



Innovations of Agricultural GM Technology in China's Public Sector: Successes and Challenges

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The solution for future agriculture problem should be solved by bioengineering, by high technology.

Deng Xiaoping, 1980s

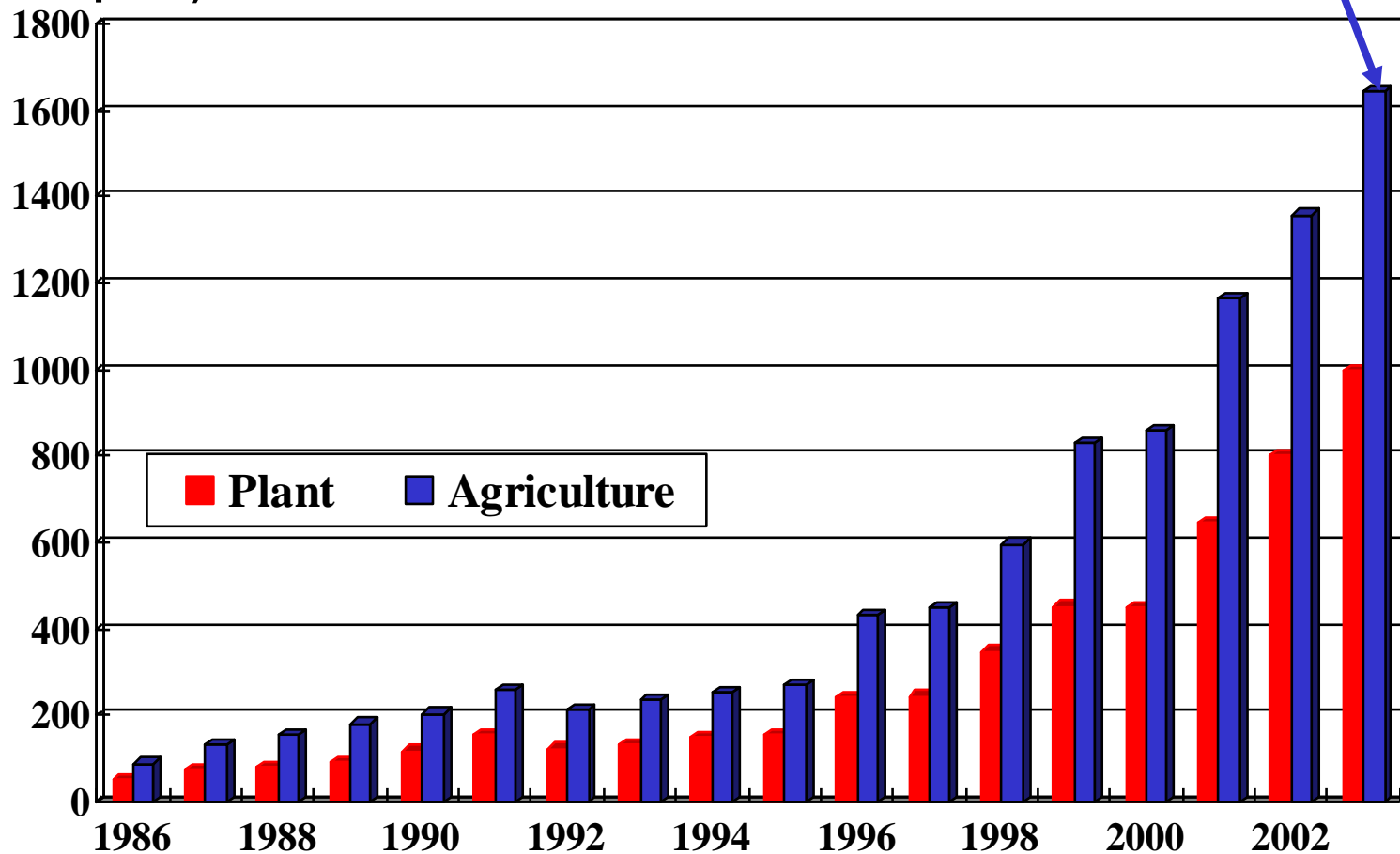
Solving the food security problem should rely on **BIG science and technology, rely on biotechnology and transgenic...**

—Premier Wen Jiabao, 2008

Investment in agri biotech research had been doubled in every 4 years

2003: 1.65 billion yuan = US\$ 200 million
or US\$ 950 million in PPP

(million yuan
in 2003 price)



Major progresses in China's agricultural biotechnology before 2006

- **By 2006, China's biosafety committee received more than 1500 cases with 1024 cases approved for various trails or commercialization:**
 - 456 for small field trials;**
 - 211 for enlarged field trails;**
 - 181 for production trials;**
 - 176 cases for commercialization.**

Commercialized GM plants in China by 2006

- **Cotton** 1997
- **Petunia** 1997
- **Tomato** 1998
- **Sweet pepper** 1998
- **Poplar trees** 2005
- **Papaya** 2006

Although there had been a rising number of cases of GM crops approved for trials, with the exception of Bt cotton varieties and a few minor plants, no major crop (e.g., rice, maize and soybean) had been approved for commercialization before 1999...

Questions

- **Why no major GM crops such as GM rice and maize in production?**
- **Is there no technology available?**
- **...**

Status of GM plants in 2008

		Small field trial	Enlarged field trial	Production trial	Safety certificate for production
1	Cotton	√	√	√	√
2	Rice	√	√	√	No
3	Maize	√	√	√	No
4	Tomato	√	√	√	√
5	Sweet pepper	√	√	√	√
6	Papaya	√	√	√	√
7	Poplar trees	√	√	√	√
8	Petunia	√	√	√	√
9	Wheat	√	√	√	No
10	Soybean	√	√	√	No
11	Rapeseed	√	√	√	No
12	hot pepper	√	√	√	No
13	Potato	√	√	No	No
14	Peanut	√	√	No	No
15	Cabbage	√	√	No	No
16	Sweet melon	√	No	No	No
	...				

GM rice

- ***Bt (cry1Ab/cry1Ac) rice Sanyou 63* was almost approved for commercialization in 2000:**
 - it passed enlarged field trial and was supposed to get safety certificate for production application in about 2000;
 - However, a new stage of biosafety trial, production trial (about 2 years), has been added after 2000.
- **Bt rice production trial: started in 2001 and has been continued since then...**

In 2009, MOA issued Bt rice the safety certificate for production application!

Historical events in 2009

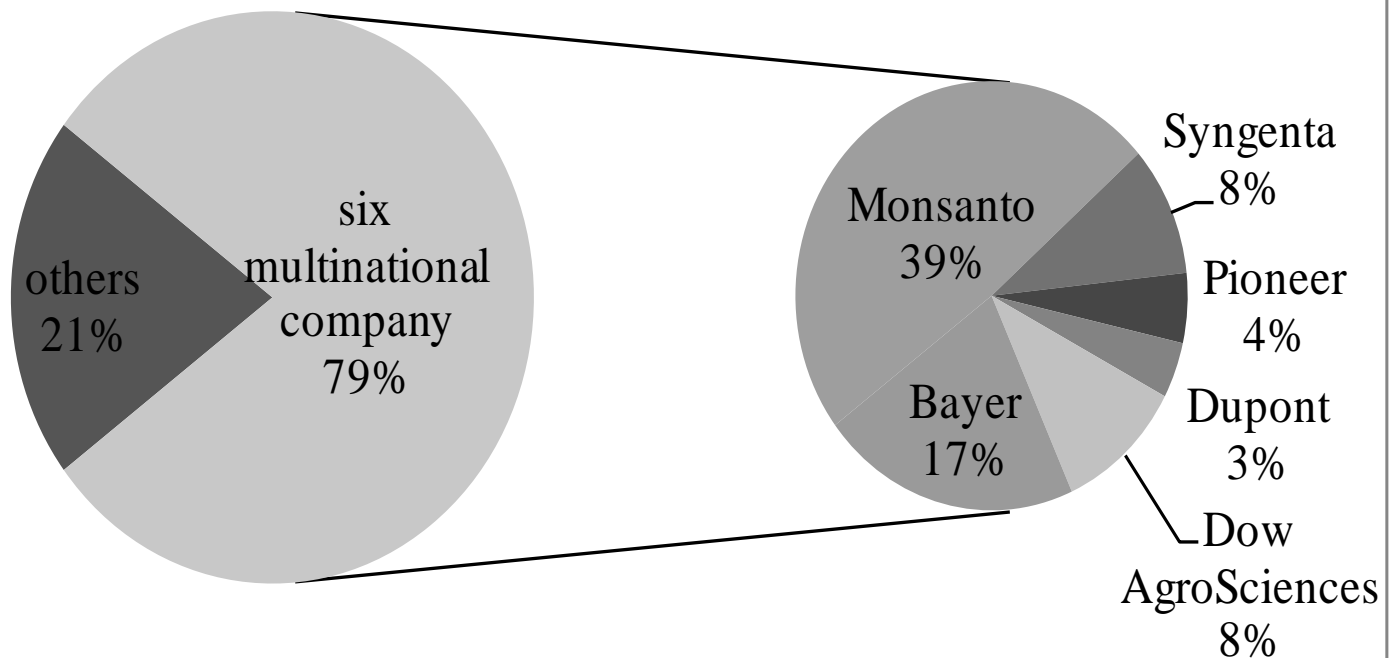
1. **Transgenic Bt rice “Huahui 1#”** containing *Cry 1Ab/1Ac* genes with insect resistance (restore line)
2. **Transgenic Bt rice “Bt Sanyou 63#”** containing *Cry 1Ab/1Ac* genes with insect resistance
3. **Transgenic maize “BVLA 430101”** containing phytase gene in Shandong



The R&D framework

In the developed countries,
R&D of GM technology is dominated by **MNCs**

The distribution of events in the major multinational companies



The R&D framework

In China, R&D of GM technology is conducted by **public sectors**

Numbers and proportion of agricultural researchers, 2005-2010

	2005	2008	2009	2010
Agriculture ^b	95608	93567	94976	NA
Biotechnology	10239	12161	13052	13626
- Ph.D Degree (%)	33.4	41.1	43.4	44.6
- Master Degree (%)	27.1	28.0	27.9	27.7
- Others (%)	39.5	30.9	28.7	27.7

Questions

The overall goal is to assess if Chinese GM technology based on its public sector is competitive?

- To document the performance of Chinese R&D in GM technology**
- To identify the successes and challenges of Chinese public GM technology program**

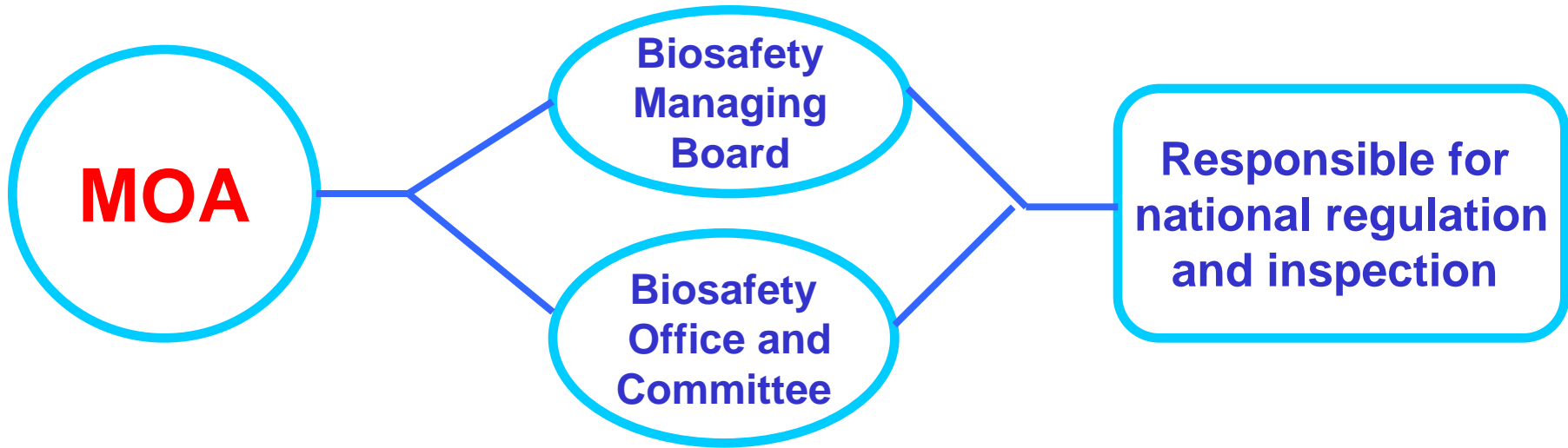
The rest of presentation

- **The objectives and stages of biosafety regulations, and approval of GM rice and maize;**
- **Data source on R&D in public sectors**
- **Descriptive statistics on performance of R&D in public sector**
- **Successes and challenges of Chinese public GM technology program**

Objectives of biosafety regulations

1. To promote the **research and commercialization** of agricultural GMOs;
2. To strengthen **safety administration** of agricultural GMOs;
3. To safeguard human **health** and safety of animals, plants and microorganisms;
4. To protect the **environment**.

Administrative Regulatory System



Principles of biosafety Assessment

- 1. Science-base principle;**
- 2. Substantial-equivalence principle;**
- 3. Case-by-case principle;**
- 4. Step-by-step principle;**
- 5. Familiarity principle (Bt cotton);**
- 6. Precautionary principle.**

Stages of biosafety assessment of GMOs

- **Laboratory study approval**
- **Small field trial: 0.3 ha limited data 1-2 yrs**
- **Enlarged field trial: 0.3-2 ha more data 1-2 yrs**
- **Production trial: >2 ha 2 or ??**
- **Safety certificate for :**
 - **Production**
 - **Processing/marketing**
 - **Import/export**

Approval Process of GM Rice

Application → Approval

- **Small field trial:** Early 1990s Yes
 - **Enlarged field trial:** Mid 1990s Yes
 - **Production trial:** 2000-2008 No
 - **Safety certificate:** 2009 YES
- (for production application)

Took about 20 years !

(Note: normally 5-6 years for cotton)

Why?

Major concerns: policy makers

1990s

- **Food security and economic benefit**
- **Food-safety**
- **Environmental safety**

Major concerns: policy makers

1990s

- Food security and economic benefit
- Food-safety
- Environmental safety
- Media:
 - +++; -

2006-2008

- Food security and economic benefit
- Food-safety
- Environmental safety
- Media:
 - ++; ---

China's Actions in late 2000s

- **Approval of a New GMO program (US\$ 3.8 billion) by the State Council in 2008 and requiring immediate implementation;**
- **Adjustment in GM policy: more pro-GMO...**

Adjustment in GM policy in 2008

- **Before 2008:**

“科学规划，积极研究，稳步推进，加强管理”

“Scientific plan, active research, steady move, enhancing management”

- **After 2008:**

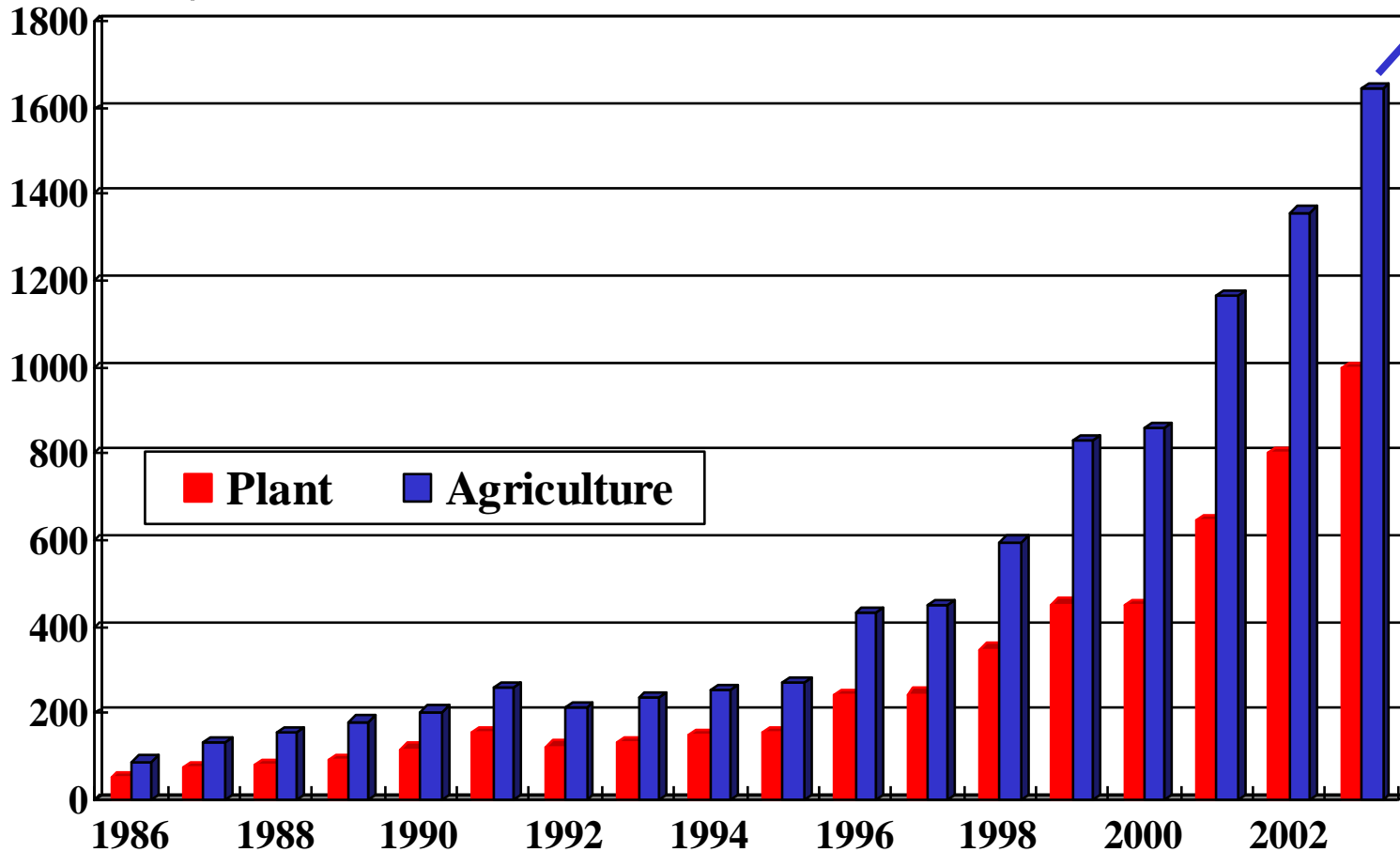
“加快研究，推进应用，规范管理，科学发展”

“Accelerate research, push application, standardize management, scientific development”

Investment in agri biotech research had been doubled in every 4 years

2008-2020 GM Special program US\$ 3.8 billion

(million yuan
in 2003 price)



2008

China's Actions in late 2000s

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MOA's roles have been expanded:

- **Biosafety assessment (since early 1990s)**
- **GMO R&D National Program (MOST before 2008 and MOA after 2008)**

Major concerns: policy makers

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- Food security and economic benefit
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- Media:
 - +++; -

2006-2008

- Food security and economic benefit
- Food-safety
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 - ++; ---

2009-2010

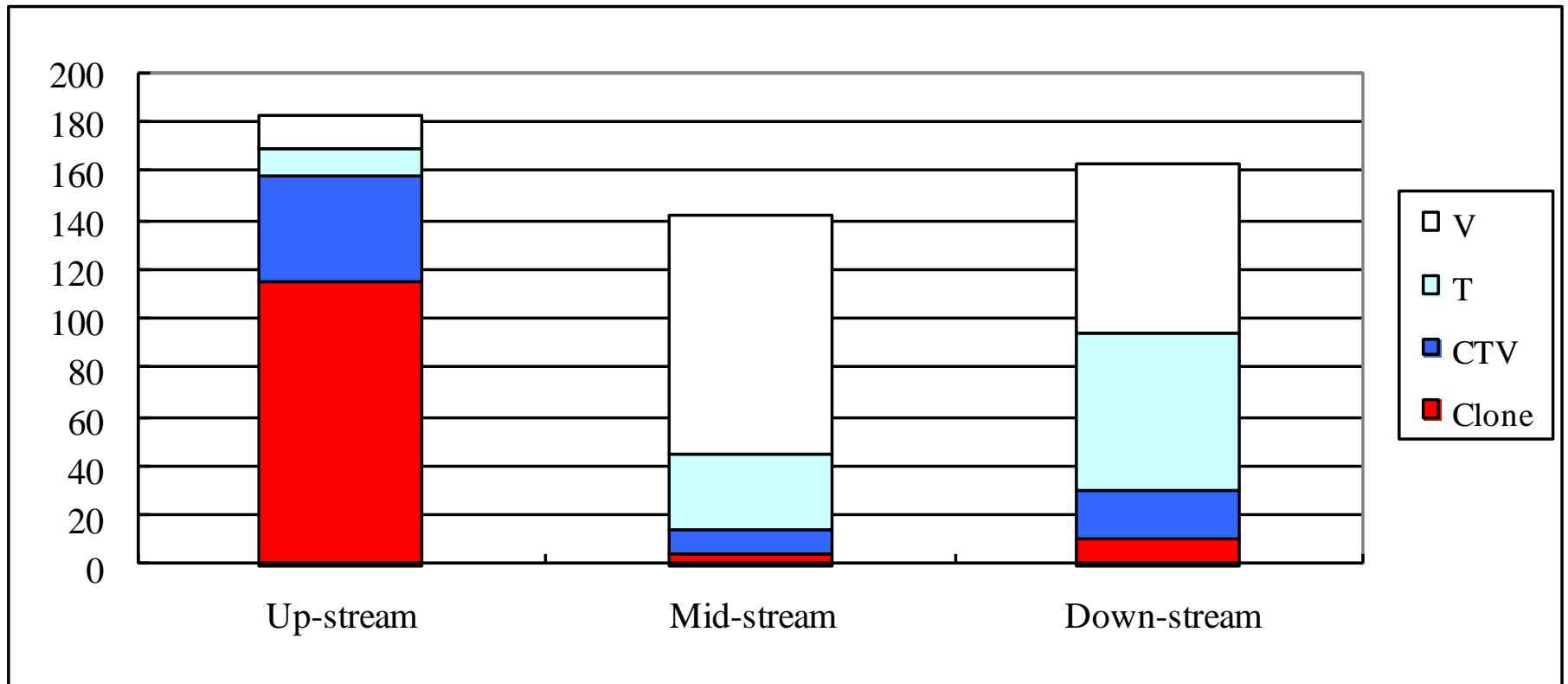
- IPR
- Food security, econ. Benefit, consumers
- Food-safety
- Environmental safety
- Media:
 - +; - - - -

R&D of GM technology in China's public sector

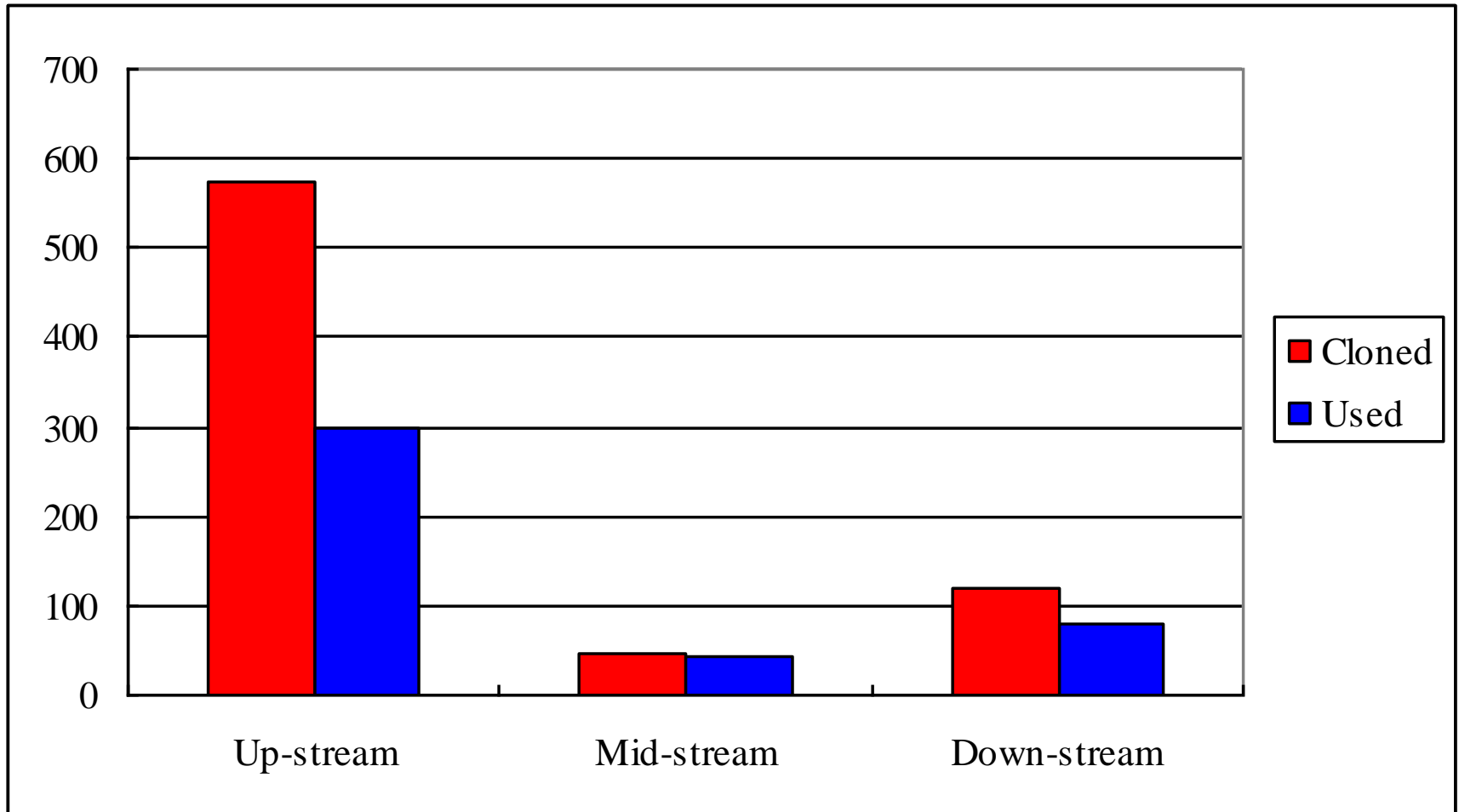
Survey by CCAP in 2010

- **Census survey: 197 universities**
487 research teams
- **Survey instrument: by mail and phone call**
- **Research teams:**
 - **R&D in 5 crops and 3 animals**
 - **up-, mid- and down-streams**

The numbers of research teams engaged in GM technology R&D in 2010



The numbers of gene cloned and used in research by 2010



Descriptive statistics of the characteristics of research teams

Indicator	Definition	Total (mean) (1)	Worked in gene clone (2)	Not worked in gene clone (3)	T-test (2) vs (3) ^a (4)
University	1=university; 0=otherwise	0.51	0.56	0.46	<0.05**
N-institute	1=national research institute; 0=otherwise	0.26	0.32	0.21	<0.01***
P-institute	1=provincial research institute; 0=otherwise	0.21	0.10	0.30	<0.01***
Ph.D	The percent of researchers with Ph.D degree (%)	43	48	39	<0.01***
GM-fund	Annual funding from GM Special Program, million yuan per person	0.11	0.13	0.09	<0.01***

Successes and challenges of Chinese public GM technology program

- China has invested significantly in GM technology
- China will continue to use GM tech as one of major tools to boost its agricultural productivity and to improve its food security;
- After 10 years of delay of GM rice, China made a historical decision to move its GM technology commercial application from fiber to feed and food crops in 2009;

Successes and challenges of Chinese public GM technology program

- The R&D progress has been impressive
 - Numerous genes have been cloned in three streams
 - Many cloned genes have already been used
- China's current public led GM program lacks of coordination
- R&D is not product-oriented yet

hanks