Green Revolution in China: Past and Future

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Chinese ancestors made great contributions to agriculture.

Cultivar rice over 6000 years discovered in Zhejiang Province.
Hani Terrace in Yunnan (constructed over 1200 years ago)

Xu GuangQi (1562-1633), Ming Dynasty
Significant Achievements in Grain Productivity in China in Green Revolution

7% of arable land to feed 22% of world population in China
Key People to China for Green Revolution

Deng, Xiaoping

He, Kang

Yuan, Longping

World Food Prize Laureates
Agricultural Production Determinants

• Agricultural Policy
• Technology and Inputs
• Income growth and changing preference
• Arable Land and Water Resources
Reform of Agriculture Policy in 1978 made significant contribution to food security in China.
Small family-based farming system:

- 4.4 persons per household with 2.8 laborers working on 0.6 hectare of cultivated land
- One farmer on average produces (in a year):

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>grain</td>
<td>1362.0kg</td>
</tr>
<tr>
<td>cotton</td>
<td>15.4 kg</td>
</tr>
<tr>
<td>oil-bearing crops</td>
<td>88.9 kg</td>
</tr>
<tr>
<td>red meats</td>
<td>174.1 kg</td>
</tr>
<tr>
<td>aquatic products</td>
<td>148.8 kg</td>
</tr>
<tr>
<td>milk</td>
<td>55.2 kg</td>
</tr>
</tbody>
</table>

High cost and low productivity hard to compete on market
Figure 1. Nitrogen Inputs in China's Agriculture, 1952-96

Source: FAO 2003
Hybrid Rice:

Yield Increase: 20%
15 million ha.
(more than 1/2 of rice planting area in China)

Yuan Rongping
Shares of Urban and Rural Population

Per Capita Income of Rural Resident
Output of Livestock Products (10,000 tons)
## Structure of China's Agricultural Economy, 1970-2000

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crop</strong></td>
<td>82</td>
<td>76</td>
<td>69</td>
<td>65</td>
<td>58</td>
<td>56</td>
</tr>
<tr>
<td><strong>Livestock</strong></td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>26</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td><strong>Fisheries</strong></td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td><strong>Forestry</strong></td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Sources: CNSS, China Statistical Yearbook (various issues) and China Rural Statistics Yearbook (various issues).
Structural changes in the crop sector

- **Cereals**
  - 1978: 80.30%
  - 1985: 65.20%
  - 1990: 19.70%
  - 1992: 34.80%
  - 2002: 65.20%

- **Cash crop**
  - 1978: 0%
  - 1985: 10%
  - 1990: 20%
  - 1992: 30%
  - 2002: 34.80%
New Stage of China Agriculture since late 1990s

- The supply of agricultural products has undergone historical transformation from chronic shortage to basic equilibrium or supply surplus in good years.

- Income to farmers increases, consumption and demand change from quantitative to qualitative

- Contribution of agriculture to the China’s economy declines.

- Both environment and conditions of agricultural development have undergone profound and significant changes, especially entered WTO.
Contribution of agriculture to the China’s economy:
Rapid declining of agriculture’s share in total GDP

Economic Growth 1978-2003
- GDP: 9.4%
- Agriculture: 4.5%
- Industry: 11.6%
- Service: 10.3%
China-USA Trade

- Trade Balance
- Chinese currency value (RMB) with US $ exchange rate
- Intellectual property right
Bilateral Trade in Agriculture between China and USA 2000-2004 (US$ million)

<table>
<thead>
<tr>
<th>Year</th>
<th>China’s Import</th>
<th>China ‘s Export</th>
<th>China ‘s Trade Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>7,693.69</td>
<td>2,395.77</td>
<td>5,297.92</td>
</tr>
<tr>
<td>2003</td>
<td>5,014.79</td>
<td>2,102.88</td>
<td>2,911.91</td>
</tr>
<tr>
<td>2002</td>
<td>2,722.79</td>
<td>1,679.72</td>
<td>1,043.07</td>
</tr>
<tr>
<td>2001</td>
<td>2,739.06</td>
<td>1,259.57</td>
<td>1,533.49</td>
</tr>
<tr>
<td>2000</td>
<td>2,590.96</td>
<td>1,184.36</td>
<td>1,406.60</td>
</tr>
<tr>
<td>Total</td>
<td>20,815.29</td>
<td>8,622.30</td>
<td>12,192.99</td>
</tr>
</tbody>
</table>
China’s agricultural trade: 1992-2003

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Gross Value Added</td>
<td>RMB billion</td>
<td>580</td>
<td>1199.3</td>
<td>1462.8</td>
<td>1541.2</td>
<td>1611.7</td>
<td>1709.2</td>
</tr>
<tr>
<td>Agricultural Gross Value Added</td>
<td>USD billion</td>
<td>105.3</td>
<td>143.6</td>
<td>176.7</td>
<td>186.1</td>
<td>194.6</td>
<td>206.4</td>
</tr>
<tr>
<td>Agricultural exports</td>
<td>USD billion</td>
<td>11.3</td>
<td>14.4</td>
<td>15.6</td>
<td>16.1</td>
<td>18.1</td>
<td>21.2</td>
</tr>
<tr>
<td>Imports of agricultural products</td>
<td>USD billion</td>
<td>5.3</td>
<td>12.2</td>
<td>11.2</td>
<td>11.8</td>
<td>12.4</td>
<td>18.9</td>
</tr>
<tr>
<td>Net Export</td>
<td>USD billion</td>
<td>6.0</td>
<td>2.2</td>
<td>4.4</td>
<td>4.3</td>
<td>5.7</td>
<td>2.3</td>
</tr>
<tr>
<td>Share of agriculture, in total trade</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share of total exports</td>
<td>%</td>
<td>13.3</td>
<td>9.7</td>
<td>6.3</td>
<td>6.1</td>
<td>5.6</td>
<td>4.8</td>
</tr>
<tr>
<td>Share of total imports</td>
<td>%</td>
<td>6.6</td>
<td>9.2</td>
<td>5.0</td>
<td>4.9</td>
<td>4.2</td>
<td>4.6</td>
</tr>
<tr>
<td>Ratio to AGVA</td>
<td>%</td>
<td>10.8</td>
<td>10.0</td>
<td>8.8</td>
<td>8.7</td>
<td>9.3</td>
<td>10.3</td>
</tr>
<tr>
<td>Exports</td>
<td>%</td>
<td>5.0</td>
<td>8.5</td>
<td>6.3</td>
<td>6.4</td>
<td>6.4</td>
<td>9.2</td>
</tr>
<tr>
<td>Import and export</td>
<td>%</td>
<td>15.8</td>
<td>18.5</td>
<td>15.2</td>
<td>15.0</td>
<td>15.7</td>
<td>19.4</td>
</tr>
<tr>
<td>Net export</td>
<td>%</td>
<td>5.7</td>
<td>1.5</td>
<td>2.5</td>
<td>2.3</td>
<td>2.9</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Deficit in agriculture trade reached to $5.5 billion in 2004
Soybean: Import and Export in China

Import: 26 million ton from USA, Brazil and Argentina
In 2005. China produced only 16 million tons
Soybean Imports

- Total imports of soybean reach to 26 million tons in 2005. Highest in history. Will continue increase this year.
- Imports:
  - USA: 11 million tons
  - Brazil: 6 million tons
  - Argentina: 5 million tons
### Soybean Consumption and China Import (2000-2005)

<table>
<thead>
<tr>
<th></th>
<th>World consumption</th>
<th>USA consumption</th>
<th>China consumption</th>
<th>China import</th>
<th>Percentage of China import in world import</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>25773</td>
<td>8305</td>
<td>3182</td>
<td>1325</td>
<td>24.91%</td>
</tr>
<tr>
<td>2001</td>
<td>27146</td>
<td>8548</td>
<td>3071</td>
<td>1039</td>
<td>19.07%</td>
</tr>
<tr>
<td>2002</td>
<td>29322</td>
<td>8080</td>
<td>4002</td>
<td>2142</td>
<td>34.04%</td>
</tr>
<tr>
<td>2003</td>
<td>28100</td>
<td>7178</td>
<td>3679</td>
<td>1693</td>
<td>31.22%</td>
</tr>
<tr>
<td>2004</td>
<td>31361</td>
<td>8821</td>
<td>4520</td>
<td>2570</td>
<td>39.49%</td>
</tr>
<tr>
<td>2005</td>
<td>33168</td>
<td>8781</td>
<td>4920</td>
<td>2750</td>
<td>40.57%</td>
</tr>
</tbody>
</table>

In 2005, the import of beans in China has occupied 40.57%, so it greatly influences the price of beans in the futures market in the world.
## Cotton Production and Import in China

<table>
<thead>
<tr>
<th>Year</th>
<th>World Production</th>
<th>World Consumption</th>
<th>China Production</th>
<th>China Consumption</th>
<th>China Import</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>1935</td>
<td>3575</td>
<td>442</td>
<td>911</td>
<td>5</td>
<td>0.88%</td>
</tr>
<tr>
<td>2001</td>
<td>2150</td>
<td>3810</td>
<td>531</td>
<td>943</td>
<td>10</td>
<td>1.52%</td>
</tr>
<tr>
<td>2002</td>
<td>1921</td>
<td>3712</td>
<td>492</td>
<td>937</td>
<td>68</td>
<td>10.38%</td>
</tr>
<tr>
<td>2003</td>
<td>2070</td>
<td>3730</td>
<td>486</td>
<td>963</td>
<td>192</td>
<td>26.05%</td>
</tr>
<tr>
<td>2004</td>
<td>2622</td>
<td>4221</td>
<td>631</td>
<td>1049</td>
<td>139</td>
<td>19.42%</td>
</tr>
<tr>
<td>2005</td>
<td>2432</td>
<td>4441</td>
<td>533</td>
<td>1112</td>
<td>348</td>
<td>38.63%</td>
</tr>
</tbody>
</table>

In 2005, the imported cotton has occupied 38.63%
### Projections of Grain Production, Demand and Imports in China, 2020 (million metric tons)

<table>
<thead>
<tr>
<th>Projections</th>
<th>Rosegrant et al.</th>
<th>Huang et al.</th>
<th>USDA</th>
<th>World Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain Production</td>
<td>541</td>
<td>552</td>
<td>443</td>
<td>566</td>
</tr>
<tr>
<td>Grain Demand</td>
<td>565</td>
<td>594</td>
<td>481</td>
<td>600</td>
</tr>
<tr>
<td>Grain Imports</td>
<td>24</td>
<td>43</td>
<td>37</td>
<td>34</td>
</tr>
</tbody>
</table>

Note: 'Grain' is defined in this table as wheat, rice (milled basis see note 4), corn, sorghum, millet, barley and oats.

WTO: Demonstration in HongKong, 2005
Agriculture is the major issue

China: Deficit in agriculture trade reached to $5.5 billion in 2004
Government took strong action in enhancing the agricultural production in 2004

• Reduction the agricultural tax in the first time in history and will cut it to 0 next year in whole country
• To increase the price of grains, some of them increase about 20% or more, encourage farmers to stay in farm.
• To control the price of fertilizer and farm machines.
• To exempt education expenses for farmers children
• To encourage the investment in rural area.

Results show high increase in the production, 9% increase comparing to 2003, the highest in last 5 years. Farmers incomes Increased 6.8%
Strategic Actions and Consideration

- Future growth of agriculture and farmers’ income largely depends on public policy and investment. Restructure of farming system.
- Reducing the number of farmers will facilitate expansion of farm size, increasing labor productivity and competitiveness.
- Transformation of employment structure within agriculture is important.
- New technology applications are key factors to increase the production and food quality.
Global Area of Biotech Crops (ISAAA):
- USA
- Argentina
- Brazil
- Canada
- China
- Paraguay
- India
Roger Beachy, 1986, Illinois
Regulation of Transgenic Plants in China

- 1986  National 863 R&D Program on transgenic plants
- 1993  National Biosafety Committee established
- 1996  First National Regulation on GM plants issued. First approval on commercialization of GM cotton, tomato, and sweet pepper.
- 2001  State Council promulgated the Regulations on Safety of Agricultural GMOs
- 2002  Ministry of Agriculture issued 3 supporting documents for the Regulations, including Safety Assessment, Safety of import and Regulations on Labeling
GMO approvals in China
(up to June, 2006)

- 192 research organizations and companies both domestic and international applied for approvals. Total applications: 1525, Approved for trials: 456, environment releases: 211, pre-production trials: 181.
- Ministry of Agriculture has issued 424 licenses for GM crops for production
- Issued 18 licenses to imports of raw materials of GM products
Approval of Commercialization of Transgenic Plants in China

- Bt.Cotton                      Monsanto Company
- Bt.Cotton                      CAAS
- Anti-PG.Tomato                 HuaZhong Agri.Univ.
- Virus-R Tomato                 Peking Univ.
- V-R Sweet Pepper              Peking Univ.
- CHS-Petunia                   Peking Univ.
- Papaya PRV                    South China Ag. Univ.
GM Plants Tested or released in China

Cotton                     peanut
Rice                       cabbage
Wheat                      tomato
Maize                      melon
Soybean                    sweet pepper
Potato                     chili pepper
Oil rape                   papaya
Tobacco                    poplar tree

To 2005, total GM plant species:30; application:1044, approval for trials:777; commercial licenses issued:73
Insect-resistant Crops
Cotton: 200 million farmers, textile exports reached to $115.7 billion in 2005, 15% of total exports.
Over 60% cotton fields, about 6 million farmers adopted Bt cotton in 2005.
Public Debates on GMO
Transgenic Rice in China

Transgenic rice have been tested in fields and preproduction trials:

- Insects resistant
- Bacteria blight and fungal blast resistant
- Salt tolerance
- Herbicide tolerance
- Nutritional improvement
- Rice dwarf virus resistance
Integration of Xa-21 and bt-rice
Field-trial of Bt-rice
Bt Transgenic Rice
Herbicide-tolerance Transgenic Rice
Transgenic Rice, Salt Resistant
Commercialization of Transgenic Rice

- National Biosafety Committee approved the production of Xa-21 GM rice against leaf blight disease in Nov 2004, waiting for final approval from government.
- Green Peace involved in Chinese transgenic rice and made announcement of detection of GM rice in seeds market in HuBei Province, April, 2005.
- Japan and South Korea made decisions afterwards for detection the transgene in rice before importing from China.
- Still no approvals for any transgenic rice for production commercially.
- Iran approved for commercialization in 2005.
BEIJING, CHINA -- April 12, 2005 Greenpeace called for an urgent, international product recall after uncovering the release of a variety of genetically engineered (GE) rice in China.

Samples of rice seeds have been collected from seed companies, farmers and rice millers. Testing by the international laboratory Genescan has confirmed the presence of GE DNA in 19 samples out of 25 samples.
Scandal: Greenpeace discovers illegal GE rice in China

13 April 2005

HUBEI, China — In a startling development that may have repercussions on exports of China’s biggest crop, Greenpeace has uncovered genetically engineered (GE) rice, unapproved for human consumption, that appears to have been planted and sold illegally in China for the last two years.

Farmer selling GE contaminated rice.

The Chinese government has not authorised GE Rice for commercial planting, and has to date permitted only field testing. Nevertheless, it appears GE Rice is being sold, planted, consumed, and possibly exported in China, one of the
Recent Problems in EU in GM Rice

- August in this year, EU announced the finding of GM rice imported from USA (long-grain rice contained GM Liberty Link rice LL601) and block the importation.
- Last month, Sept.5, Green Peace announced the discovery of GM components in import rice products (rice noodles).
- The same day, EU urged member countries to enhance the monitoring GM in food. To date, EU prohibit 25 member countries to sale and to import GM rice and its products.
- French administrators searched the largest rice noodle company (TangFreres) in France and tested their products. Asked them to stop the sale during the investigation.
GM Rice Needed to Be Approved

- Last month, Aug.26, the China National Biosafety Committee of Agricultural GMOs had a meeting for approvals of GM rice.
- Total 7 GM rice varieties have been discussed
- 6 varieties are related to insects resistance with genes of cry1Ac, Cry1Ab and sck.
- 1 variety is related to bacterial resistance with gene Xa21
GMO Debates and Facts: GMO food safety

- So far, only two major genes are used mostly, Bt and herbicide resistance genes, in GM crops.
- Since 1960s, Chinese and other parts of world have used Bt bacterial as biological control for insects in vegetables and pine trees. No any toxic reported.
- China has imported GM soybean from USA since 1999 and products including soybean oil, soy sauce, tofu, feeds for animals have been used. No reports on unsafe issue.
- Over 2 billion people from USA, Argentina, Brazil, Canada and some other countries have been using GM food for over 6 to 10 years, no case reported that toxic GM food to consumer.
GMO Debates and Facts: Environment Safety

- Less pesticide or herbicide used in GM crops, create better or at least no worse environment.
- More other species of insects in Bt-cotton fields than fields spreading pesticides due to less pesticide.
- Cross pollination to wild rice if happened but the same when planting rice cultivars
- 40,-50,000 people poisoned due to pesticides in China annually, 400-500 people died.
Insecticide Use on Bt and Non-Bt Cotton in China 1999-2001, (kg/hectare of formulated product)

<table>
<thead>
<tr>
<th></th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Bt</td>
<td>60.7</td>
<td>48.5</td>
<td>87.5</td>
<td>65.5</td>
</tr>
<tr>
<td>Bt</td>
<td>11.8</td>
<td>20.5</td>
<td>32.9</td>
<td>21.7</td>
</tr>
<tr>
<td>Non-Bt - Bt</td>
<td>48.9</td>
<td>28.0</td>
<td>54.6</td>
<td>43.8</td>
</tr>
</tbody>
</table>

Source: Pray et al., 2002.
Percentage of Bt and Non-Bt Cotton Farmers Suffering from Pesticide Poisonings in China 1999-2001

<table>
<thead>
<tr>
<th></th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Bt</td>
<td>22</td>
<td>29</td>
<td>12</td>
</tr>
<tr>
<td>Bt</td>
<td>5</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Non-Bt - Bt</td>
<td>17</td>
<td>22</td>
<td>4</td>
</tr>
</tbody>
</table>

Source: Pray et al., 2002
### Distribution of Benefits between Farmers, Seed Companies, and Research Institutes

<table>
<thead>
<tr>
<th></th>
<th>CAAS</th>
<th>Ji Dai</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Benefits to farmers</td>
<td>46-70 M USD</td>
<td>31-61 M USD</td>
</tr>
<tr>
<td></td>
<td>83-88 %</td>
<td>83-90 %</td>
</tr>
<tr>
<td>Gross revenues to seed co.</td>
<td>9.6 M USD</td>
<td>4.8 M USD</td>
</tr>
<tr>
<td></td>
<td>12-17 %</td>
<td>7-12 %</td>
</tr>
<tr>
<td>Returns to CAAS &amp; Monsanto, Deltapine &amp; Singapore Economic Development Board</td>
<td>0 M USD</td>
<td>1.9 M USD</td>
</tr>
<tr>
<td></td>
<td>0 %</td>
<td>3-5 %</td>
</tr>
</tbody>
</table>

Huang et. al. Survey
Labeling System for Agricultural GMOs

- 17 products are required to be labeled.
- Soybean seeds, soybean, soybean flour, soybean oil, and soybean meal.
- Corn seeds, corn, corn oil, corn flour
- Rape seeds, rapeseed, rapeseed oil, meal.
- Cotton seeds
- Tomato seeds, fresh tomatoes and tomato sauce
Labeling in China:

• Required to be labeled in 2002
• 6 months after announcement, none of foods are labeled as “transgenic”
• Many vegetables are labeled as “non-transgenic”

Science and Technology Diary
Sept. 12, 2002

• Soybean oil products have been reinforced to be labeled in 2004, markets are not affected
• Cost increases over 50% in production and sale management with labeling system
Biotech crops foods: non organic?

• Transgenes and their proteins are organic!
• Biotech crops should not be discriminated
• Green revolution continues.

Figure 1. Nitrogen Inputs in China’s Agriculture, 1952-96

Atmospheric
deposition
Biofixation
Organic Recycling
Fertilizer

Nitrogen Nutrients, metric tons

0 10 20 30 40

Figure 1. Nitrogen Inputs in China’s Agriculture, 1952-96

Atmospheric
deposition
Biofixation
Organic Recycling
Fertilizer

Nitrogen Nutrients, metric tons

0 10 20 30 40
Consideration

• It has spent great amount of money in the world recently years for studying the safety of GMO and show no any evidence of toxic to human or animals or to environment. But because of regulation in each country, people still repeat each other for this work.

• People in many parts of the world are suffering from shortage of food. But this important technology could not be used in these countries.

• We should learn the experiences from DNA recombinant drugs.

• Europe is key region for application of biotech crops in the world. “Luxury Syndrome” should be changed.

• Agriculture Biotechnology combined with conventional breeding methods are very effective in crop improvements and should be considered as an important step in Green Revolution.
Thank you.

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