

A Rational Look at GMOs

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Foreword

GM technology is new and so is modern bio-breeding industry, both seeing broad prospects. GM technology is aimed at introducing artificially separated or modified genes into organisms to make them meet the needs of agricultural production and human consumption, in regard of disease/insect resistance, degeneration resistance, nutrition and quality augmentation, being the new frontier of modern biological studies.

Presently, there is a strong global trend of GM technology development, as all developed countries are making dedicated efforts to take the commanding height and many developing countries working proactively to keep up in the field. As a large agricultural country and agricultural product consumer, China is confronted with challenges such as a large population, little arable land, water shortage, drought and flooding and frequent disease and pest breakouts. Technological renovation is the only way to ensure our food safety and effective important agricultural product supply by finding our place in the high-tech area of GM technology to boost our say.

Looking back on the history of technological development in the world, major scientific discoveries, theoretical renovations and technological breakthroughs are always coupled with intense debates but never held back by them, as continuous progress is made in the discussions, which will eventually serve our communities and benefit the mankind. GM technology development is no exception. In China, the contention over the GMO issue in recent years is focused on, primarily, food and environment safety from a scientific perspective, which later extended to the industrial safety issue.

Generally speaking, the public have 3 GMO related concerns: first, consumption safety, for fear that it would endanger human health and affect our future generations; second, bio-environment safety, for fear that GM crop release may lead to herbicide-tolerant and insect-resistant plants that may threaten biodiversity; third, possibility of affecting China's industrial safety when GMOs are allowed industrialized production.

We must say that the public's misgivings and concerns are normal, because, first and foremost, as a kind of new-hi-tech, GMO research and application began late in China and the public don't know enough about the technology itself and the country's GMO safety management. In the mean time, the public's understanding of GMO is also affected by the negative media coverage and mentality of "Rather believe it exists than not and better be safe than sorry".

To propagate agricultural GM technology and understanding of our safety management and improve public awareness, the Inter-Ministerial Joint Conference Office of the Agricultural GMO Safety Management Department and Popular Science Department of the China Association of Science and Technology have organized specialists to compile this brochure for popular science publicity entitled *A Rational Look at GMOs* in the hope of disseminating scientific, authoritative and objective information to the public and allow them to look at GMOs and their products from a scientific and rational perspective.

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Part I: What Kind of Technology is GM Technology?

1. What is GM technology?

Answer: In general, GM technology refers to the technology of transferring one or several genes of known functions of one organism into another organism, giving it new properties. It is a product of technological advancement. The Austrian scientist, Mendel, discovered that biological properties were controlled by genes in 1856; the American scientist, Morgan, founded genetic studies in 1910; Watson, American, and Crick, British, presented double Helix model of DNA in 1953; gene cloning technology came about in 1973; the world's first GM reorganization *Escherichia coli* through genetic engineering in insulin was made possible in 1982; the world's first GM tobacco emerged in the same year; and large scale GM crop industrial growing began in 1996.

2. In what fields is GM technology used?

Answer: GM technology is widely used in areas of pharmaceuticals, industry, agriculture, environment protection and energy. Wide GM technology application first took off in pharmaceuticals. In 1982, USFDA gave approval to commercial production of human insulin using GM microorganism, being the first ever GM product commercial application. Consequently, GM made drugs, e.g. recombinant vaccine, somatostatin, interferon (IF) and human growth hormone (HGH), etc., came about one after another. Agriculture is the next area of wide GM technology application, including GM animal, plant and microorganism breeding, of which, GM crops have seen the most rapid development, with large scale insect/disease-resistant and herbicide-tolerant GM crops spreading out and the emergence of crops of better quality, nutritious efficiency, drought-resistance and salt-tolerance. Industrialized use of GM technology also has a pretty long history, for instance in enzyme preparation, additive and washing enzyme preparation making using GM engineered microorganisms. Furthermore, GM technology is also widely used in areas of environment protection and energy industries, for instance, pollutant biodegradation and fuel alcohol production using GMO fermentation.

3. What's the difference between GM breeding and conventional breeding?

Answer: Along with the continuous scientific and technological developments, breeding technology has evolved from the primitive natural domestication, human selection, artificial mutagenicity and cross breeding to today's marker-assisted breeding, molecular designed breeding and GM breeding. Therefore, GM breeding is a natural outgrowth of the conventional breeding technology.

Conventional breeding achieves genetic reorganization through cross breeding of different species and GM breeding achieves the same through targeted gene transfer, both virtually obtaining the desired properties through modifying the genes or their structures. GM breeding's advantage lies in the possibility to make cross-variety genetic discovery and expand the use of genetic resources to accomplish targeted and efficient known gene transfer to attain human desired properties, offering a new technological approach for breeding new high-yield, high-quality and high-resistance crops.

Such a way of breeding, basing on precisely targeted operation on the gene, is more efficient and accurate. For example, the insect-resistant cotton is created by transferring the herbicide protein gene in *Bacillus thuringiensis* into the cotton, which can exclusively restrain cotton bollworm occurrence, reduce risk and pesticide use and achieve steady output, quality and efficiency improvements. Herbicide-tolerant crop is created by transferring the herbicide tolerant glyphosate gene into the crop so when herbicide is used, it only kills the weeds without hurting the crop. It raises planting density, removes the weeds, lessen the work load and weeding cost, being capable of improving farming cost effectiveness.

4. What is the international GM technology development trend?

Answer: The global GM technology development trend now is quite strong, as the developed countries are racing for the commanding height and developing countries making proactive efforts to keep up. With the government's positive attitude and clear orientation, the US takes a leading position in the global GM industry development with an obvious edge in the global seed industry. The US is the first to apply industrialized GM crop growing with over 90% of planting areas of insect-resistant corns and herbicide-tolerant soya beans, respectively. 70% of the processed food

on the US market contains GM elements. Once more advanced than the US, the European GM research and development turned more cautious later, lagging behind markedly now. Presently, some EU members are actively pushing for policy changes. In 2013, five countries, Spain, Portugal, Romania, Czech and Slovak grew 148,000 hectares of insect-resistant corns, of which, the growing area in Spain is the largest, 94% of the total. On 11 February 2014, the EU Ministerial Conference approved the growing of the new GM insect-resistant corn TC1507 developed by the International Pioneer of DuPont, showcasing some GM policy change of the EU.

5. Why China needs to develop GM technology?

Answer: As a country of large population, to meet the 1.3 billion people's food demand is always the top priority in China, in the face of challenges such as a big population, little arable land, irreversible trend of arable land dwindling, agricultural resources shortage, eco-environment fragility, frequent occurrence of major diseases and insects, extreme weather conditions of drought, happenings of heat and cold from time to time, pesticide and fertilizer overuse and prominent agricultural water supply issue. According to the figures, about 60% of China's farmland lacks irrigation infrastructures, some 700 million Mu (15 Mu = 1 hectare) are under constant threat of drought and 500 million Mu of saline-alkaline soil need improvement. Rigid restrictive factors on sustainable agricultural and rural development are increasingly outstanding, making it hard to meet the rising demand for agricultural products by singularly relying on production expansion. To ensure food self-sufficiency and absolute safety, filling up China's rice bowl with domestic produce, efforts must be made to break free from the resources restraints in terms of farmland, water and energy, by relying on technological renovation. Departing from the point of future international competition and industrial division and as an important approach to ensure China's food and ecological safety and sustainable agricultural development, to promote GM technology research and application is a natural choice made in the light of the overall trend.

The global GM technology application practice shows, wide insect-resistant and herbicide-tolerant crop application may improve insect resistance, herbicide tolerance, saline resistance and drought tolerance properties of the crops to prevent output loss and achieve quality improvement, environment protection and yield augmentation outcome. For instance, the Brazilian and Argentinean soya bean outputs have risen dramatically since the introduction of GM crops, having made them the world second and third largest soya bean exporters respectively. When South Africa introduced the insect-resistant GM corn, its unit output has doubled due to insect diminution and planting density increase. As a result, South Africa turned from a corn importer into an exporter. When India introduced insect-resistant GM cotton, it has transformed from a cotton importer to exporter. China grew 4.2 million hectares of insect-resistant cotton in 2013, 95% being composed of self-developed breeds, which has reduced pesticide use and raised the cotton growers' income.

6. What's China's GM technology research and application promotion strategy?

Answer: China's basic GM technology research and application policy is proactive and cautious, which is to say, making bold researches but precautious promotions. On the one hand, bravery is needed in researches and renovations to seize the commanding height of GM technology and self-developed intellectual properties, taking active part in the international competition. On the other, steady efforts should be made in accordance with the international norms and state regulations in GM crop industrialization and commercial application promotion to ensure safety.

In 2008, China launched a major project for new agricultural GMO species breeding technology; in 2009, the State Council issued the GM Industry Development Speed-up Measures, stating "Efforts should be made to speed up turning bio-industry into a pillar of the new-hi-tech and strategic emerging industry of the country".

The CCP Central Committee Directive No. 1 of 2009 points out, "Speed up the major new GMO species breeding technology project by incorporating research resources and increasing efforts in creating a new group of disease-resistant, degeneration-resistant, high-yield, high quality and high-efficiency GM crops and push for their industrialization."

The CCP Central Committee Directive No. 1 of 2010 points out, "Continue to implement the major new GM crop breeding technology project, making efforts in developing new species of functional genes and bio-products of important application value with self-owned intellectual properties and promote their industrialization on the basis of scientific assessment and legal

management.”

The CCP Central Committee Directive No.1 of 2012 points out, “Continue to implement the major new GM species breeding technology project and boost implementation efforts in the public-benefiting and agriculture-related industrialization researches.”

Part II: GM Food Safety

7. Is there any authoritative conclusion for GM food in the world?

Answer: There is authoritative conclusion for GM food in the world, e.g. GMOs and their products that have passed safety assessment and received safety certificate are safe. Before marketing, GM food is required to undergo strict safety assessment and certification procedures when the average food isn't. A series of GM food safety assessment guide made by the Codex Alimentarius Commission is the globally recognized food safety assessment norms and standards for WTO to judge on international trade disputes. Though different countries' safety assessment modes and procedures are varied, the general principles and technology are all laid down in accordance with the Codex Alimentarius Commission's requirements.

The international organizations, developed countries and China have conducted numerous researches and all believe that GM food is as safe as conventional foodstuff. The WHO declares, “No evidence so far has shown any impact occurring on human health when the public take GM food in the countries where it is approved”. The OECD, WHO and FAO have reached a conclusion, basing on broad and comprehensive debates, that, “All GM food marketed now are safe”. Over 25 years and participated by some 500 independent scientific institutions, some 130 research projects organized by the EU Commission have come to the conclusion that “Biological technology, especially GM breeding technology, is no more dangerous than traditional breeding.” The International Scientific Council states, “The existing GM crops and their products are found safe for consumption and the testing methods used are considered reasonable and appropriate.” The Royal Society of Medicine (RSM) of the UK, National Academy of Sciences of the US, Academy of Science of Brazil, China Academy of Science (CAS), Indian National Science Academy (INSA), Academy of Science of Mexico and Third World Academy of Sciences (TWAS) have jointly published the *GM Plants and World Agriculture*, which announces, “GM technology can be used to produce food, as it is more nutritious, storage-stable and, in principle, health augmenting to benefit consumers in the industrialized and developing countries.”

8. What's China's GM food safety assessment comprised of?

Answer: Basing on the *DNA Reorganized Plant and Food Safety Assessment Guide* issued by the Codex Alimentarius Commission and *Agricultural GMO Safety Management Regulations* and the accompanying *Agricultural GMO Safety Management Measures* issued by China, China's GMO research and application are required to undergo regularized and rigorous assessment procedures. Food safety assessment is primarily aimed at evaluating the genes and their expressions in terms of possible toxicology, hypersensitivity, nutrient components and antinutritional components, in compliance with requirements of the laws, regulations and norms, to see if they might bring about any safety risk. Following the international norms, China makes efforts to ensure the evaluating indicators are sound and complete, procedures regularized and accurate, conclusion authentic and reliable and decision-making extremely cautious. The performance has shown, by raising the researchers and developers' sense of responsibility and through rigorous assessment, strong government supervision and public monitoring, risk can be effectively prevented to ensure GM food safety and better serve the mankind.

9. How China assesses GM food safety?

Answer: China has made the *Food Safety Assessment Norms and Technical Guide for GMOs and Their Products* in accordance with the Codex Alimentarius Commission requirements, featuring four parts: the first is about basic information: which covers food donor and receptor safety, gene operation, introduction, modification and property description, actual series insertion and deletion information, gene and vector construction maps and safety, vector insertion segment area information, GM methodology and inserted series expression, etc. The second is about nutriology assessment, which includes principal nutrition components and antinutritional components analysis. The third is about toxicology assessment, covering acute toxicity test and subchronic toxicity test, etc. The fourth is about allergy assessment, which is conducted in accordance with the FAO and WHO's allergy evaluation decision tree sequentially to prohibit

known allergen transfer. Moreover, safety assessment is also conducted on GMOs and their products' processing procedural safety, GM crops and their products compound accumulation and unintended effects, etc.

For instance, the safety certificate issued to GM rice in China in 2009 took 11 years' exacting assessment on a scientific basis. In the nutriology aspect, comparative experiments had been conducted on the nutrition components, micronutrient levels and antinutritional factors, among others, which found the GM rice containing the same nutrition components as the non-GM species with no biologically significant difference. In the toxicology assessment aspect, 90-day bandicoot feeding test, short-term feeding test, genetic toxicity test, three-generation reproduction test, chronic toxicology test and acute toxicology test on Bt protein had been conducted to find no adverse effect on the experimental animals. In the allergy assessment aspect, the amino acid sequence homology ratio of Bt protein with known allergen protein test and non-sequential similarity between Bt protein and known allergen protein test had been conducted to the conclusion that there is no allergy rise risk. The experimenting institutions also conducted foreign protein simulated in vitro gastrointestinal digestion test to find that the transgenic expression is easy for digestion and safe for body absorption, metabolism and effective constituent utilization. Basing on the results of the insect-resistant GM rice safety assessment by the National Agricultural GMO Safety Committee and laboratory test results from the Centre for Disease Control of the Nutrition and Food Safety Institute of China, Food Institute of the China Agricultural University and Center for Farm Produce Quality and Safety of the Ministry of Agriculture, the insect-resistant GM rice "Hua Hui No. 1" is found safe for consumption as the controlled non-GM variety.

10. Is there any assurance for the safety of GM soya beans China has imported in large quantities in recent years?

Answer: China began importing soya beans in large quantities since 2000, having imported up to 63.38 million tons by 2013, mostly comprised of GM products, all used for processing and none for commercial growing. The US, Brazil and Argentina, among others, are the main sources of China's soya bean imports, which largely grow GM varieties. In 2013, GM soya beans were grown 93% in the US, 92% in Brazil and 100% in Argentina.

Importing GM soya beans is a successful measure China takes in making dualistic use of the international and domestic markets and resources. The soya beans imported are of good quality and high oil-yield. According to figures from the specialists, the cost of GM soya bean oil processing is RMB300 lower per ton than the non-GM species. China grows about 120 million Mu (15 Mu = 1 hectare) of soya beans a year. There is a gap between the technical levels of the foreign products and domestic species and prominent issues of planting and harvesting mix and labor cost rise, with the issue of domestic output falling short of the demand being the key. In recent years, China would import more than 50 million tons of soya beans a year, which requires more than 400 million Mu of farmland to grow. Basing on the existing species and technology, the growing area is close to that for corn or rice. It means, for growing these 50-60 million tons of soya beans, it would require the sacrifice of the same size of other high-yield crop growing area.

GM soya beans have the benefits of low-cost and industrialized production ready. Growing herbicide-tolerant GM soya beans is an effective, efficient, low-cost and harmless weed control approach, which may alleviate rural labor shortage, simplify field operation and elevate farming cost-effectiveness. With support from the state's major new GMO species breeding project, we have made important process in herbicide-tolerant GM soya bean research, integrating GM technology and conventional breeding, in cultivating glyphosate-tolerant new soybean varieties. The new varieties are disease and lodging resistant, high in fat and protein content, yielding no less than the controlled variety in the domestic testing region, of which, the EPSPS gene herbicide-tolerant soya bean crop, the "Hu Jiao 06-698", turned out to yield 5% more, with 12% higher oil content and 70% lower weeding cost than the control group.

The Chinese government attaches great importance to GMO safety management, having conducted stringent safety assessment in accordance with the *Agricultural GMO Safety Management Regulations* and related measures on the GM soybeans imports. Therefore, soya beans and their products that have received the safety certificate are safe.

Part III: GM Safety Management

11. Can China's GM safety management system and operational system assure our safety?

Answer: China's GM safety management system and operational mechanism are regularized, cautious and capable of ensuring our safety. China has instituted a series of laws, regulations and technical management norms suitable to the domestic situation and in compliance with the international practice, covering GM research, experimentation, production, processing, marketing, import certification and compulsory labeling. The State Council has issued the *Agricultural GMO Safety Management Regulations* and the Ministry of Agriculture has made and implemented the *Agricultural GMO Safety Assessment Management Measures*, *Agricultural GMO Import Safety Management Measures*, *Agricultural GMO Labeling Management Measures* and *Agricultural GMO Processing Approval Measures* and the AQSIQ has put into force the *GMO Product Import and Export Inspection and Quarantine Management Measures*.

China has founded the National Agricultural GMO Safety Committee (the GMO Safety Committee) composed of 64 cross-discipline specialists, which is in charge of conducting scientific, systematic and comprehensive safety assessment on the five stages of experimental studies, semiplant test, environment release, industrial experimentation and production/application safety certificate request. China has also founded the National Technical Committee for Agricultural GMO Safety Management Standardization consisting of 41 experts, which has announced 104 GMO safety norms.

China has established the Inter-ministerial Conference for Agricultural GMO Safety Management comprising of 12 government departments, which oversees major agricultural GMO safety management researching and coordinating issues. The Ministry of Agriculture has established the Agricultural GMO Safety Management Office to watch over the routine nationwide agricultural GMO safety coordination and management. The agricultural administrations of the People's governments above the county level are made responsible for agricultural GMO safety supervision and management in their administrative jurisdictions.

GMO product safety is assessed by cross-disciplinary scientists in accordance with rigorous and cautious scientific norms and strict legislative procedures, not by the decision of any one single department or individual. GMO research, experimentation, production, processing, marketing and import are all performed in accordance with the laws and regulations and strict procedures, which assure GM technology application won't pose any risk to human health or animals, plants and microorganisms and is able to ensure our eco-environment safety. GMO products that have passed the safety assessment and received safety certificate are safe.

12. What's China's GMO safety assessment procedure?

Answer: China applies classified and phased safety assessment management system for agricultural GMOs. The researcher/developer makes report, presents application and technical information to the bio-safety management department of the employer and government regulatory department. The management department organizes specialists to conduct technical assessment and gives feedback to the applicant. The regulatory department conducts regular supervision and inspection. Any institution or any China-foreign joint research and experiment institution, joint venture or completely foreign owned entity intending to apply for environment release, industrial experimentation and safety certificate must present written information in accordance with the safety assessment guide requirements when receiving the approval from the Agricultural GMO Safety Group and Agricultural Administration of the Province (Autonomous Region, Municipality directly under the central government) where the experiment takes place, and submit application to the Administrative Approval Office of the Ministry of Agriculture for administrative permit. The Ministry of Agriculture summons the GMO Safety Committee to conduct the assessment and gives the approval. The information about the Agricultural GMO Safety Certificate issuance is publicized on the Ministry of Agriculture's official website. Upon receiving the Agricultural GMO Safety Certificate, the applicant institution still needs to take other production and application related procedures. For instance, a GM crop can only be produced and grown upon receiving the species approval in accordance with the requirements of the Seed Law and production and marketing permit.

13. How transparent is China's GM safety management information?

Answer: In 2013, basing on the *Regulations on Government Information Disclosure of the People's Republic of China*, the Ministry of Agriculture (MOA) publicized the agricultural GMO laws, regulations, safety assessment guide, norms, testing institutions, GMO Safety Committee working procedures and committee members list under the "Hot Issues" and "Authoritative GMO Watch" sections of its official website (<http://www.moa.gov.cn/ztl/zjqwgz>). MOA has also publicizes the GMO safety assessment results and related information on a yearly basis in a prompt manner available to the public by online search. In the mean time, at the individual request from the public, the MOA also publicizes government information on agricultural GMO safety management to any applicant in accordance with the law. Through information disclosure, China's agricultural GMO safety certification and management transparency is made greater to ensure the public's right to know. It must be said, China's agricultural GMO safety management information is open, transparent and in line with the international norms.

14. Is there any connection between GM food labeling and safety?

Answer: When any food is processed with imported or domestically approved GM agricultural products or their processed products, it is GM food. To label GM food is to ensure the consumers' rights to know and choose. Whether GM food is safe is known through safety assessment, i.e. GM products that have passed the safety assessment and received safety certificate are safe. Therefore, GM product labeling is not connected to safety.

China has instituted a categorized compulsory GM product labeling system. In 2002, MOA issued the *Agricultural GMO Labeling Management Measures*, laying down the first ever labeling list to impose compulsory labeling requirements on 5 categories of 17 varieties of GM products, including soya beans, canola, corns, cottons and tomatoes, and voluntary labeling for other agricultural GM products. Since the release of the first List, the only approved GM crops in China are cotton and papaya and materials approved for import for processing are soya beans, corns, cottons, canola and sugar-beet. What product to label depends on the viability, operability, cost-effectiveness and supervision decision-making practicability. For example, GM Chinese pawpaw is not put on the first List largely due to the high proportion of small-scaled and dispersed pawpaw growing and direct marketing by the farmers, which makes labeling difficult. As the labeling cost is pretty high, no country in the world requires all GM products to be labeled, at the moment.

15. What is the international rule for GM food labeling and can it ensure the public right to know?

Answer: At the moment, there are four GM labeling management approaches in the world: first, on voluntary basis, such as in the US, Canada and Argentina; second, comprehensive compulsory quantitative labeling; i.e. all products need be labeled when GM content is over the threshold. For instance, the EU requirement is 0.9% or more, Brazil 1% or more. Thirdly, partial compulsory quantitative labeling, i.e. when GM content of a specific product is over the threshold, labeling is required. For instance, in Japan labeling is required for 24 varieties of food made of soya beans, corns and natto, such as Tofu and corn made snack food, the threshold is set at 5%. Fourthly, categorized qualitative labeling, i.e. listed products must be labeled if they have GM content or processed from GM crops. At present, China is the only country using the last approach, having the most labeling requirements for GM products. All GMOs and their directly processed products listed in MOA's *Agricultural GMO Labeling Management Measures* are required to be labeled to fully protect the public rights to know and choose. As countries using quantitative labeling have all set their thresholds, which GM content in food normally can hardly reach, such food are not labeled though being GM products. Therefore, labeled GM products are hard to find on the markets in these countries.

16. Is China's GM industry controlled by interest groups?

Answer: No interest group is capable of controlling China's GM industry. China's GM safety research is supported by the state budget, assessed by authoritative third party institutions and scientist teams under government auspices and is eventually approved by the government through safety certificate and permit issuing, the industrial decision being made by the central government.

The Chinese government has established sound legislative and regulatory systems for GMO safety management and founded the State Council Inter-ministerial Conference, Agricultural

GMO Safety Commission consisting of specialists from various departments and industries and certified third party authoritative testing institutions on scientific basis, which are fully capable of safeguarding the impartiality and justice of GMO safety and industry management decision making process to protect the interests of the country and public.

In regard to intellectual property protection, through over 2 decades' development and accumulation, China has built up an elementary GM breeding innovation and industry development system in terms of functional gene cloning, genetic transformation, variety breeding, safety assessment, product development, application and promotion and has achieved a large number of genes and technologies with self-owned intellectual properties, with the overall GMO research and development ranking at the top of the developing countries for the industry not to subject to any one single group's control.

Part VI: Facts

17. Is there any conclusion for GM food safety?

Answer: There is conclusion on GM food safety, i.e. all GM food that have passed the safety assessment and received safety certificate is safe for carefree consumption. The Codex Alimentarius Commission established the Special Inter-Governmental Working Group on Biotechnology Food in 1997, believing risk control should be imposed on GM technology to establish GMO risk analysis principles and GM food safety assessment guide, which are the globally recognized food safety norms and WTO standards in judging international trade disputes. Before marketing, GM food must undergo stringent toxicology, sensitization and teratogenicity safety assessment and approving procedures. The WHO and FAO insist: all GM food that is marketed after passing the safety assessment is as safe as conventional food for carefree consumption. Since GM food commercialization, not a single safety issue of the approved food has happened so far.

18. Why there is no human experiment in GM food safety assessment?

Answer: When conducting GM food safety assessment, it is unnecessary and impossible to have human experiment.

Firstly, following the internationally recognized chemical toxicology assessment principle, GM food safety assessment normally chooses to use model mice and bandicoot for high-dosage, multigenerational and long-term feeding tests. Computed by the 2-year life span of a bandicoot, a 3-month assessment period makes up one eighth of its life span, and a 2-year assessment period equalizes its entire life span. Scientists use zoopery to deduce the human experiment results and, therefore, using bandicoot in stead of humans is the normal procedure for the world scientific community.

Secondly, scientists don't normally use humans to conduct long-term multigenerational toxicology safety assessment, because, first of all, the toxicity and bio-information data currently available is sufficient to conclude if there is any safety issue. Next, basing on the world recognized ethics, scientists should not and may not make experiment on human beings for them to take one kind of food for 10 or 20 years, which could be even carried on through to offspring. Thirdly, humans spend their lives eating all kinds of food and if any human were used in the GM food safety assessment, strict control like in the animal test would be highly improbable to exclude disturbances from other food components.

19. If it is safe to consume GM food now, can it ensure the safety of our future generations?

Answer: For long term consumption safety, in GM food safety assessment experiment, borrowing from the current concepts of chemistry, food, food additive, pesticide and pharmaceutical safety assessments, paranormal experiment using extraordinarily large doses is conducted. Applying universally recognized experiment model, simulated experiment and zoopery test that are totally replaceable for human experiment are conducted to deduce if there is any safety issue for long-term human consumption. The difference between GM food and non-GM food is that the target substance of GM expression is normally protein, which, in the safety assessment, allergen and toxin gene expression transfer is absolutely prohibited. In the case GM expression protein is not allergic protein or toxalbumin, this protein is not different from other proteins, which

is nutritious and digestible to be made into small molecular components in the stomach and intestines to provide nutrition and energy to human body.

Human consumption of plant and animal food has tens of thousands years of history and contains all kinds of similar genes. From a biological perspective, the foreign genes in the GM food are the same as the genes contained in conventional food, all absorbable and digestible by the human body. Therefore, GM food consumption cannot transform human hereditary properties. In fact, even the most conventional plant and animal food for human consumption may contain tens of thousands of genes and, therefore, one cannot and does not need to worry that the genes from the animals, plants or microorganisms in our food may change our genes or pass it onto our future generations. The modern day science has not discovered a single case of any food's hereditary substance being passed on into the human hereditary system.

20. Does GM food affect fertility?

Answer: Since February 2010, an internet post entitled *Random Check Finds Sperm Abnormalcy in 50% Male Students in Guangxi Province: GM Corns Rumored to Have Been Grown for a Long Time* went viral on the web, causing public panic for GM products. The post claims, "Years of eating GM corn leads to sperm motility decline in male college students and affects their fertility in Guangxi Province".

The "Dica 007/008" corn is a regular conventional hybrid and not GM species, the Monsanto Company, Guangxi Seed Management Station and Ministry of Agriculture made reassurances basing on different perspectives. On 9 February, the Monsanto Company publicized *An Explanation on Rumors concerning 'Dica 007/008' Corn* on its official website, pointing out, the species is a conventional hybrid corn developed by the company, which has passed crop certification by the Guangxi Zhuang Nationality Autonomous Region in 2000 and plantation was launched in the province in the following year. "Dica 008" is an upgrade version of "Dica 007", which received approval in 2008 and plantation was launched in the same year. The statement was reaffirmed by the Guangxi Seed Management Station. On 3 March, the MOA's Agricultural GMO Safety Management Office declared that the Ministry had never approved any GM grain seed import and growing in China and there was no GM crop growing in the country.

The so-called sperm abnormalcy among the college males in Guangxi came from the *Survey Report on Guangxi College Student Sexual Health* compiled on the basis of a survey conducted by the First Affiliated Hospital of the Guangxi University of Medicine, in which the authors never mentioned that sperm abnormalcy had anything to do with GMOs. Instead, environment pollution and unhealthy lifestyle such as long-time online activities were cited as possible reasons. The root cause of the public panic is the post maker's connection of sperm abnormalcy with GM corns.

21. Why insects can be killed by GMOs but not humans?

Answer: The Bt protein in the insect-resistant GM crop is a highly dedicated insecticidal protein, which can only mix with a specific receptor in the Intestinal epithelial cells of the targeted pests that leads to insect Intestinal perforation and death, while other non-targeted insects remain safe eating it. Only the intestines of the targeted insect have the binding site for the protein while it doesn't exist in the intestinal cells of human beings and other mammals. Therefore, it doesn't pose any danger to human body. Moreover, human beings discovered bacillus thuringiensis, the source organism of Bt protein, more than 100 years ago and the safe use of Bt preparations for biopesticide has a history of some 70 years and more than 18 years of large scale trans-Bt-gene corn and cotton growing and application history that have not seen any report of bacillus thuringiensis and protein allergy so far.

22. Is "Xian Yu 335" corn a GM variety and does it cause mice reduction and sow abortions?

Answer: The *International Herald Leader* reported, "In Shanxi and Jilin Provinces, abnormal incidents of rat reduction and sow abortions occurred due to 'Xian Yu 335' growing" on 21 September 2010. The report was reprinted by the media and induced heated cyber debates, creating a strong impact. Soon later, DuPont released an announcement, pointing out, "Xian Yu335"s male parent was PH4CV and female parent PH6WC and that made it not a GM corn. The Ministry of Science and Ministry of Agriculture set up a specialist panel composed of scientists from various disciplines to conduct repeated field investigations and came to the conclusion that Shanxi and Jilin Provinces didn't grow GM corns and the mice reduction and sow abortions had nothing

to do with GMOs. The mice drop was directly related to the fact that Yushu City, Jilin, and Jinzhong City, Shanxi, had both carried out consecutive years of unified pest control operations and the ban on very poisonous rodenticide served to increase mouse predators and the use of concrete flooring in the farmers' barns made mouse burrowing more difficult. Moreover, during the Olympic Games time, Taiyuan City, as an alternate airport site, launched a mice elimination campaign. As for the assertion of "sow abortions", it was absolutely unrelated to the local reality and found to be a sheer fabrication. The *International Herald Leader* report was named one of the *Top 10 Scientific Lies* by the *Beijing News Daily*.

23. Does tumor invasion in China have anything to do with GM soya bean oil consumption?

Answer: In an article *GM Soya Beans are Highly Related to Tumor and Infertility* published in June 2013, a senior official of a provincial soya bean association, totally misreading the figures in the *China Tumor Registration Yearly Report 2012* released by the China Tumor Registration Center, claimed, as Henan, Hebei, Shanghai, Guangdong and Fujian were areas where GM soya bean oil consumption was the highest and had seen concentrated tumor invasion, the cause for the disease was highly related to GM soya bean oil consumption.

Having no epidemiological basis, the allegation is rejected by medical experts. In fact, there is no causality between high tumor invasion and GM soya bean oil consumption, at all. When such a connection may be drawn in multitudes, two related things may not have any causality. For instance, in statistical terms, as wheat jointing stage is also the season of measles outbreak, there is no direct connection between the two phenomena. As we all know, human life span is getting longer and pesticide use on the rise, if a connection is drawn between the two, there might be some kind of correlation. Nonetheless, if anyone concludes that there is causality between them, it would be utterly preposterous. Many elements may cause tumor, including individual hereditary difference, food habit and lifestyle; environmental elements of water, air and soil; and social elements of medical service and aging, all significantly correlated to the incident of cancer.

24. Is the French researcher's GM corn leads to bandicoot cancer report reliable?

Answer: The magazine *Food and Chemical Toxicology* published the French professor Gilles-Eric Séralini's article *Long Term Toxicity of Roundup (glyphosate) Herbicides and Roundup (glyphosate) Herbicide Tolerant GM Corns* On 19 September 2012, which concluded that GM corn "NK603" could cause cancer.

Séralini's conclusion is completely rejected by the authoritative organizations. The European Food Safety Agency declares, the conclusion of the research does not only lack supporting data but also contains grave loopholes in the test design and methodology: 1) the bandicoot used is a cancer susceptible species; 2) the study didn't follow internationally recognized standard experimental preparation and implementation procedures; 3) when the Codex Alimentarius Commission requires at least 50 bandicoots in each experimental group for this kind of research, the researcher used only 10 in each group, not enough to distinguish if the cancer happened out of probability or special treatment; 4) Details such as food components, way of storage and possible hazardous substance content (e.g. fungal toxin) in the feed are lacking. François Houllier, President of French National Institute for Agricultural Research (INRA), points out in an article published on *Nature*, the research lacks sufficient statistical data and the experiment approach, data analysis and conclusion are all flawed.

The magazine *Food and Chemical Toxicology* issued a statement on 28 November 2013 to withdraw the Séralini article and emphasized that the decision (to withdraw) was based on a thorough and longtime analysis on the article and reported data and a survey on the peer review process for publishing that article.

25. Is GM food consumed in the West? Is the West "zero-tolerant" of GM food?

Answer: The US is strong on GM technology research and development and also a large GM food producer and applier. According to the figures released on 30 June 2013 by the US Department of Agriculture (USDA), in terms of plantation area, 90% of the corns and cottons, 93% of soya beans, 99% of sugar beat are composed of GM varieties in the country. GM sugar beat is used for sugar making and nearly 100% for domestic consumption. According to statistics from the US Grocery Makers Association (GMA), 75-80% of the processed food in the US contains GM elements. Wiseman, adviser to the USDA Secretary, said in a media interview in October 2013

that over 90% of the American corns and soya beans were GM species, of which, 20% of the corns and 40% of the soya beans were for export and the rest for domestic consumption; and 70% of the processed food on the US market contained GM elements. According to the FAO figures (2009), the US produced 91.417 million tons of soya beans in the year, of which, 44% was exported and the rest consumed domestically, 93.1% for food. In the same year, the corn output was over 330 million tons and of which 14.6% was exported and 28.7% consumed domestically as food. It may be said, the US is a country where the most varieties of GM food are consumed and for the longest time.

Europe is also a region where a lot of GM products are imported and consumed, each year importing 4 million tons of corns and 33 million tons of soya beans that mostly contain GM elements. In 1998, the EU approved GM corn growing and marketing in the continent, giving approval to GM crops of 23 varieties of corns, 3 varieties of canola, 1 variety of potato, 3 varieties of soya beans and 1 variety of sugar beat. In 2013, Spain, Portugal, Czech, Slovak and Romania altogether grew 148,000 hectares of trans-Bt corns. The EU Committee approved a new variety of GM corn growing on 11 February.

26. Will GM herbicide-resistant crop growing create “super weed” and undermine eco-environment?

Answer: GM herbicide-tolerant crops won't become uncontrollable super weeds, nor will growing them make other plants into uncontrollable weeds. Basing on the gene flow, it was found in Canada's canola field in 1995 that some specific canola plants could be tolerant to 1-3 types of herbicides and thus they were named “super weeds”. In fact, “super weeds” is merely a figure of speech and there is currently no proof of “super weed” existence. Moreover, gene flow does not start with GM crops but has been out there all the time. Without gene flow, there would be no evolution and not so many species of plants or hybrid crops now. Of course, as a cross pollinated plant with insects as pollination media for long distance pollen dissemination, and related species and weeds that could cross breed, there should be, therefore, close follow-up on the canola gene flow consequences. *Nature*, the internationally authoritative magazine, published a special issue of *GM Crops: Facts and Rumors* in 2013, which contends, in the modern agricultural production system, it is implausible to give up chemical herbicides totally, as they are more effective than the traditional plow-farming for weed control.

27. What rules has China made on GM crop growing? What regulatory measures are there for illegal planting?

Answer: Industrial GM crop growing is required to, in addition to observing the *Regulations on Agricultural GMO Safety Management* and obtaining the *Agricultural GMO Safety Certificate* issued in accordance with the associated rules and norms, take other production and application related procedures. For instance, GM crops also need to receive seed production approval and marketing permit in accordance with the stipulations of the Seed Law before going into production and planting.

To step up GM crop growing management, MOA has made the *GM Crop Field Test Safety Inspection Guide* to intensify supervision on GM crop field test and regularize inspection approaches and contents. GM crop field test inspection is comprised of: 1) seeding period inspection mainly covering testing materials, testing area, safety control measures and surplus material disposal; 2) flowering period inspection mainly covering testing record, isolation measures and testing area; 3) harvesting period inspection mainly covering testing materials collection, storage, disposal and plant residue deactivation; 4) post-test inspection mainly covering volunteer plant elimination measures and residues.

MOA makes GMO safety management plan each year to describe the supervisory emphases and measures and offer guidance to local agricultural administrations' safety management work, for the regular GM content testing and sample testing and beefing up species approval procedures. All species for promotion should apply for approval beforehand and may only proceed with seed production and marketing upon receiving the approval. All crop species applying for approval are tested for GM components and an approval candidacy is immediately canceled upon any discovering of violation. Every illegal GM crop marketing or growing case is investigated and dealt with.

28. Can GM crops raise output?

Answer: The output is not merely decided by the genes, as agricultural output subjects to multitude of elements. Insect-resistant and herbicide-tolerant GM crops may virtually mitigate insect and weed risks, cut production loss and achieve greater output. Therefore, GM crops' output raising effect is objective existence. In the mean time, there are numerous types of genes of diverse functions. Quite a number of types of genes are connected with crop output rise, which maybe directly related to the theoretical yield as well as other output affecting elements (e.g. disease, insect, salinization and drought, etc). Whether the output of a crop could be increased is related to the properties of the transferred genes. Currently, the prevalently transferred genes are the insect-resistant and herbicide-tolerant types, not for output boosting. Nevertheless, as pesticide use lessens and growing density increases, objectively speaking, the output grows, as the cost is down, effectiveness up and loss reduced. In a long-term point of view, GM crops' output hike relies directly on scientific advancement. What to mention is, upon the launch of GM soya bean growing, outputs in Brazil and Argentine have seen dramatically growth, which turned them respectively into the second and third largest soya bean exporters in the world. Since South Africa introduced insect-resistant GM corns, its unit output has doubled, making it a corn exporter from an importer. When India introduced insect-resistant GM cotton, it has also become a cotton exporter from an importer.

29. Are cherry tomatoes, colored bell peppers, mini-pumpkins and mini-cucumbers currently on the market GMOs?

Answer: A "GM food list" is going wild on the Internet, which includes cherry tomatoes, large colored bell peppers, mini-pumpkins and mini-cucumbers. In fact, all of them are not GM products. Plants are the Nature's gifts to the mankind. Throughout longtime farming practice, man cultivates and domesticates wild plants and has produced a great variety of crop types. The plant properties, wild plant varieties, global climate and ecological condition change, together with artificial selection, have created farming crop diversity.

Take tomatoes for example, originated in countries like Peru, Ecuador, Bolivia and Chile in South America where all the wild species are still found today, the local natives have picked them for food since ancient times. Along with the extinction of the Inca Empire and Indian migrations, tomato was first brought to Mexico, southern North America. In the fertile land and moderate and moist climate of Mexican Bay, through natural evolution and human selection, numerous variations of tomatoes have emerged. There are a wide range of tomato varieties on the market, which could be divided into the extra large, large, medium, small and very small types in shades of fiery, pink, orange, golden, yellow and lemon and in shapes of round, oblate, heart, apple, peach, oblong, cherry, pear and plum, among others.

The colored bell peppers showoff various colors as they contain different types of anthocyanin. The fruits and vegetables on the market today are diversely colored. The colors of the bell peppers are created by different genes existing in the Nature, which are related to species and varieties but not gene modification. Peppers of different colors have existed naturally but were never grown on a large scale and that is why consumers seldom saw them before.

30. Does GM breeding violate the Law of Evolution?

Answer: "Survival of the fittest through natural selection" as organisms turn from simple to complicated, low to high, through inheritance, mutation in the fight for survival and natural selection, changing and developing constantly. Through parallel transfer within or without one group and even cross different species, the primeval interspecies segregation is continuously broken down, which is an important reason for biological evolution. Studies on the origin of species and biological evolution demonstrate, interspecies gene transfer breaking away from reproductive isolation has happened since ancient times and is still happening in the quiet, which is just unnoticed by the non-professionals. For instance, the classical GM approach – agro-bacterium-mediated transformation - in wide application today is the result of human learning from the Nature. Under natural conditions, Agro-bacterium is capable of transplanting its genes into plants and having their expressions.

Today, the majority of the crops we are growing are no longer wild species from natural evolution, which are made available through thousands of years of human modification, continuous breaching of inter-organism reproductive isolation and new varieties and species creating through gene transfer, being the results of human domestication. GM technology is the newest breeding

and domestication technology of the mankind, which has not only achieved internal but also interspecies gene transfer, making our breeding technology more accurate, efficient and targeted.

Conclusion

Mark Lynas, the environmental activist, declared in January 2013 in a speech made on the Oxford Farming Conference, "I am sorry that I helped launch the anti-GM campaign in the middle 1990s and contributed to demonizing this important technology option that may benefit the environment." He added, "To the anti-GM lobbyists, ranging from the British nobles and prominent chefs to the American gourmets and Indian farming groups, I would like to say, when you have the right to your own points of view, but now you must know, your views are not supported by science. We are approaching a critical moment and, for the mankind and our earth, it is time that you went away and let the rest of us start feeding the world in a sustainable way."

Mark Lynas' apology is doubtlessly a new starting point. We believe, as long as we adhere to the government decision for scientific assessment, lawful management and increased publicity, we can promote the healthy growth of China's biological breeding technology renovation and industry and make new contribution to seizing the commanding height of the international agricultural science, safeguarding China's food security and ecological safety and bringing better harvests to the farmers.