Recently Progress of Agri-Biotech Crop in China

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Agri-Biotechnology in China

**Phase I: 1986-2000**
- **Mission:** Tracking global frontier of science and technology
- Gene cloning
- Plant transformation
- Transgenic crops field-tests

**Phase II: 2001-Present**
- **Mission:** Developing independent innovation capacity of science and technology
- Commercialization of GM crops
- Bio-safety
- Genomic sequencing
- Functional genomics and new gene identified
Major National Research Plan

◆ National High-tech R&D Program of China (863 Program)--The Ministry of Science and Technology
◆ National Key Basic Research Program (973 Program) --The Ministry of Science and Technology
◆ National Science and Technology Major Special Program--Government ministries
GM New Variety Breeding Major Project
(2006-2020)

From 2006 to 2020, Chinese government, local government and industry will invest more than ¥30 billions to support R & D of transgenic technology, including crops and domestic animals. The content of this project including:

- Cloning of genes related to important agronomic traits,
- Breeding new transgenic varieties,
- Industrialization of GM crops,
- Establishment of laboratories and bases,
- Risk assessment & bio-safety on GM crop
- Public Communications
Research Progress of GM Crops in China
The Commercialized Transgenic Crops for the First Time in China

- Insect-resistant cotton (CAAS)
- Insect-resistant cotton (Monsanto)

Virus-resistant transgenic tomato (Peking University)

Long shelf tomato (Huazhong Agriculture University)

Virus-resistant transgenic sweet pepper (Peking University)

CHS Transgenic Petunia (Peking University)
Bollworm Resistant Transgenic Cotton
The Application of Bt-Cotton in China

- In China, the area of Bt cotton has reached 72% of total cotton farming land in 2008.
- The cumulated plant area of Bt cotton has reached 220 million Mu during 1999 to 2008.
- The plant area of Bt cotton developed by Chinese scientists has increased from 7% in 1999 to 93% in 2008.
- Reduce pesticide usage to 80%, accumulative reduction 45,000 Tons during 1999 to 2008.
- Increase income and reduce expenditure ¥220 / per Mu, accumulative benefit about ¥40 billion. 30 million farmer families are benefit from Bt cotton.

1 hectare = 15 mu
Three Lines Hybrid Bt Cotton

Lint production increase to 26.4%
Seed Production Process of Three Line Hybrid Bt Cotton

- Due to avoid manual remove stamen, three Line system is more efficiency.
- Saving time and labor; the cost is lower, the price of hybrid seed decrease from ¥30-65 to ¥18-25/kg.
**PRSV-Resistant Transgenic Papaya**

South China Agricultural University

Symptom in papaya showing PRSV infection

Huanong 1, GM papaya

Huanong 1, GM papaya with replicase gene of papaya ringspot virus (PRSV), performance of high virus resistance

Field trials of GM papaya
Bt Pest-resistant Poplar

Transgenic poplar with resistance to Lepidoptera insect pests.

(Prof. LU Mengzhu)
Transgenic Rice

In China, more than 5% of the total production rice production losses caused by insect pests, it is about 10 million tons. Expenditure for chemical insecticide and application will cost about 3 billion US $ per year.

*Lepidopteran insects caused serious damage to rice production* -- XianFang City, Hubei Province
Transgenic insect-resistant rice through the safety evaluation, will enter a variety of regional trial and the validation, a significant reduction in pesticide usage and improve economic benefits of rice farmers.
Insect-resistant Transgenic Rice Obtained
Financial Support by 863 Program
Fuzhou, Fujian Province, May (L) and Aug.®

Transgenic rice: Number 863 and border
Wild type rice as control: others
Transgenic Rice with Resistance to Brown Plant hopper

Insecticidal crystal protein (ICP) genes, cry30 and cry54 were cloned from *B. thuringensis*, which showed significant resistance to brown planthopper. Resistance level of transgenic rice with cry30 increased from grade 9 to 3.

### Brown Planthopper Resistant Assay on cry30 Transgenic Rice

<table>
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<th>Sample Code</th>
<th>TN1</th>
<th>Mudgo</th>
<th>ASD7</th>
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<tr>
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### Brown Planthopper Resistant Assay on ICP

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<th>Sample</th>
<th>No. worm</th>
<th>24H</th>
<th>48H</th>
<th>72H</th>
<th>96H</th>
<th>Mortality 96H (%)</th>
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<tr>
<td>Normal feed</td>
<td>92</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td><em>E. coli</em></td>
<td>90</td>
<td>0</td>
<td>5</td>
<td>7</td>
<td>11</td>
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<tr>
<td><em>B. thuringensis</em> MC28</td>
<td>91</td>
<td>0</td>
<td>23</td>
<td>87</td>
<td>91</td>
<td>100.00</td>
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<td>cry54 expression protein</td>
<td>101</td>
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<td>42</td>
<td>66</td>
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<td>cry30 expression protein</td>
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<td>26</td>
<td>57</td>
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<td>78.41</td>
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The 60-80% of the phosphorus exists in the form of phytic acid in plant seeds, which is anti-nutritional factor. Phytase catalyze hydrolysis of phytic acid into myo-inositol and inorganic phosphate, which can be utilized by livestock.

A bacterial Phytase gene has been transferred into maize, and transgenic maize with high phytase activity has been obtained, the expression up to 120,000 U/kg.

This transgenic event has passed through the safety evaluation by MOA.

(Chinese Academy of Agricultural Sciences Prof. FAN Yun-Liu)
Field Trials of Phytase Transgenic Maize

Chinese Academy of Agricultural Sciences Prof. FAN Yun-Liu
Insect-Resistant Transgenic Corn
China Agricultural University

GM maize lines for insect resistance have been approved for field testing.
Resistance to **WYMV** of CP Transgenic Wheat
**Transgenic rice seeds increase in iron (Ferritin)**

Expression of Soybean Ferritin in Transgenic Rice Seeds

Western Analysis of Trans-Ferritin Rice Seeds

Iron Contents in Trans-ferritin Rice Seeds

Western Analysis of Trans-Ferritin Rice Seeds
Starch Quality Improvement

Transgenic rice with high content resistant starch has been obtained, which can be used as staple food for diabetic patients.
Transgenic rice per hectare production of human serum albumin valued at up to one million US$.
Endosperm Specially Deleted System

A safe plant transformation system is established based on lox/cre and specific expression technologies. Insecticidal protein only specifically expressed in the leaves and stems, but not expression in the embryo and endosperm. Meanwhile, in the endosperm of exogenous genes are effectively deleted. Deleted frequency up to 100%.
Gene discovery is the key step in the GM crop development, and new important genes with intellectual property right is the basis for the establishing and developing national agricultural biotechnology industry.
IPA1 (Ideal Plant Architecture 1), a semi-dominant gene, which determine the tiller’s angle and number, leaf and panicle length, and which can be used to increase yield of varieties.

Jiao et al. (2010) Nature Genetics
Cloning of Erect Panicle Gene EP2

EP2 determine the shape of rice panicle, and significantly increase the yield per rice plant.

Zhu et al. (2010) *Genetics* 184: 343-350
Rice mutant P13, results Length/width ratio of grain to more than 4.0.

long-grain related gene \textit{gl-7 (t)} has been isolated from P13, which significant increase in grain length (+8.3%).
Mutant *S5* overcome infertility between subspecies, which make it possible to the widespread use of strong hybrid vigor between indica and japonica.

Chen et al 2008 PNAS
Identification of Rice Brown Planthopper Resistant Genes

PCR-based marker selection system developed for *Bph14/15*
**Xa26, a Gene for Resistance to Xanthomonas oryzae pv. oryzae**

- Encoding a LRR-Receptor-like kinase
- Conferring whole growth process resistance at both seedling and adult stages

Sun et al. Plant J 2004
# Cloning of Important Agronomic Traits

<table>
<thead>
<tr>
<th>Genes</th>
<th>Phenotype</th>
<th>Institution</th>
<th>Journal</th>
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<td>DEP1</td>
<td>Spike Shape</td>
<td>Inst.Genet &amp; Devel. Biol..CAS</td>
<td>Nature Genet.,2009</td>
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<td>OsSKIPa</td>
<td>Drought-Tolerance</td>
<td>Huazhong Agr.Uni.</td>
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<td>AKT1</td>
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<td>Cell,2006</td>
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<td>Nature,2006</td>
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<tr>
<td>SKC1</td>
<td>Salt-Tolerance</td>
<td>Shanghai Inst.Plant Physiol.CAS</td>
<td>Nature Genet.,2005</td>
</tr>
</tbody>
</table>
From DNA to Variety

DNA Sequence

Gene

GM plants

Cultivar

Sequencing → Genomics → Transformation → Molecular breeding

Bph14
The Challenge of the GM Crops Commercialization in China
Status of Seed Industry in China

- **The lower level of aggregation:** In China, there are more than 8,700 seed companies and twenty thousand seed sellers.

- **Small-scale seed enterprises:** Top 50 seed companies market share is only 30% of seed market.

- **Lack of independent R & D capabilities:** At present, China's agricultural biotechnology research is mainly in institutions and universities, rather than in seed companies.
The Development of Modern Agriculture Seed Industry

- On 18 April. 2011, State Council issued “Recommendations on Accelerating the Development of Modern Crop Seed Industry”.

- **Mission:** Rapidly increasing national agricultural and seed industry's technological innovation capability, and enhancing enterprises international competitiveness, updating the national crop seed industry, and establishing a modern national crop seed industry system.

- **Key measures:** Improving laws and regulations system; Policy support; Increase investment.
Anti-GMO NGO Activity in China

I refuse to use pesticides and genetically modified food

A Trusted Supermarket
The Movement Against Genetically Modified Food

Firmly opposed to genetically modified foods

Protect the safety of race, rejection of AROWANA brand GM soybean oil.

Rejection of GM food, care of family health
Compared with 2003, in 2010 the proportion of accept GMO dropped down of 7%, the opposition has risen 5%.

Data From Professor Huang jikun
On Feb.28, 2013, Agricultural biotechnology science communication platform initiated by 5 society including Chinese Biotechnology Society was formal launched.
Activities of the Platform


James Clive give the present on global progress of Bio-tech crops.

On May 18, the platform will organize large-scale science publicity on Bio-tech crops during “The 2nd of the International Plant Day”. 