.71	3.82	0.34
Media reliability	0.65	*0.07	0.84	0.52	0.73	0.61

***statistically significant at 1% level, ** at 5% level, * at 10 % level.

To illustrate the results with respect to the coefficients of the previous M-logit model, given that the other variables in the models are held constant, the relative risk of choosing conventional rice over GM rice is expected to increase by a factor of 1.67 for respondents who had bachelor degree relative to those who did not. One unit increase in household size would decrease the relative risks for preferring indifferent and neither over GM rice by 0.8 and 0.5. More generally, if a subject were to have one more household member and failed to have a bachelor's degree, he would be expected to prefer GM rice as compared to other alternatives.

Figure 7 plots predicted preferences of referendum questions by treatments under four different outcomes with other variables set at their mean values.

Figure 7 The adjusted prediction of rice preferences under treatments with 95% CIs



Marginal effects estimation

The estimations of the multinomial logistic model are difficult to interpret quantitatively, and the illustration from the relative risk model can be difficult to comprehend. To better understand the m-logit model coefficient estimates, marginal changes in probabilities were computed for the four outcomes with all continuous variables set at their mean values. A post estimation method called contrast of margins was applied to extend model capabilities of contrasting nonlinear responses. MERS (marginal effect at representative values) were computed to obtain the overall effect of the factor variables and illustrate intuitively meaningful results.

Table 11 MERs (marginal effect at representative values) of the four outcomes in M-logit model

Variables	Non-GM rice	GM rice	Indifferent	Neither

	MER	P-value	MER	P-value	MER	P-value	MER	P-value
Male	-3.45%	0.22	2.62%	0.15	1.06%	0.66	-0.23%	0.70
Bachelor's degree	7.46%	***0.01	-3.39%	*0.07	-4.23%	*0.09	0.16%	0.82
Salary status	0.71%	0.80	-2.87%	0.13	3.02%	0.21	-0.86%	0.20
Cheap talk	4.47%	*0.10	-1.94%	0.28	-2.78%	0.23	0.25%	0.68
Information and order (No information base)								
Health br	8.77%	**0.08	-5.36%	*0.09	-2.43%	0.58	-0.98%	0.37
Health rb	3.12%	0.55	0.73%	0.84	-2.84%	0.51	-1.01%	0.35
Environment br	1.34%	0.80	-2.04%	0.56	-0.37%	0.93	1.08%	0.51
Environment rb	5.36%	0.29	-4.85%	0.13	-0.36%	0.94	-0.15%	0.90
Stacked br	-0.49%	0.93	0.93%	0.80	0.18%	0.97	-0.62%	0.59
Stacked rb	2.23%	0.67	-0.51%	0.89	-0.16%	0.97	-1.55%	0.11
City size(Middle as base)								
Large	-1.21%	0.76	7.11%	**0.03	-5.16%	0.13	-0.74%	0.39
Small	0.04%	1.0	6.85%	***0.01	-5.38%	*0.07	-1.50%	**0.03
Administrative divisions(Capital city base)								
Second level city	-16.26%	***0.0	4.90%	*0.06	9.83%	***0.01	1.53%	* 0.09
Town	-9.92%	***0.01	5.95%	***0.01	3.86%	0.26	0.11%	0.79
Village	-14.21%	***0.00	4.78%	0.12	7.52%	*0.09	1.91%	0.14
Media reliability	-5.73%	**0.04	2.93%	* 0.10	2.77%	0.24	0.03%	0.96

***statistically significant at 1% level, ** at 5% level, * at 10% level.

Variable means: Age=37.6, Household=3.5, Income=7261.6, True false accurate rate = 0.36.

Based on the results from Table 11, we can interpret the marginal probability of each outcome over different variables. These marginal effects represent changes in probabilities of selecting outcomes. Respondents who had a bachelor's degree were 7.46% more likely to choose "Non-GM rice" and 3.4% less likely to choose "GM rice" among all the alternative options. Having a bachelor's degree also decreased the probability of choosing "Indifferent" by 4 % (p-value < 0.10). The administration of the cheap talk script applied increased the probability of choosing "non-GM rice" 4.5% (p-value < 0.10. Compared to those who had the no specific trait information treatment, respondents who had "Health br" treatment are 8.77% more likely to choose "non-GM rice", 5.4% less likely to choose "GM rice" (p-value < 0.10), and 2.4%, and 1% less likely to choose "Indifferent" and "Neither" thought both are insignificant.

Compared to respondents who lived in a middle-sized city, people who lived in either a large or small population density city were more likely to choose “GM rice” over the other three alternatives. Respondents who lived in a capital city were significantly more likely to choose “conventional rice” and those who lived in town were 6% significantly more likely to choose “GM rice”. Respondents who thought TV and newspaper media sources offered more reliable food information were significantly less likely to pick “non-GM rice” by 5.7% and more likely to pick other outcomes on the response scale. In conclusion, respondents who lived in a capital city, had a bachelor’s degree, had a health related information formatted in benefit risk order treatment are more likely to choose non-GM rice; respondents who lived in a small city or town, did not have a bachelor’s degree and had “no information” treatment were more likely to choose GM rice over other alternative rice products regardless of price difference

Double bounded contingent valuation and WTP

Based on the answer to the reference question, the sample was divided into three sub samples. 725 respondents who chose non-GM rice were assigned lower starting prices in the double bounded questions set; those respondents who preferred GM rice and those who were indifferent were grouped together as 254 observations to a higher starting prices double bounded questions set; the 15 respondents who showed no preference to purchasing rice products were excluded from the WTP estimation. The double bounded elicited module in STATA was utilized to obtain the DBDC parameter estimates (Lopez-Feldman, 2012). Table 12 summarizes the additional independent variables’ description for the double bounded analysis included as the DBDC but not the multinomial logit regression.

In the survey, many variables were had more response categories than what were actually used in the DBDC model. Here we provide a detailed explanation about how we merge

the sub categories. The education level was simply redefined into a dummy variable of whether the subject had a college education or not. “Having a stable wage” acted as a standard line to adjust the career classification. “The rice purchasing frequency” and “GM rice prior knowledge” were redefined into three levels. When referring to media reliability, “TV” and “Newspaper, magazines and books” were determined as government controlled media sources, and the other as non-government controlled sources. The acceptance rate of rice products over 50% was considered as 1, and less than 50% as 0 when process the analysis.

Table 12 Variable description of DBDC model

Original categories	Variable label	Description
Information and order treatment combination	EO1	Environmental information benefit risk order
	EO2	Environmental information risk benefit order
	HO1	Health information benefit risk order
	HO2	Health information formatted in order2
	CO1	Aggregated information formatted in order1
	CO2	Aggregated information formatted in order2
Meals	Meals	Number of meals with rice per day
Administrative division	VL1	Respondents reside in capital cities
	VL2	Respondents reside in secondary cities
	VL3	Respondents reside in towns
	VL4	Respondents reside in villages
Rice purchase frequency(rp)	Once/month	Respondents who purchase rice once a month
	< once	Purchase rice less than once a month
	> once	Purchase rice more than once a month
Rice stock	<5kg	Current house rice stock less than 5 kg
	5kg-10kg	5kg<Current house rice stock<10kg
	>10kg	Current house rice stock more than 10kg
Heard of Terms	terms_1	Heard of term: hybridization
	terms_2	Heard of term: Gene
	terms_3	Heard of term: biotechnology
	terms_4	Heard of term: Genetically modified food

Subjective knowledge(GMPK)	Gm good	Subjectively valued GM knowledge as good
	Gm neutral	Subjectively valued GM knowledge as normal
	Gm poor	Subjectively valued GM knowledge as poor
Golden rice case	golden	Have heard the 2012 golden rice case
Acceptance of GM products	ac1	Acceptance rate of GM soybean oil over 50%
	ac2	Acceptance rate of GM fed livestock maize over 50%
	ac3	Acceptance rate of GM pest resistant rice over 50%
	ac4	Acceptance rate of GM health enhanced rice over 50%
Objective knowledge	TF accuracy	The accuracy ratio for six true false questions

Lower starting prices DBDC and WTPs

Each respondent who preferred non-GM rice for the reference question was assigned to the lower starting price double bounded dichotomous question set. Ten starting prices from 2.5 Yuan/kg to 4.75 Yuan/kg with a 0.25 Yuan/kg interval were randomly assigned to the 725 participants. Based on the response on the first bound question, a follow-up dichotomous question was then provided with the secondary price set as either double or half the premium (here we defined the premium as the price difference between the starting point price and the reference price of 5Yuan/kg for non-GM rice). The proportion of positive answers declined as first bound prices increased, which indicated that individuals were sensitive to the bid amount. Regardless of the difference in starting prices, 72.5% respondents chose “no” to buy GM rice at the first bid questions. Table 13 summarizes how respondents react according to different bidding prices.

Table 13 Responses according to biding prices for the lower DBDC group

Starting prices	First responses	Number	Secondary prices	No	Yes

			and responses		
2.5	No	44	0	28	16
	Yes	31	3.75	5	26
2.75	No	44	0.5	39	5
	Yes	23	3.875	4	19
3	No	57	1	48	9
	Yes	18	4	4	14
3.25	No	43	1.5	34	9
	Yes	30	4.125	11	19
3.5	No	48	2	36	12
	Yes	23	4.25	6	17
3.75	No	47	2.5	37	10
	Yes	20	4.375	12	8
4	No	61	3	49	12
	Yes	17	4.5	9	8
4.25	No	54	3.5	39	15
	Yes	12	4.625	6	6
4.5	No	59	4	55	4
	Yes	19	4.75	7	12
4.75	No	69	4.5	63	6
	Yes	6	4.875	1	5

The fact that the proportion of positive answers declines as the prices increased proved that our subjects were sensitive to price discounts. Regardless of price difference, 526 participants chose "no" to purchase GM rice at the starting prices. At the second round dichotomous question, with different level of price discounts, 493 "no" answers were observed versus 232 "yes". A majority of the respondents of this group went through a second bounded question with prices discounts for GM rice, however, the expanded discount seemed unattractive, and the amount of "no" responses far exceeded the "yes" responses. Therefore, a lower WTP was expected to be predicted from the DBDC model. Table 14 summarizes the DBDC model estimation.

Keeping other variables at their mean value, having a bachelor's or higher degree decreased the willingness to pay by 0.56 Yuan. A one unit increase in household number decreased WTP by 0.24 Yuan. A one unit increase in meals with rice per day decreased the WTP for GM rice by 0.48 Yuan. A thousand Yuan increase of a respondent's monthly salary

significantly decreased the WTP for GM rice by 7 Fen (0.07 Yuan). Purchasing rice on a monthly basis decreased the WTP for GM rice by 0.8 Yuan. Respondents whose household rice stock is less than 5 kg had a 1 Yuan lower WTP than respondents from households with other stock levels. The awareness of hybrid technology and bio-technology also negatively affected the WTP in by decreasing the price of GM rice 1.4 Yuan and 1 Yuan, respectively. Subjects who stated their understanding of GM rice as good or normal were willing to pay less for GM rice by 0.86 Yuan and 0.76 Yuan. Not surprisingly, the acceptance of GM related products had a positive impact on the WTP of GM rice. Relative to Bt rice, a one unit increase of acceptance for GM soybean oil, GM corn-fed livestock and GM health enhanced rice increased the WTP of GM rice by 0.7 Yuan, 1.2 Yuan and 1 Yuan, respectively.

Table 14DBDC model for lower starting price sub-sample(n=725)

Variables	Coef.	P-value
EO1	0.03	0.96
EO2	-0.17	0.75
HO1	-0.34	0.51
HO2	-0.58	0.27
CO1	-0.06	0.92
CO2	-0.44	0.40
Cheap talk	0.3	0.28
Male	0.08	0.78
Age	0.01	0.44
Have bachelor's degree*	-0.56	0.10
Household size*	-0.24	0.06
Salary status	-0.25	0.38
Income ***	-0.07	0.00
Meals*	-0.48	0.06
Capital city	-0.42	0.47
Secondary city	-0.8	0.11
Town	-0.09	0.82
Large population city	-0.62	0.14
Small population City	0.15	0.68
Purchase rice once a month**	-0.78	0.03
Purchase rice less than once a month	-0.36	0.38

Current rice stock<5kg***	-0.99	0.02
Current rice stock 5kg-10kg	-0.5	0.14
Heard of Hybridization***	-1.36	0.00
Heard of Gene	0.16	0.76
Heard of Biotechnology***	-0.99	0.01
Heard of GMO*	-0.3	0.55
GM rice good*	-0.86	0.09
GM rice neutral*	-0.75	0.08
Heard of golden rice case in 2012	-0.48	0.14
GM soybean oil acceptance**	0.74	0.06
GM corn fed livestock acceptance ***	1.21	0.00
GM pest resistance rice acceptance	0.44	0.21
Health enhanced GM rice acceptance ***	1.09	0.00
Media source reliability	-0.16	0.56
Objective knowledge accuracy	-0.26	0.76

***statistically significant at1% level, ** at 5% level,* at 10% level

Variables: “VL4”, “ middle city”, “ >once” , “ >10kg” and “gm bad” were omitted to avoid collinearity.

To verify the significance between treatments, several Wald tests were computed. Firstly, the seven coefficients with respect to treatments were hypothesized to be zero. Then differenced values of informational paired coefficients were compared with zero to see if there are effects of formatted orders and information type. Lastly, the values from the second test were tested against each other to check the order effect across type of information. All Wald tests were all rejected. Bootstrapping was first introduced by Efron et al 1979, it draws with replacement amount of observations from the total sample with the interested parameter and collected statistics, providing a way of measuring standard error and providing better projections. The bootstrapping command was used to test the significance between treatments, and predictions of WTPs. Table 15 summarize the results.

Table 15 Mean WTP for GM rice by respondents who preferred non-GM rice

WTP	Yuan/kg	Std.Err

Mean	1.60	0.37
No specific trait information	1.83	0.51
Health trait information	0.91	0.73
Environmental trait information	1.69	0.72
Stacked trait information	1.33	0.73
Order benefits risks	1.46	1.04
Order risks benefits	0.64	1.04
With cheap talk	1.45	0.40
Without cheap talk	0.76	0.39

Table 15 presents the WTP estimates among information treatments. With every variable set at their mean value, the mean WTP for GM rice by this particular group is 1.60 Yuan/kg, which is a 68% discount from non-GM rice price at 5 Yuan/kg. The WTP for respondents who received the neutral no specific trait information treatment was 1.83 Yuan/kg which was significantly higher than the mean WTP and other information treatments.

Consumers who were provided with health related information registered the lowest WTP among the information treatments at 0.91 Yuan/kg, not significantly different from 0. A low WTP result was also obtained for the stacked event rice trait information and order formatting. The mean WTP under different information treatments provided the following WTP rank of No specific trait information> environmental trait information> stacked trait information>health information. With respect to benefits and risk information ordering, respondents were WTP a much higher amount when informed of benefits followed by risks than vice versa. Indeed when risks were presented first, respondents had a very low WTP for GM rice of 0.64 Yuan/kg, not significantly different from zero. Cheap talk was tested as the calibration method. The results suggest that hypothetical bias for this sample that prefers non-GM rice lowers the WTP estimate for GM rice. The WTP estimate was almost twice higher for the

respondents provided the cheap talk script. This result suggests that the respondents in this particular group had a significantly large hypothetical bias against GM rice.

The effects of the variables presented in Table 14 on the WTP provide additional insights. Treating the respondent as one who purchases rice once a month, leaving all other independent variable values as their mean values, the WTP is 1.28 Yuan/kg, 20% lower than the Mean WTP. Respondents whose current rice stock was less than five kilograms offered a WTP of 1.05 Yuan/kg for GM rice. Compared to those who had no awareness of hybrid technology and biotechnology, respondents who had heard of these terms were willing to pay much less for a kilogram of GM rice, 1.33 Yuan/kg vs.2.68 Yuan/kg; and 1.31 Yuan/kg vs.2.30 Yuan/kg, respectively. Respondents who indicated a high acceptance of GM soybean, GM corn fed livestock, and health enhanced rice, were WTP more for GM rice. The WTP estimates for GM rice were: 1.92, 2.10, and 2.04, respectively, exceeding the mean WTP for the total sample. Consumers with less than a bachelor's degree were WTP more for GM rice than those who had a bachelor's or higher degree, (1.87 Yuan/kg vs.1.33 Yuan/kg) however, it was only significantly differently at the 90% level. Respondents who had more intensive rice diets were WTP less for GM rice. Respondents who subjectively considered themselves with good and normal knowledge on GM rice were willing to pay significantly less than those who considered themselves less knowledgeable. Finally, respondents with higher incomes were WTP significantly less for GM rice

Higher starting prices DBDC and WTPs

The same DBDC analysis was conducted for the sub-sample who responded to the reference question as having preferred GM rice or was indifferent to GM and non-GM rice at a price of 5 Yuan/kg. This sub-sample of 254 respondents were randomly assigned to 10 higher

starting prices for the first bound ranging from 5.25 Yuan/kg to 7.5 Yuan/kg with a 0.25 Yuan/kg

Starting prices	First responses	Number	Secondary prices and responses	No	Yes

interval. The “yes” “no” responses scale was listed at below table, and it showed that respondents for this group were also price sensitive. Table 16 presents the responses scale for the higher DBDC group.

We observed that the proportion of positive answers declined as the prices increased, which indicates that our subjects are price sensitive. Regardless of price difference, 156 participants stated “no” interest in purchasing GM rice at the staring prices. When provided with certain price discount, 74% still rejected to purchase GM rice. In this subgroup, the double bounded response scales are 115:41:59:39. (NN, NY, YY, YN)

5.25	No	15	5.125	9	6
	Yes	18	5.5	6	12
5.5	No	11	5.25	8	3
	Yes	12	6	3	9
5.75	No	23	5.375	19	4
	Yes	12	6.5	7	5
6	No	16	5.5	11	5
	Yes	11	7	5	6
6.25	No	25	5.625	17	8
	Yes	8	7.5	4	4
6.5	No	11	5.75	9	2
	Yes	13	8	8	5
6.75	No	15	5.875	10	5
	Yes	9	8.5	3	6
7	No	16	6	12	4
	Yes	3	9	1	2
7.25	No	8	6.125	6	2
	Yes	3	9.5	0	3
7.5	No	16	6.25	14	2
	Yes	9	10	2	7

Table 16 Responses according to biding prices for the higher DBDC group

With only 254 observations, using the same variables the fewer observations from the lower DBDC model might diminish estimation accuracy. Therefore, several variables were modified. Instead of setting sub factors as individual dummy variables and a base line, categorical variables were introduced as they were designed in the survey questionnaire. Table 17 summarizes the analytical results for the higher DBDC model.

Variables	Coef.	P

EO1	0.18	0.76
EO2	0.28	0.66
HO1	-0.86	0.20
HO2	0.20	0.74
CO1	0.78	0.18
CO2	-0.17	0.78
Cheap talk	-0.3	0.38
Male	0.23	0.49
Age**	0.03	0.05
Have bachelor's degree	0.38	0.39
Household size	0.08	0.60
Salary status**	-0.73	0.05
Income ***	0.05	0.00
Meals	0.43	0.14
Rice purchase frequency	-0.18	0.42
Current rice stock	-0.10	0.68
Heard of Hybridization	-0.1	0.82
Heard of Gene	-0.22	0.74
Heard of Biotechnology	0.35	0.44
Heard of GMO	-0.54	0.38
GM rice good	-0.11	0.85
GM rice neutral	0.62	0.23
Heard of golden rice case in 2012**	0.87	0.02
GM soybean oil acceptance	0.56	0.34
GM corn fed livestock acceptance	0.30	0.62
GM pest resistance rice acceptance	-0.14	0.78
Health enhanced GM rice acceptance	0.16	0.19
Media source reliability*	-0.16	0.07
Objective knowledge accuracy**	2.47	0.02
***statistically significant at1% level, ** at 5% level,* at 10% level		

Table 17 DBDC model for higher starting price sub-sample (n=254)

As clear from Table 17, relatively few variables were statistically significant. Age of the respondent was associated with a higher WTP; a one unit increase in age would lead the WTP increase by 3 Fen. A one unit (1000 Yuan) increase in income would also increase the WTP by 5 Fen/kg. Holding other variables at their mean values, respondents who were salaried were WTP 0.73 Yuan/kg less than those who were not. Objective knowledge was associated with a significantly higher WTP. The difference between 100% accuracy rate and 0% accuracy rate was 2.47 Yuan/kg. Surprisingly, the awareness of 2012 Golden rice experimental event was associated with a significantly higher WTP by 0.87 Yuan/kg. Respondents who were aware of the school children Golden rice

experimental study were WTP 6.16 Yuan/kg compared to 5.29 Yuan/kg by those who were not aware of this scandal.

Table 18 Mean WTP for GM rice by respondents who preferred or were indifferent to GM rice

WTP	Yuan/kg	Std.Err
Mean	5.72	0.168
No specific trait information	5.62	0.418
Health trait Information	4.96	0.804
Environmental trait information	6.07	0.750
Stacked trait information	6.23	0.733
Order Benefits risks	5.72	1.143
Order Risks benefits	5.92	1.138
With cheap talk	5.55	0.252
Without cheap talk	5.85	0.227

The mean WTP for GM rice by the upper price bound sub-sample was 14.4% higher than for non-GM rice. The WTP ranked by information treatment was: Stacked trait information > Environmental trait information > No specific trait information > Health trait related information. In this higher starting prices DBDC group, respondents were WTP more for environmental trait GM rice than for the health trait GM rice. The ordering effect of benefits and risks had no significant effect even though, surprisingly, the WTP when risks were ordered first was slightly higher than the WTP when benefits were ordered first. Also the calibration using the cheap talk script showed no significant difference in WTP, although there was a slight bias to a higher WTP by those respondents who were not administered the cheap talk script.

The mean willingness to pay for the GM rice for the total sample is 2.67 Yuan/kg, which was 47% lower than the conventional rice price. The total mean WTP was estimated by the weighted ratio of the two groups. The result suggests that consumers are only willing to purchase GM rice with a substantial, percentage price discount; concerns remain for the daily consumption of GM rice.

V. SUMMARY AND CONCLUSIONS

This paper provides an assessment of Chinese consumer attitudes and WTP for GM rice based on a survey of 994 urban consumers in the summer of 2013. The survey covered thirteen main rice producing provinces along the Yangzi River and the Pearl River Delta area. We also collected socio-demographic information with regards to objective and subjective knowledge of genetically modified organisms. Using a set of true-false questions, this study found an improvement with regard to consumer's objective knowledge about bio-technology compared to findings from a survey conducted ten years ago that used identical questions.

Under Fishbein et al. (1963) "bottom up" attitude framework, consumers can be classified according to their attitudes towards a product. Their attitude towards a certain product is based on knowledge and the product attributes. By asking consumers whether they had heard of GM related terms, we found the greatest familiarity was for the terms "genetics" and "GMO". In general, higher income and higher education are associated with greater awareness of "GMO"; other career types and federal government employees were associated with lower awareness of "GMO".

To further study the acceptance of GM related products, two Tobit models were estimated. It was found that consumer acceptance differed significantly as a function of age, gender and objective knowledge about transgenic terminology. Higher income and residing in a suburban area were associated with increased acceptance of Bt rice. Lower income and higher levels of subjective knowledge about GM rice increased the acceptance of health enhanced rice.

This study used a reference question to create sub-samples of respondents according to their preference for GM rice relative to non-GM rice at a reference price of 5 Yuan/kg. A large

majority, 73% of the sample, preferred non-GM compared to GM rice. The remainder of the sample responded to the reference question as either preferring GM rice to non-GM rice (9%) or were indifferent (17%). Without a price difference, consumers who had achieved a higher education level (bachelor degree) and those who had received the health information treatment with a risk–benefit information order were more likely to choose ordinary rice rather than GM rice. Suburban and rural respondents had higher acceptance toward GM rice.

Two DBDC models were estimated using sub-samples that were created according to the reference question to compute the WTP. The mean WTP estimate for GM rice by those who preferred non-GM rice suggested that a discount of 68% was required to make GM rice competitive. The mean WTP for those who preferred or were indifferent to GM rice had a WTP premium for GM rice of 14.4%. I found that consumers are divided in groups that range from acceptance and optimism regarding GM food improvements to pessimism and rejection. Socio-demographic variables that significantly lowered the WTP estimate for GM rice by those who preferred non-GM rice included education level, household size, income level, rice intensity of their diet, small household inventory of rice stocks, awareness of terminology 'hybridization' and 'biotechnology' and the respondent's subjective knowledge of GM rice. A higher WTP was associated with respondents who were more likely to accept GM soy oil, livestock fed GM maize, and health-enhanced GM rice. For the respondents who preferred GM rice or were indifferent, their willingness to pay for GM rice was negatively associated with having a salaried job and trusting TV, radio and print media as more reliable sources of information on food. WTP by this group was significantly, positively related to respondent's age, income, objective knowledge of genetic and biotech facts and awareness of the Golden rice scandal. Our results showed that consumers' purchase behavior with regards to GM rice is mainly negative: the total mean WTP

for the whole sample was estimated by a weighted average of the lower price and higher price groups, and an average 47% price discount was estimated.

Along with previous findings (Hossain et al. 2003), our results showed that consumers were much segmented with respect to acceptance and attitudes toward GM rice. Individual values and attributes appear as key determinants underpinning consumer attitudes. In this study, respondents were randomly assigned to receive different information treatments. The mean WTP rank of those who prefer non-GM rice for GM rice was: No specific trait information> environmental trait information> stacked trait information>Health information. The WTP rank for those who prefer GM rice was: Stacked trait information > Environmental trait information > No specific trait information > Health trait related information. Even through in the DBDC analyses, the WTPs were found to be not significantly different between treatments. Respondents who received health related trait information generally had a lower willingness to pay. This indicated that Chinese consumer had more concerns about the biosafety than environmental sustainability.

Many previous studies have investigated the factors that affect consumers' acceptance and willingness to pay for the GM rice. Prior knowledge, education, administrative division, media effects, etc. have been identified as having significant impacts on altering consumers' purchasing behavior. Among the previous studies, Lin et al. (2006) presented a relatively comprehensive analysis of the demographic and other factors which may have an impact on WTP for Bt rice using the data that Huang and Bai collected in 2002. With the tremendous expansion of the GM rice research and development, we surmise that the public has been exposed to more information and has developed a better understanding about GM products. With

the increase of formal and unofficial discussions on this topic in public or the legislative assembly, the Chinese people's inclination toward GM rice has been altered. Our last hypothesis then is that the consumers' attitude towards GM rice will be changed by the increased supply of information, and their acceptance of GM rice will be influenced by media effects.

Compared to a similar study by Lin et al. (2007) our results showed a much lower acceptance rate for GM rice. The results suggest that the government of China is facing an increasingly difficult barrier by consumers for the commercialization of GM rice. The results suggest that the type of science-based information had little effect on WTP. While this study did not test non-science based information relative to science-based information, it can be argued that the importance of providing science-based objective information to improve the knowledge of Chinese consumers will be important to achieve broad acceptance. Respondents who thought they were more knowledgeable about GM rice are associated with a significantly lower WTP for GM rice. If the government of China is to be successful in its campaign to boost rice productivity through biotechnology, it will not only have to provide more science-based information, but also change entrenched negative attitudes and opinions with regard to GM rice.

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Appendix

Survey questionnaire

Survey code:

CC01P1

The Survey for Chinese city consumers' WTP and acceptance for genetically modified rice

Dear respondents:

Greetings, this is _____, I am a student of China Agricultural University I would like to ask you for assistance in participating in our survey. This survey is conducted to study consumer purchase behavior for GM rice in China. In the survey, you will see questions about consumer acceptance and prior knowledge towards GM rice. Your responses on the survey will be record anonymously. No identifying personal information will be collected. Only basic demographic information will be collected and the data will be sealed and maintained in secrecy. Your participation is highly appreciated.

Province (autonomous regions and municipalities)	
Cities	
Street	
ID	
Enumerator's ID	
Date	

Part One. Demographic Questions

1.1.1	1.1.2	1.1.3	1.1.4	1.1.5	1.1.6	1.1.7
Gender 1=male 2=female	Age	Education level(coded as follow)	Household size	National administrative divisions (Residence)	Career classification	Household monthly income

1.1.3 Education level code: 1. Less than or equal to Elementary school, 2.Junior high school or equal level technical school, 3.Senior high school or equal level technical school, 4.College or Bachelor degree, 5. More or equal to Master degree.
1.1.5 National administrative divisions: 1.Provincial capital or Municipality, 2.Cities, 3.County, 4.Town
1.1.6 Career classification: 1. Federal employee, 2.Company employee, 3.Private Enterprises owner or Individual Business owner, 4.Worker, 5.Farmer, 6.Unemployed, 7.Retired, 8. Student,9.Military duty, 10. Freelance, 11.Other
1.1.7 Monthly Income(RMB): 1. Less than or equal to 1,000 ,2.1,000-2,999 , 3.3,000-4,999 , 4.5, 000-6,999, 5. 7,000-8,999, 6.9, 000-10,999, 7.11, 000-19,999, 8.20, 000-29,999, 9.30, 000-29,999, 10. More than or equal to 40,000

1.2 How man meals did you take rice per day?

1.3 How often do you purchase rice?

a) Once every two months
b) Once a month
c) 2 to 3 times per month
d) Once a week
e) Multiple times per week
f) Never

1.4 What is the quantity of rice stock in your household on average?

a) Less than 5 kilograms
b) 5 to 10 kilograms
c) More than ten kilograms

Part Two Prior Knowledge test

2.1 True/ False question set

Statements	True	False	Not Sure
2.1.1 Ditch water harbors certain amount of bacteria			
2.1.2 Father's gene determines the gender of the child			
2.1.3 Genes only exist in Genetically modified food , not in conventional food			
2.1.4 If one consumers GM food, his gene will be modified as well			
2.1.5 It is not possible to transfer genes between animals and plants			
2.1.6 If we transfer a gene from a fish to a product, this product will taste like fish			

2.2 Have you ever head of the following terms?

Terms	Have you ever heard of this term? (y/n)	Where did you hear this term from?(code as follow)	How often did you hear this term?		
			Very often	Occasionally	Only once or twice
2.2.1 Hybridization					
2.2.2 Gene					
2.2.3 Biotechnology					
2.2.4 Genetically modified food					
Sources code: 1.TV or radio, 2.Newspaper, magazines or books, 3. Internet, 4. Friends or relatives, 5.Other.					

2.3 How extensive do you think your knowledge is about GM rice?

a) Very good (understand what are the pros and cons about GM rice)
b) Good (Have the basic knowledge about GM rice)
c) Normal (Heard of it, but don't exactly know it)
d) Bad (Never heard of it)
e) Don't know

2.4 Have you ever heard about the Golden rice exposure case in 2012?

a) Yes (I know exactly what happened)
b) Kind of (Occasionally heard from media source but not sure what happened)
c) No (I haven't heard it)

2.5 Which of the following sources do you think can provide more reliable information for food?

a) TV or radio
b) Newspaper, magazines or books
c) Internet
d) Friends or relatives
e) None of the above
f) Other_____

Part Three Acceptance and Attitude

3.1 Please rank your acceptance if the following GM products are put on the market

GM products	Acceptance Rank 1. Totally accept (100%) 2. Mostly accept (75%) 3. Neutral (50%) 4. Slightly against (25%) 5. Strongly against (0%) 6. Don't Know
3.1.1 Genetically modified soybean oil	
3.1.2 GM corn fed livestock	
3.1.3 Pest resistance GM rice	
3.1.4 Health enhanced GM rice	

Part Four Information shock and DBDC

Combined/ Aggregated information treatment (With framing ordering treatment): Order 1

Genetically modified rice uses bio-technology to express certain kinds of genes into the rice genome, which could confer the new variety of rice changes in terms of quality, appearances and nutritional traits.

The benefits of GM rice are:

1. It can reduce 40-60% of the pesticide applications, and save nine working days for farmers on pesticide spraying operation.
2. It can ease the pressure between productivity and ecosystem by reducing water pollution and soil degradation.
3. It can reduce the exposure of the farmers and the environment to the pesticide toxin.
4. GM rice boosts vitamin A intake compared to maize, improving the nutrition level for rice takers.
5. Increasing availability of vitamin A prevents night blindness in children caused by vitamin A deficiency and it strengthens the immune system for pregnant and lactating women.

The risks of GM rice are:

1. The *Bt.* Gene may attack non-target organisms or beneficial insects.
2. There is a 0.05% probability that the GM rice gene can escape to and contaminate other plants if GM rice variety was large scale cultivated.
3. Due to the self-renewal and rapid mutation, pests could adapt to bio-tech crops in unpredicted and disturbing ways.
4. There might be a small risk for the consumer to have a toxic or allergic reaction
5. The transgenic insertion of the new rice gene can result in an unstable gene structure of rice genome, the rearrangement of the rice genes can result in unpredictable risks.

As you prepare to answer the next few questions, please keep in mind the following phenomenon. According to our experience, we found that when a hypothetical question is given, it is easy to have a bias between the answer the participant provided to us compared to what they will actually do when the product is put on the market. Researches have shown that when respondents reply to hypothetical questions about choosing to purchase a product, 80% of the respondents will choose to purchase, but only 43% of the respondents actually bought this product when it is available in the market. Therefore in order to avoid this kind of bias, please imagine your household is ACTUALLY paying for the GM rice. "***If I choose to purchase GM rice, I have to pay the certain amount of ACTUAL money***."

4.1 Given that otherwise identical GM rice and Conventional rice is sold at the same price of 5 Yuan /kg, which of the following four options would you select?

a) Conventional rice (to 4.2)
b) GM rice (to 4.3)
c) Indifferent (to 4.3)
d) Neither (Thank you!)

4.2 Given that otherwise identical, conventional rice is sold at a price of 5Yuan/kg, m if GM rice is sold at 4.75 Yuan/kg, will you prefer to buy GM rice?

a) Yes(to 4.4)
b) No (to 4.5)

4.3 Given that otherwise identical, conventional rice is sold at a price of 5Yuan/kg, m if GM rice is sold at 5.25 Yuan/kg, will you prefer to buy GM rice?

a) Yes(to 4.6)
b) No (to 4.7)

4.4 Given that otherwise identical, conventional rice is sold at a price of 5Yuan/kg, m if GM rice is sold at 4.875 Yuan/kg, will you prefer to buy GM rice?

a) Yes
b) No

4.5 Given that otherwise identical, conventional rice is sold at a price of 5Yuan/kg, m if GM rice is sold at 4.5 Yuan/kg, will you prefer to buy GM rice?

a) Yes
b) No

4.4 Given that otherwise identical, conventional rice is sold at a price of 5Yuan/kg, m if GM rice is sold at 5.5Yuan/kg, will you prefer to buy GM rice?

c) Yes
d) No

4.5 Given that otherwise identical, conventional rice is sold at a price of 5Yuan/kg, m if GM rice is sold at 5.125Yuan/kg, will you prefer to buy GM rice?

c) Yes
d) No

Thank you!

The awareness of GM related terms between our study and 2002 study

Terminology (n=994)	Percent of respondents who had heard this term (%)		Term heard frequency (%)							
			Very often		Occasionally		Only once or twice		Never	
Year	2013	2002	2013	2002	2013	2002	2013	2002	2013	2002
1.Hybridization	78.67	90.9	23.64	58.7	44.67	29.5	10.36	2.7	21.33	9.1
2.Genetic	84.61	84.7	32.59	47.3	41.04	33.6	10.96	3.8	15.39	15.3
3. Bio-Tech.	69.22	77.3	18.61	35.8	38.43	36.5	12.17	5.0	30.78	22.8
4.GMO	86.12	66.6	35.11	22.9	39.53	33.8	11.47	9.9	13.88	33.4

The acceptance of different GM products.

		GM soybean oil		GM corn-fed live stocks		BT rice		Health enhanced rice	
Variables	Categories	Coef.	P>t	Coef.	P>t	Coef.	P>t	Coef.	P>t
Age		-0.26	*0.01	-0.30	*0.01	-0.29	*0.01	-0.39	*0.00
Male		6.04	*0.01	6.45	*0.00	7.99	*0.00	5.68	*0.02
Household size		-0.84	0.36	1.18	0.20	-1.49	0.14	-2.25	*0.03
Education (Base : primary school diploma)	Junior High	-6.76	0.17	0.58	0.91	-5.40	0.32	-6.33	0.25
	Senior High	-7.59	0.15	4.49	0.40	-3.92	0.49	-5.19	0.38
	Bachelor's degree	-11.95	*0.02	1.46	0.79	-2.65	0.64	-3.52	0.55
	Master's degree	-12.08	0.08	0.93	0.89	-5.58	0.45	-5.11	0.50
Income (Base : monthly salary less than 500 RMB)	1,000-2,999	-2.97	0.69	-9.98	0.19	-10.25	0.20	-14.06	0.09
	3,000-4,999	-6.89	0.35	-15.52	*0.04	-13.36	0.09	-8.42	0.30
	5,000-6,999	-1.80	0.81	-11.05	0.14	-6.28	0.43	-7.06	0.39
	7,000-8,999	-9.25	0.22	-19.04	*0.01	-17.94	*0.03	-11.27	0.18
	9,000-10,000	-9.74	0.23	-16.49	*0.05	-18.31	*0.04	-10.38	0.25
	11,000-19,999	-8.52	0.30	-16.22	*0.05	-15.71	0.07	-6.81	0.45
	20,000-29,999	1.59	0.88	-4.66	0.66	-10.15	0.38	-0.62	0.96
	30,000-39,999	-3.45	0.81	-6.14	0.68	-11.08	0.48	-2.50	0.88
	<= 40,000	2.55	0.83	-3.01	0.80	-3.39	0.79	10.52	0.41
Administration Division (Base: Capital city)	Second level city	-1.69	0.62	3.05	0.38	10.58	*0.01	1.49	0.70
	Town	0.40	0.90	5.62	0.08	8.01	*0.02	1.74	0.62
	Village	-6.82	0.07	3.85	0.32	9.81	*0.02	4.35	0.31
True false questions	Question 2.1.1	0.80	0.88	5.15	0.35	11.05	0.07	6.84	0.26
	Question 2.1.2	0.20	0.93	-0.91	0.70	-3.18	0.21	-4.35	0.10
	Question 2.1.3	0.40	0.89	1.55	0.60	0.74	0.82	-0.33	0.92
	Question 2.1.4	11.79	*0.00	9.55	*0.00	9.74	*0.00	10.66	*0.00
	Question 2.1.5	-2.31	0.33	-4.20	0.08	-1.44	0.58	-1.70	0.52
	Question 2.1.6	-1.38	0.56	-1.25	0.60	1.18	0.65	1.19	0.66
Prior Knowledge (base: Very good)	Good	12.31	0.06	10.58	0.11	19.06	*0.01	15.44	*0.03
	Neutral	5.84	0.37	1.44	0.83	7.50	0.29	8.73	0.23
	Bad	-5.22	0.45	-9.40	0.18	2.30	0.76	9.52	0.22
	Don't know	-14.89	0.12	-13.75	0.15	-14.61	0.16	-3.68	0.73

UNIVERSITY OF ARKANSAS

Office of Research Compliance
Institutional Review Board

May 15, 2013

MEMORANDUM

TO:	Jing Jin Eric Wailes
FROM:	Ro Windwalker IRB Coordinator
RE:	New Protocol Approval
IRB Protocol #:	13-04-693
Protocol Title:	*Consumer Acceptance and Willingness to Pay for Genetically Modified Rice in China*
Review Type:	☐ EXEMPT ☒ EXPEDITED ☐ FULL IRB
Approved Project Period:	Start Date: 05/15/2013 Expiration Date: 05/09/2014

Your protocol has been approved by the IRB. Protocols are approved for a maximum period of one year. If you wish to continue the project past the approved project period (see above), you must submit a request, using the form *Continuing Review for IRB Approved Projects*, prior to the expiration date. This form is available from the IRB Coordinator or on the Research Compliance website (http://vpred.uark.edu/210.php). As a courtesy, you will be sent a reminder two months in advance of that date. However, failure to receive a reminder does not negate your obligation to make the request in sufficient time for review and approval. Federal regulations prohibit retroactive approval of continuation. Failure to receive approval to continue the project prior to the expiration date will result in Termination of the protocol approval. The IRB Coordinator can give you guidance on submission times.

This protocol has been approved for 1,920 participants. If you wish to make *any* modifications in the approved protocol, including enrolling more than this number, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 210 Administration Building, 5-2208, or irb@uark.edu.