

Plant Biotechnology in China: Investment and Impacts

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Questions

- **Should China continue to promote biotech and commercialize its GM food, particular the food crops such as rice?**
- **How much benefit China can gain from agricultural biotech development?**
- **How important are trade restrictions on GM products by other countries**
- **Are the gains sustainable (or how can they be made so)?**

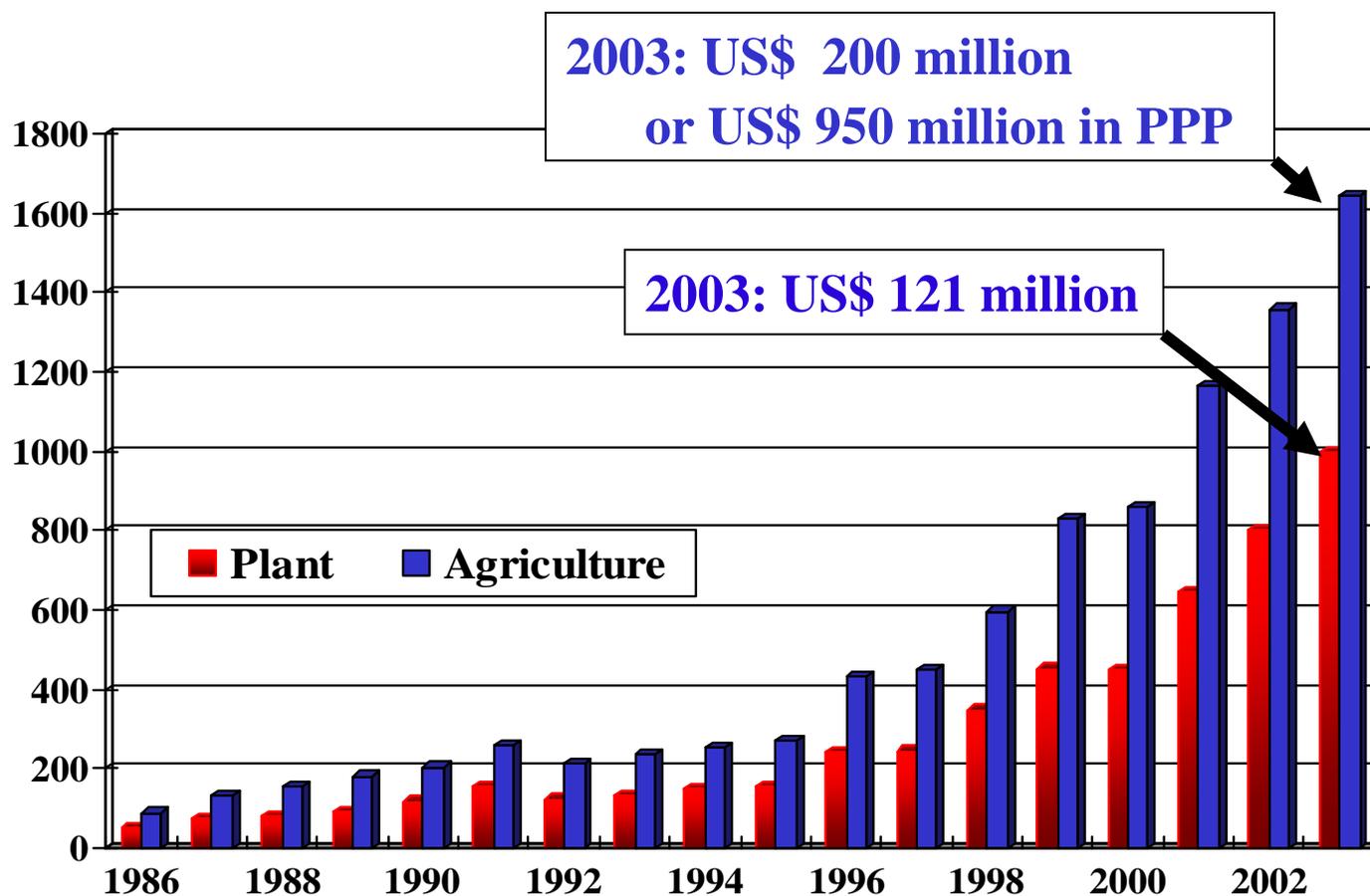
Overall goal:

**To provide an economy-wide
assessment of plant biotechnology
development in China**

Outline of presentation

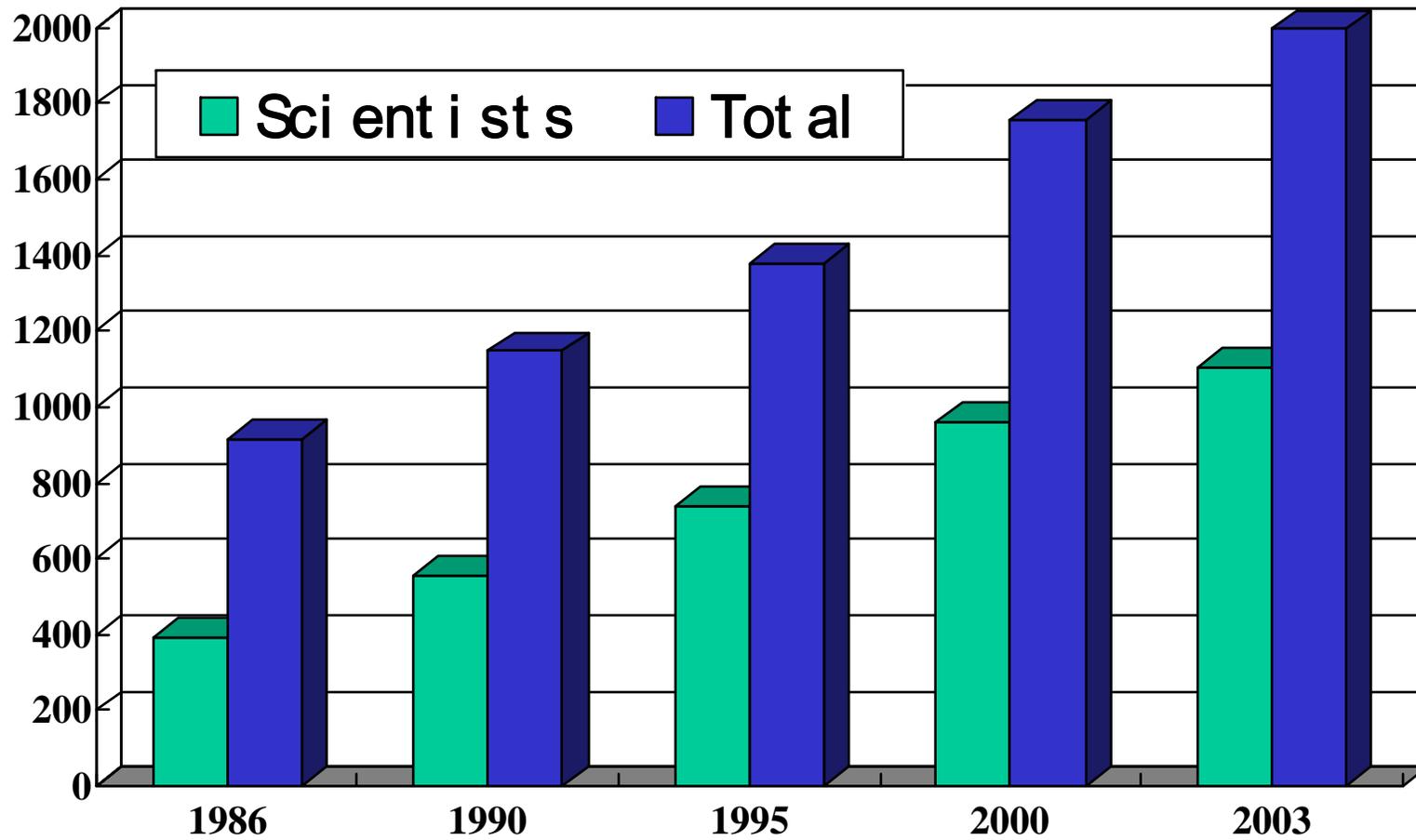
- **Overview of China's plant biotechnology research investment**
- **Bt cotton and GM rice: farm level impacts**
- **Bt cotton and GM rice: economy-wide impacts**
- **Biosafety management—successes and not**
- **Concluding remarks**

Agricultural plant biotechnology research expenditure in China, 1986-2003 (million yuan in 2003 prices)

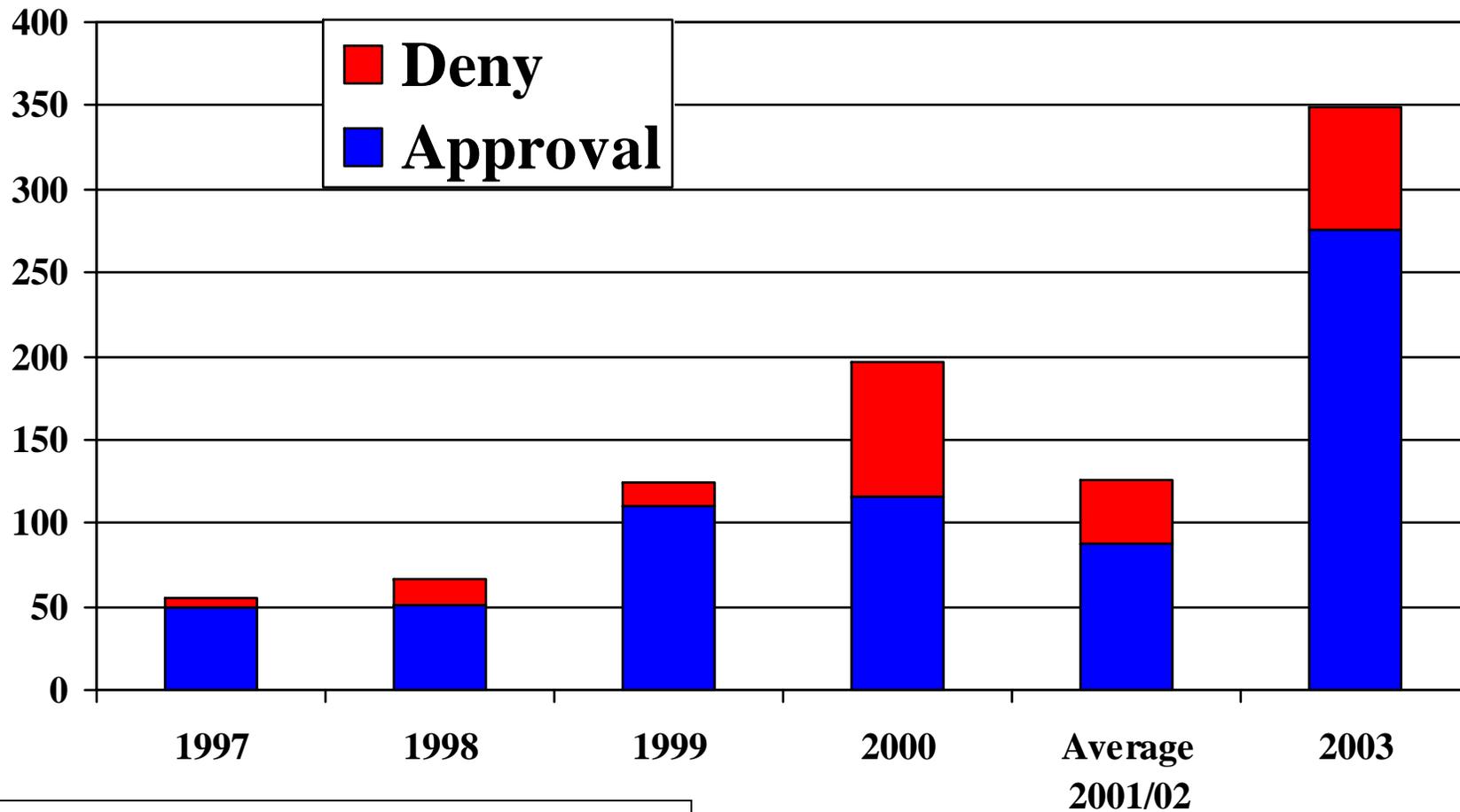


Based on CCAP's survey, 2003

Plant biotechnology researchers, 1986-2003

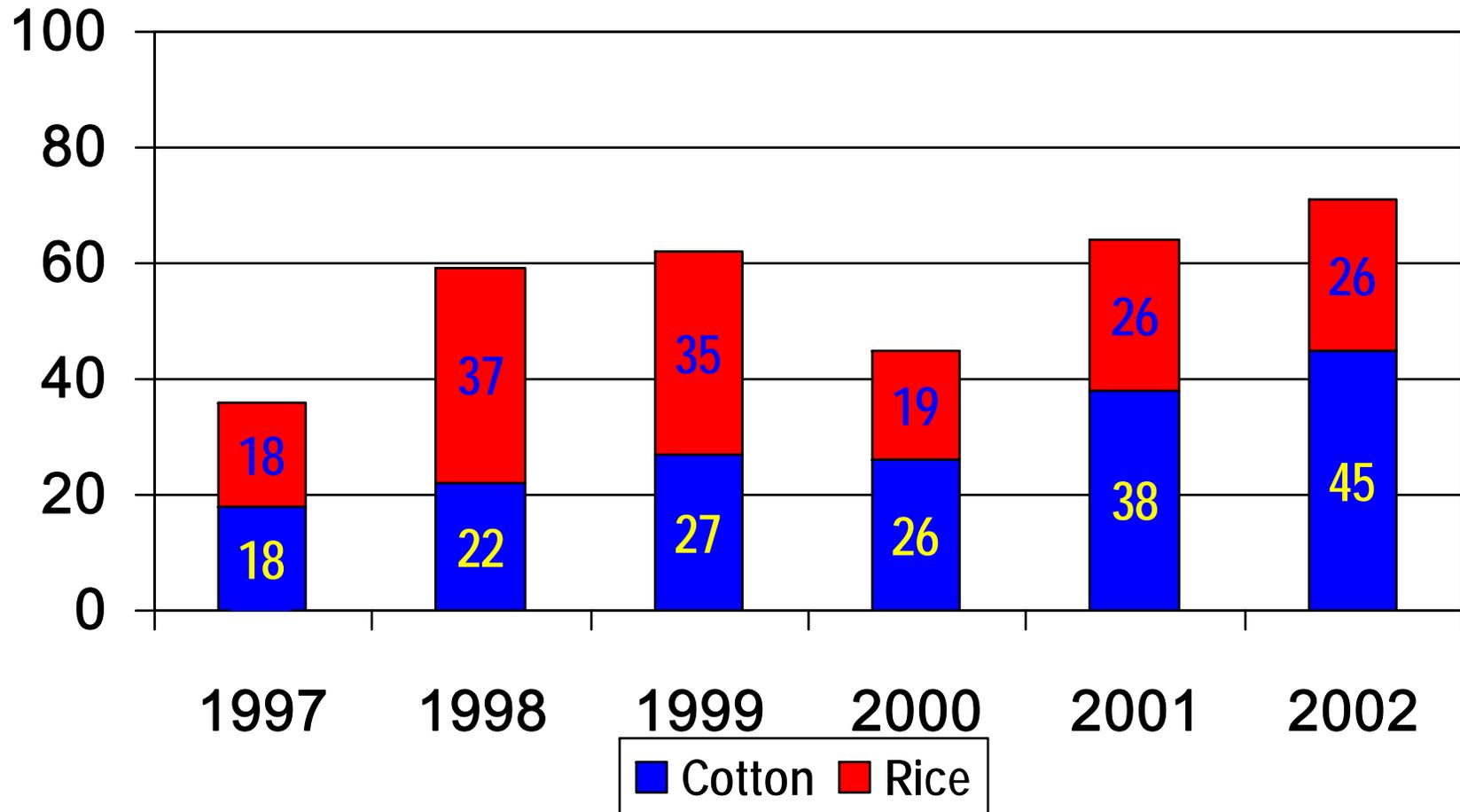


Increasing action for Biosafety Committee

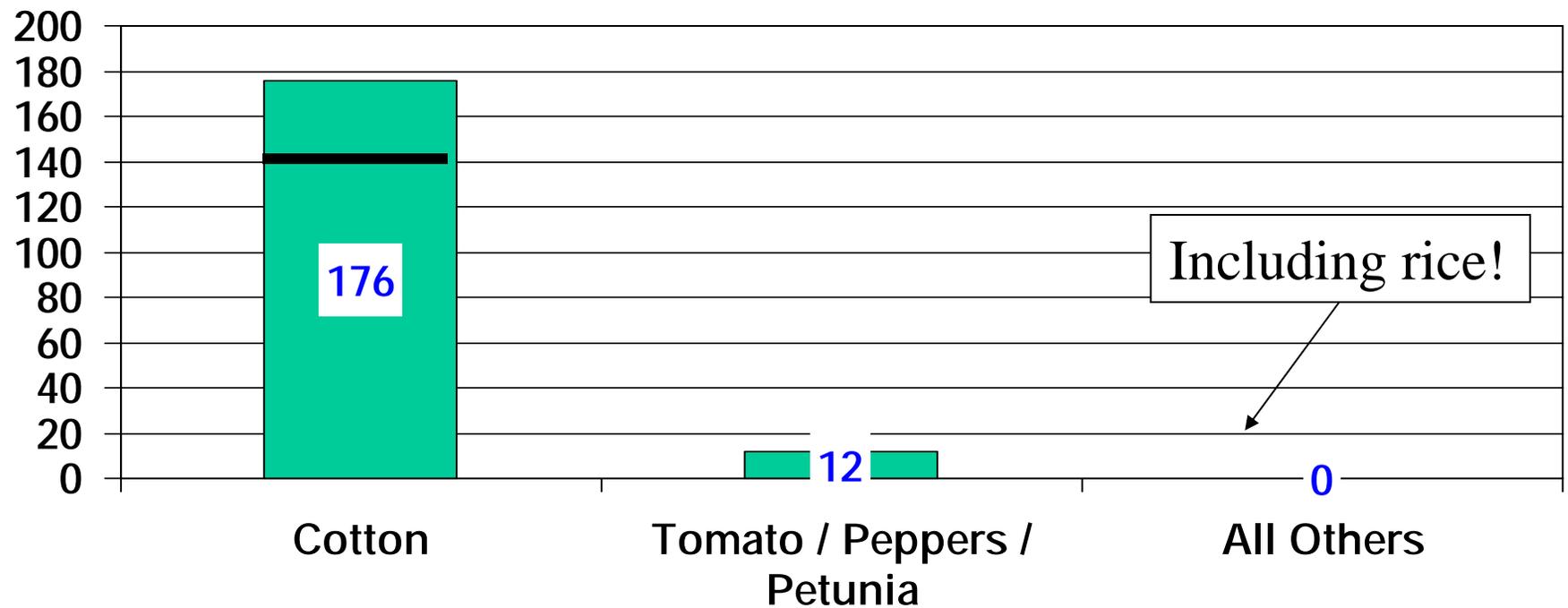


1044 cases with 777 approved

Domination of Cotton and Rice in China's GM Program



Cases approved for commercialization by 2004: 188 cases (rice case: Zero)



But, 4 cases were approved for pre-production trails since 2001 – in pre-production trials, farmers are given seed and cultivate the crop with no supervision.

Case 1: Cotton





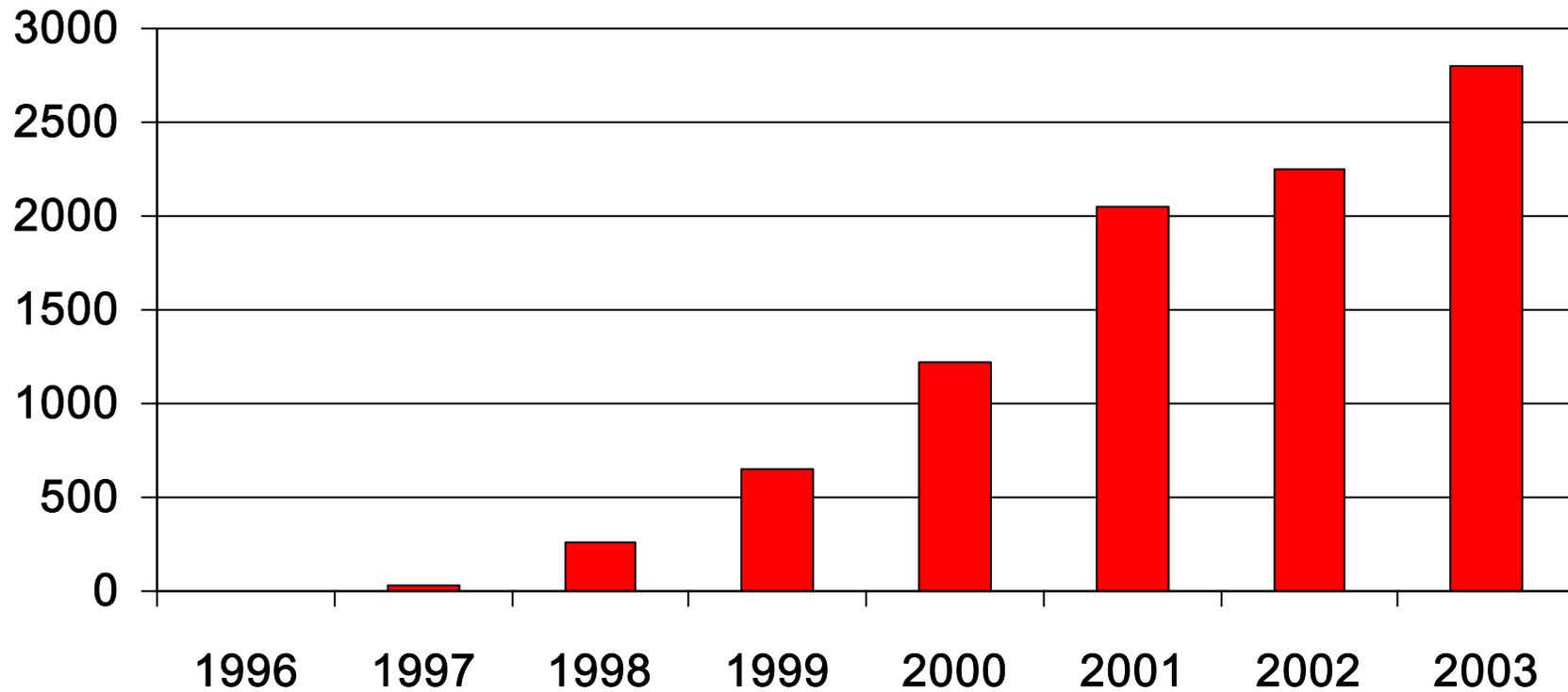
Non-Bt cotton



Bt cotton

Source: CAAS

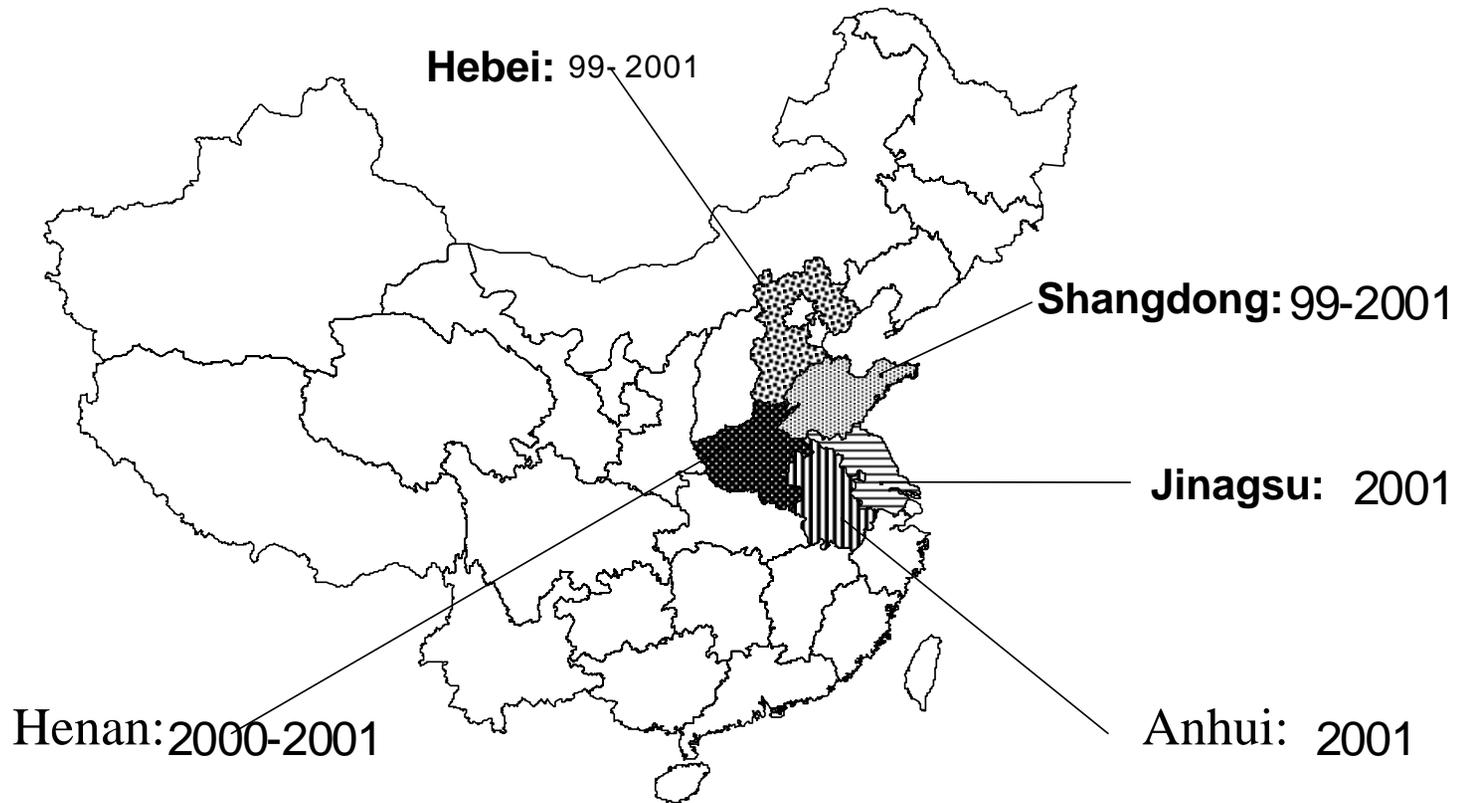
Bt cotton areas in China, 1996-2003 (thousand hectares)



More than 5 million farmers adopted Bt cotton in 2003

Case study: Bt vs Non-Bt

Samples' locations (1999-2001)



1999-2001: Sample Households: **1056**

Productivity Effects of Bt Cotton

Bt vs Non-Bt Cotton

Inputs levels:

No significant different in:

Fertilizer use

Irrigation

Machinery

Harvest cost

Significantly different in

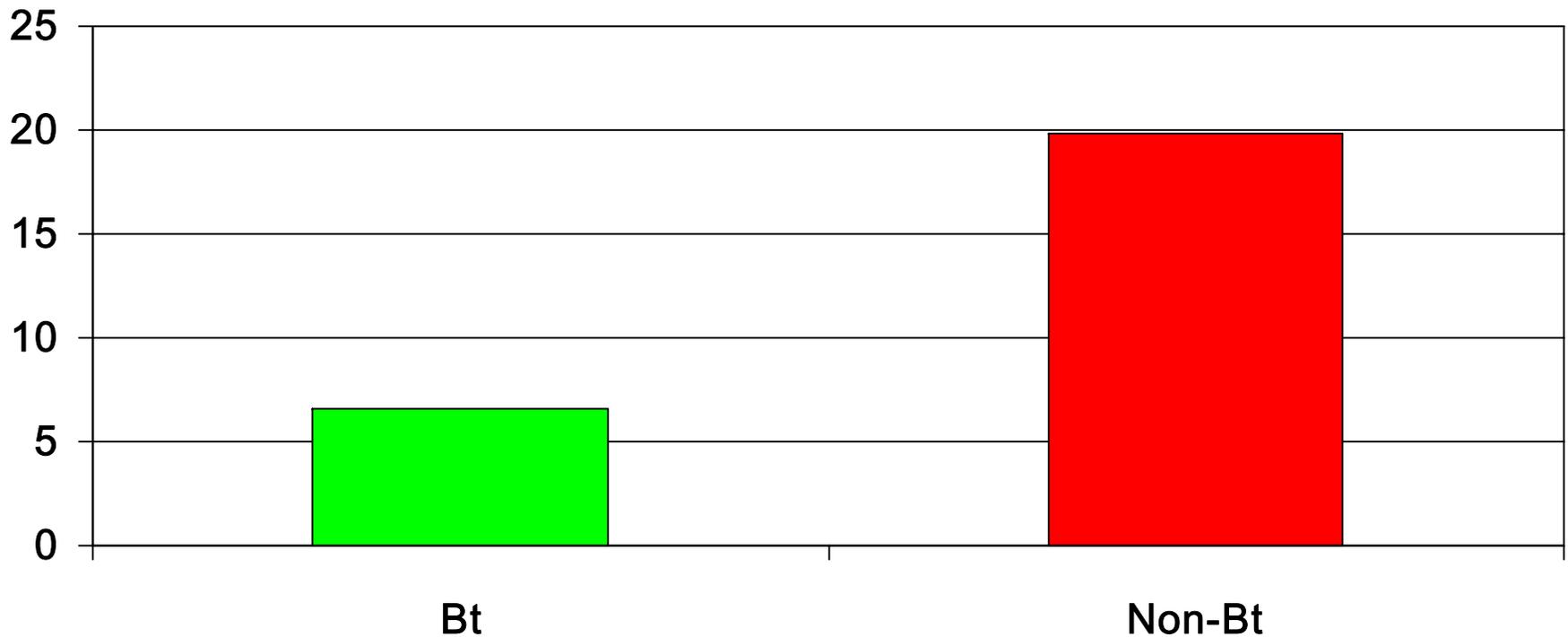
Pesticide use

Labor use

Seed price

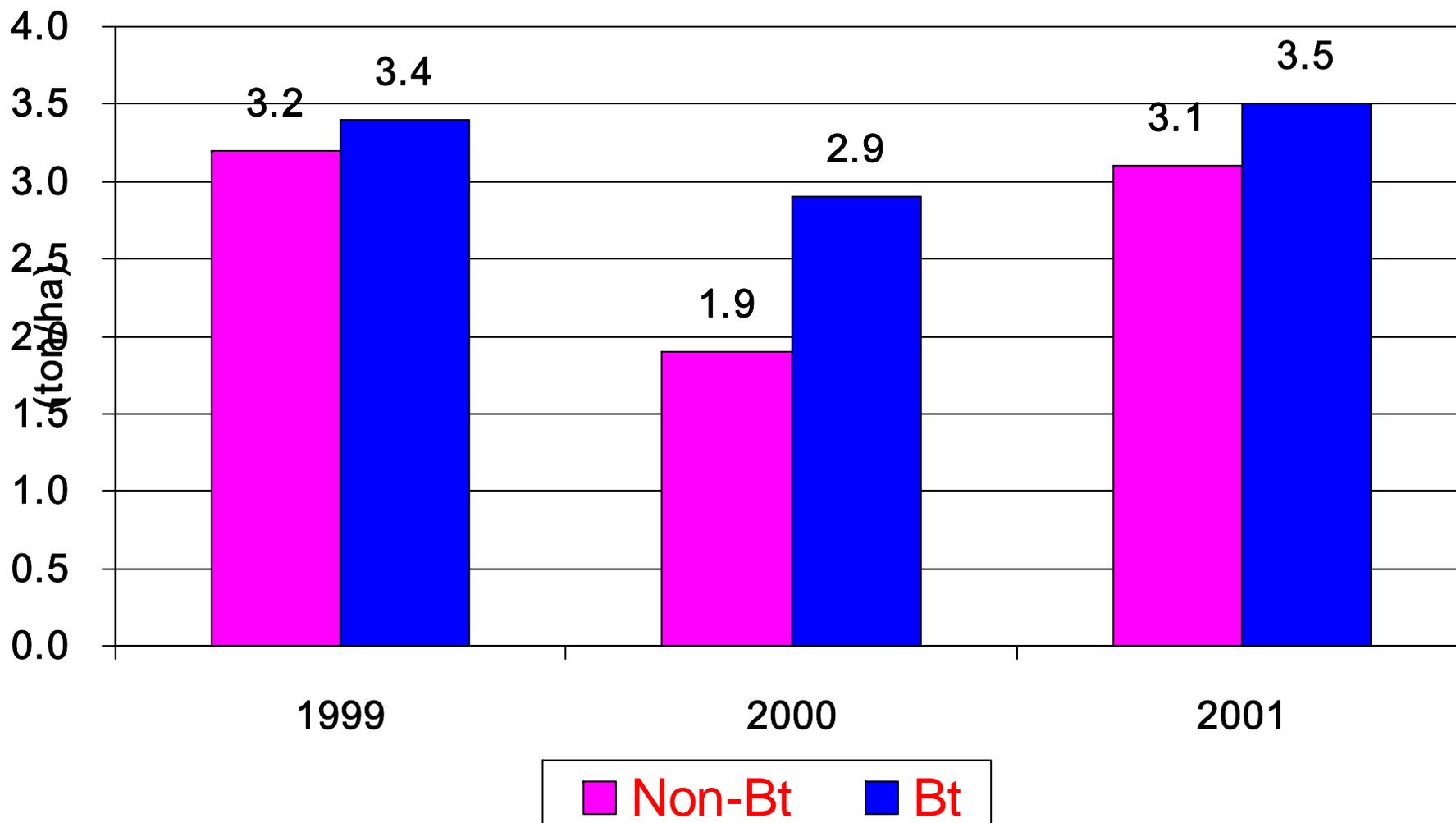
Numbers of pesticide applications in Bt and non-Bt cotton in Hebei and Shandong in 1999

-- reduced by 13 applications



In 2000: by 12 applications
In 2001: by 14 applications

Cotton yield (ton/ha): Bt vs non-Bt cotton



Methodologies

Yield Model

(1) $Y = f(X) G(Z)$,

Y : yield

X : conventional inputs, farm-specific factors and others

$G(Z)$: a damage abatement function

Z : the pesticides and Bt cotton variety

(2) $Y = a \prod_i^n X_i^{ki} [1 - \exp(-c Z)]$,

(3) $a = a_0 + a_1 Bt$

(4) $c = c_0 + c_1 Bt$

Pesticide Use Model

(5) *Pesticide use = f (Yield loss, Price, Farm size, Age, Education, Village leader dummy, Training dummy, Seed dummies, Bt cotton dummy, others)*

Major findings on Bt cotton impacts in 1999-2001 (per hectare)

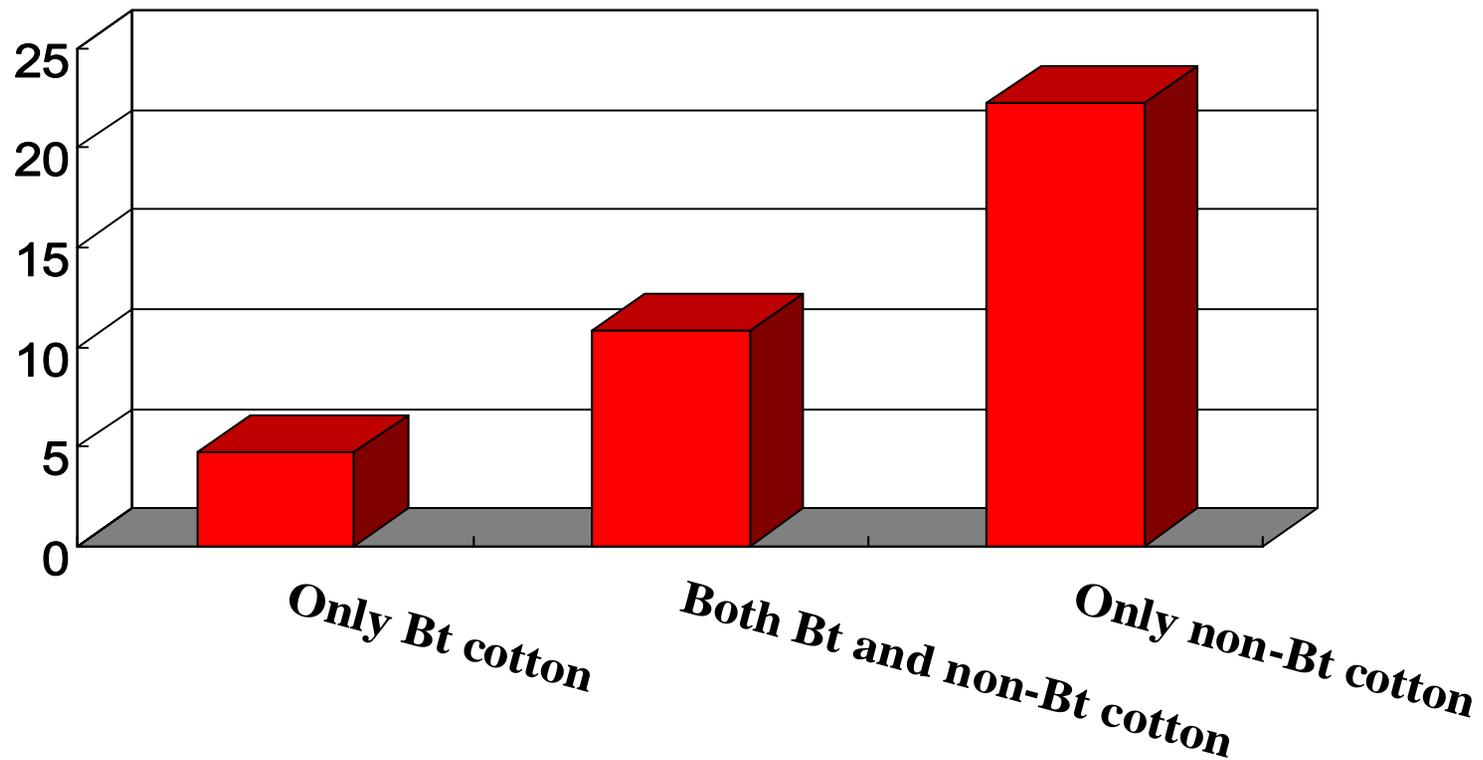
- Reduce pesticide use: 34 kg 923 yuan
- Increase yield: 9.6% 930 yuan
- Increase seed cost: 570 yuan
- Reduce labor input: 41days 574 yuan
- Increase net income: 1283-1857 yuan
(US\$ 155-225)

A net increase of net income: about 30% ...
this is a HUGE increase in productivity!

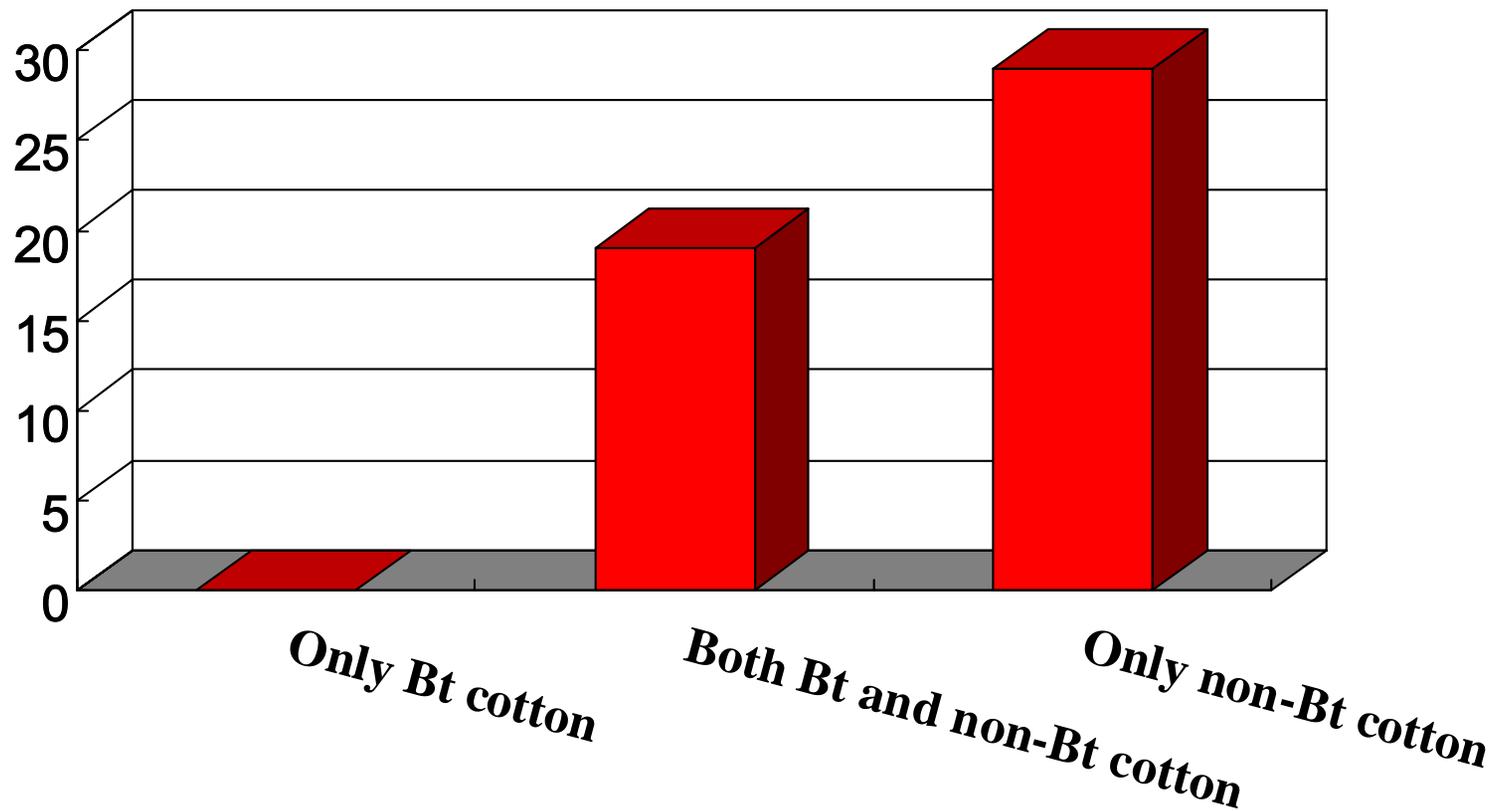


GM technology's
benefits surpass
the direct
profitability
metrics

Percentage (%) of poisonings reported as numbers of farmers interviewed in Hebei and Shandong in 1999

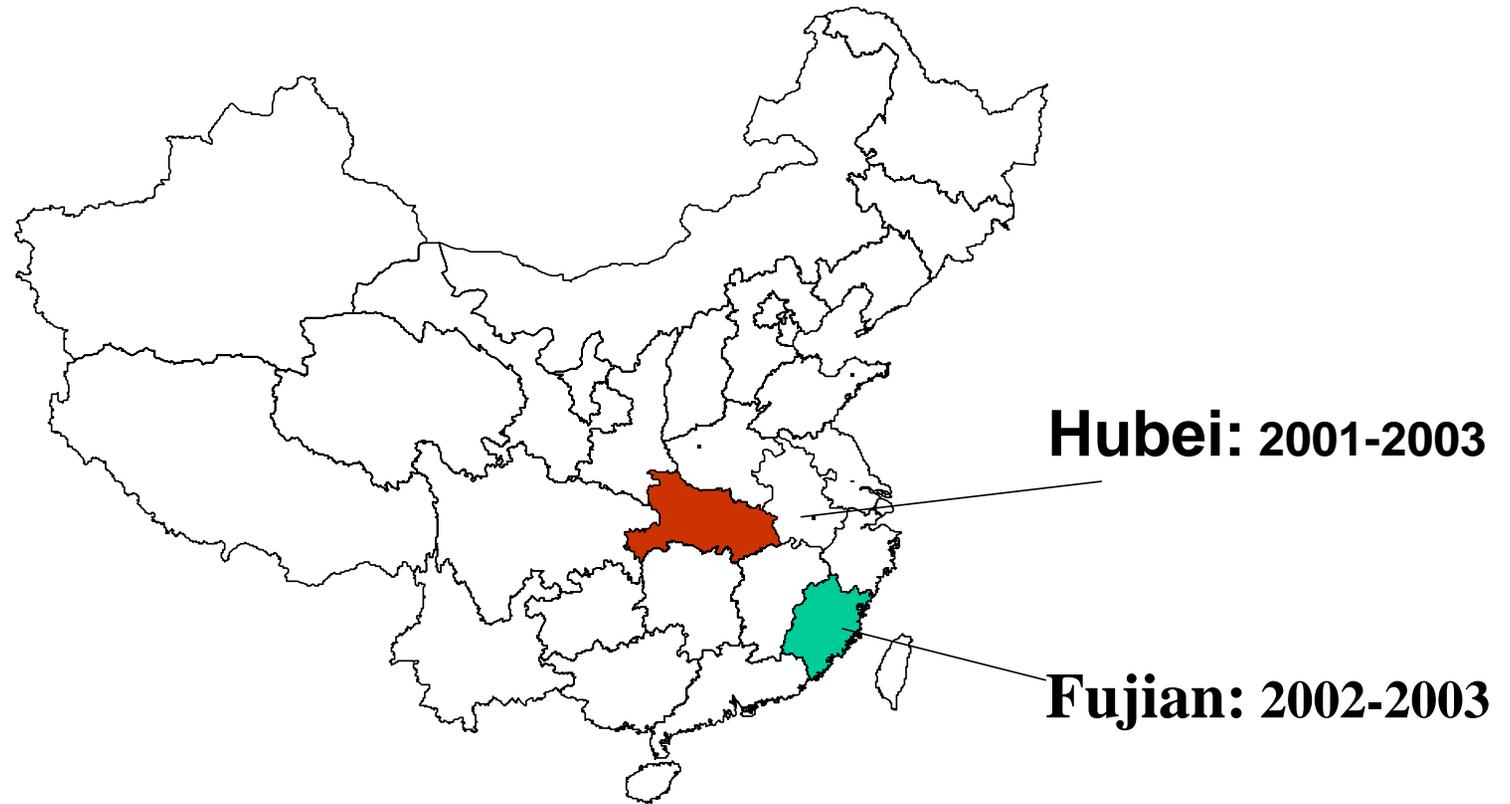


Percentage (%) of poisonings reported as numbers of farmers interviewed in Henan in 2000



GM rice: Pre-production

(2001-2003)



123 households, 512 plots

Bt rice: approved from “environmental release trials” in 2001 and 2002



2002年5月8日播种，6月1日插秧，抗虫转基因水稻恢复系株系及其配制的杂交稻组合各18个；恢复系及杂交稻组合的对照分别为明恢86及II优明86；转基因材料与对照在横竖二个方向间隔种植如国际象棋棋盘，每个方块为正方形，边长为3m。



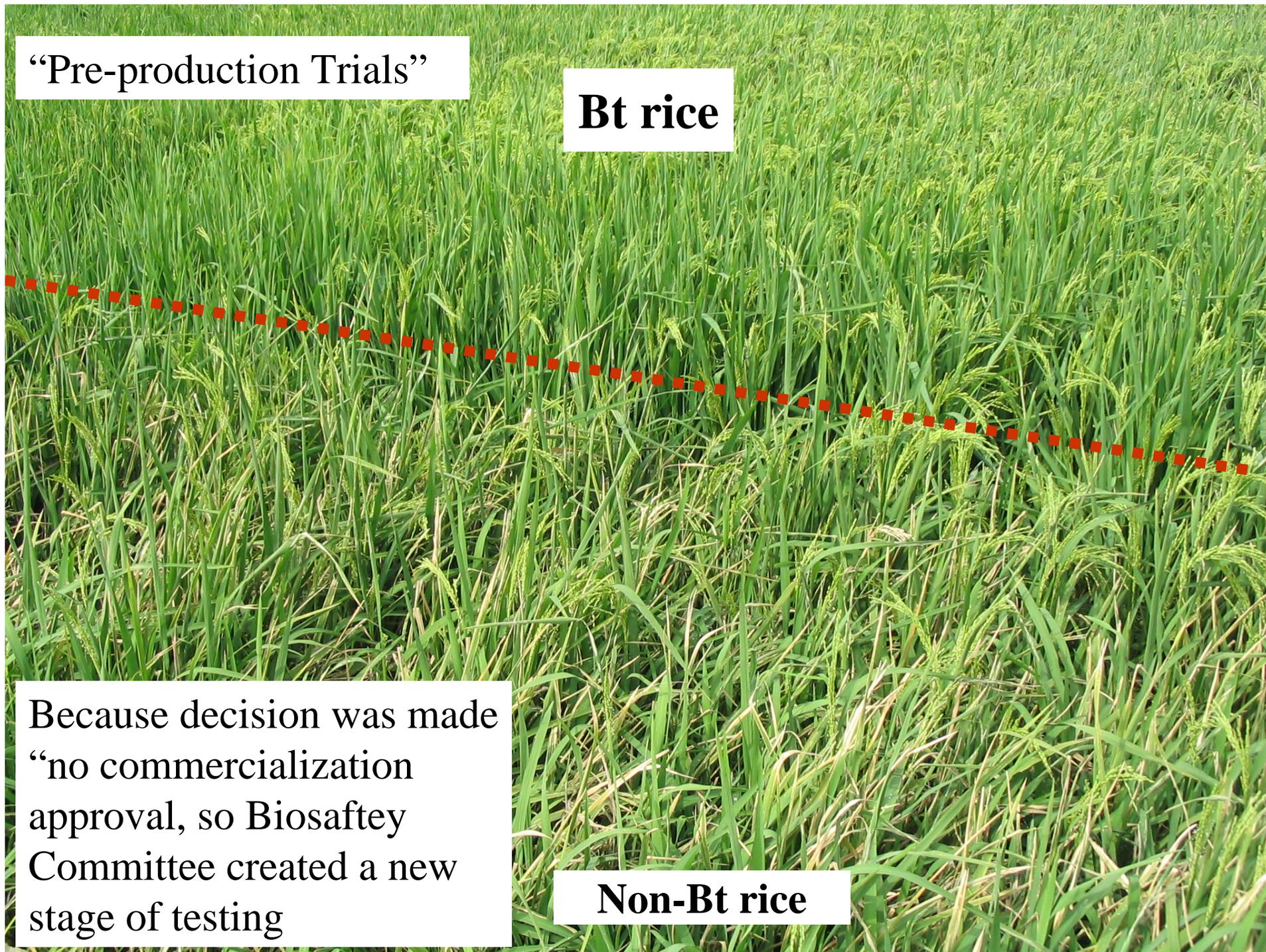
Source: Zhu Zhen

“Pre-production Trials”

Bt rice

Because decision was made
“no commercialization
approval, so Biosafety
Committee created a new
stage of testing

Non-Bt rice



Three different types of technologies in Pre-production Trials

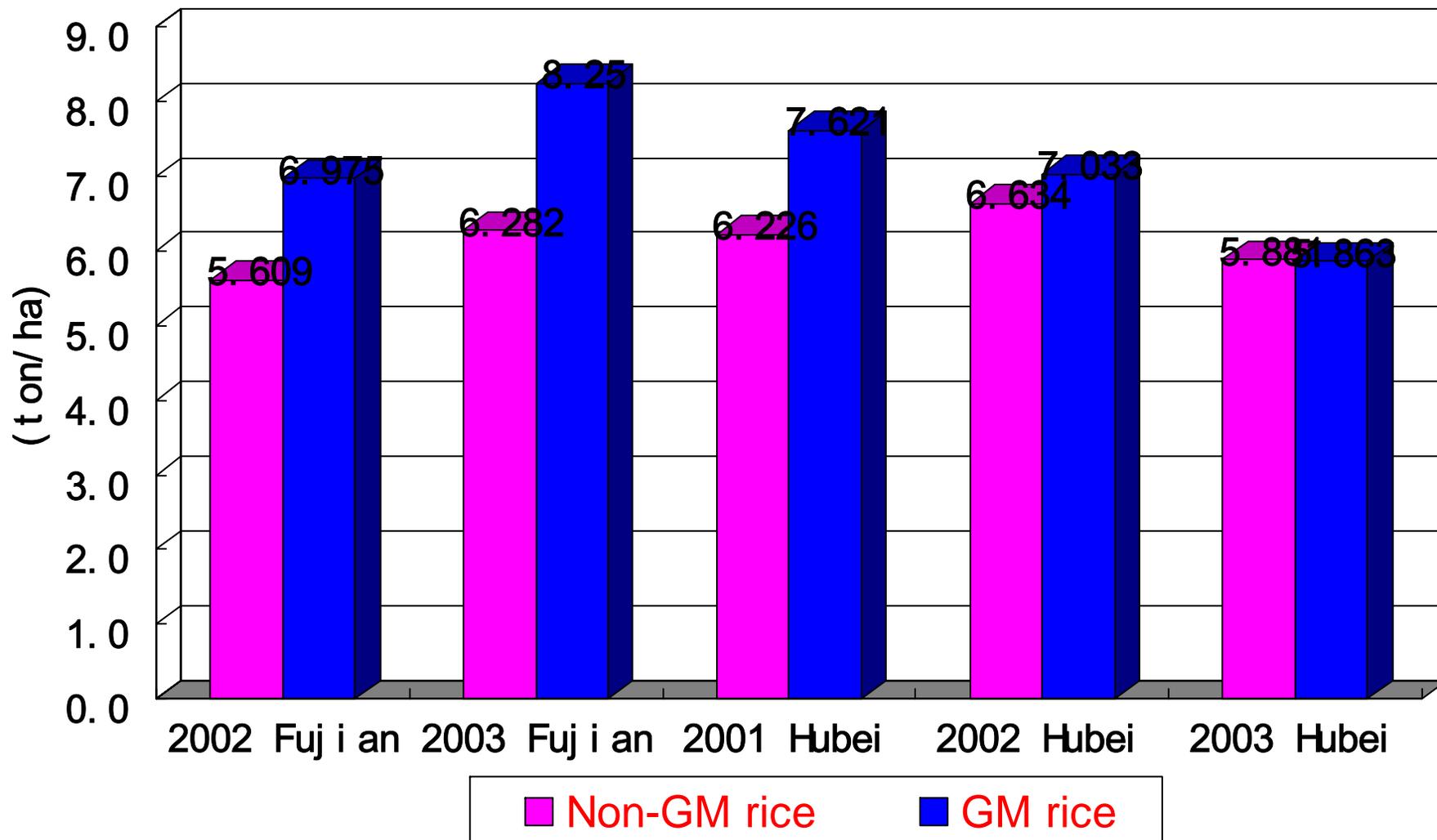
part of our study

- Bt Rice
- Bt/CPTI stacked gene
- Xa21 Blight Resistant

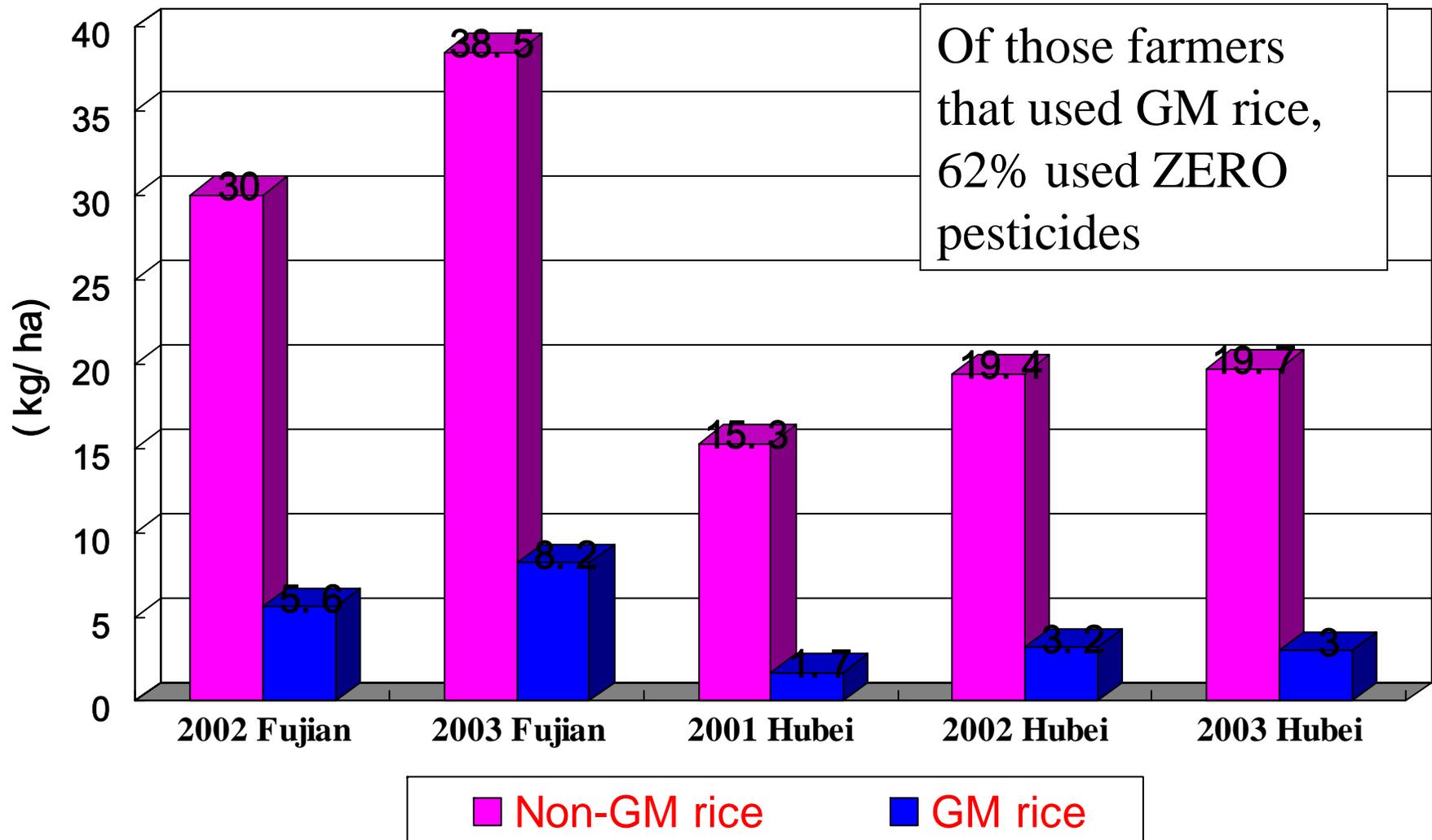
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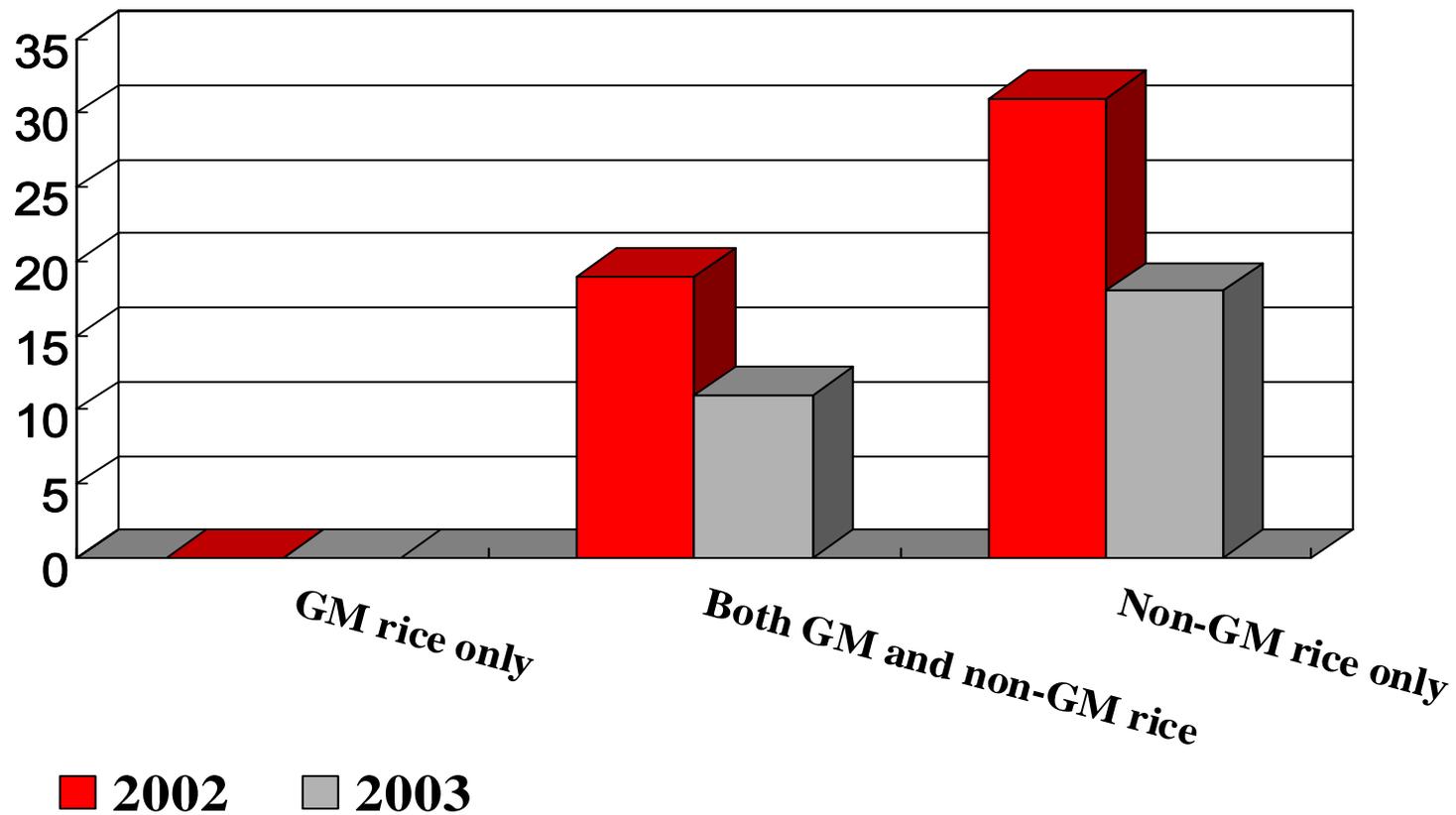
Yields of GM and non-GM rice : (ton/ha)



Pesticide uses (kg/ha) : GM and non-GM rice



Percentage (%) of poisonings reported as numbers of farmers interviewed in Fujian and Hubei in 2002-2003



Economy-wide impacts

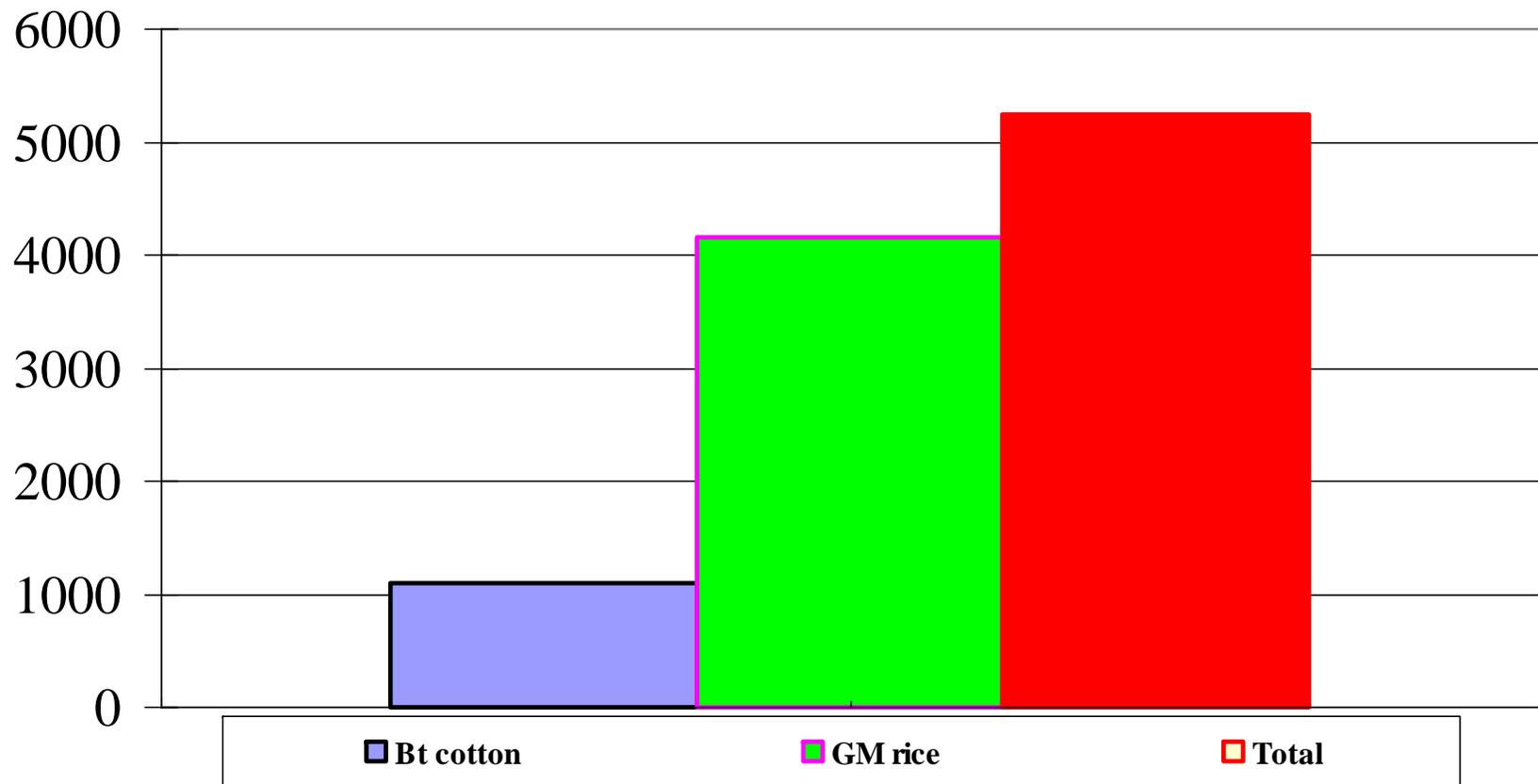
- Price**
- Supply and demand**
- Trade**
- Economy welfare**

Scenarios

- **A = [not shown]**
- **B = Commercialise Bt Cotton + Commercialise GM rice + trade patterns not affected by GM adoption**
- **C = B + Trade ban on GM rice by Japan, Korea, SE Asia, and EU.**

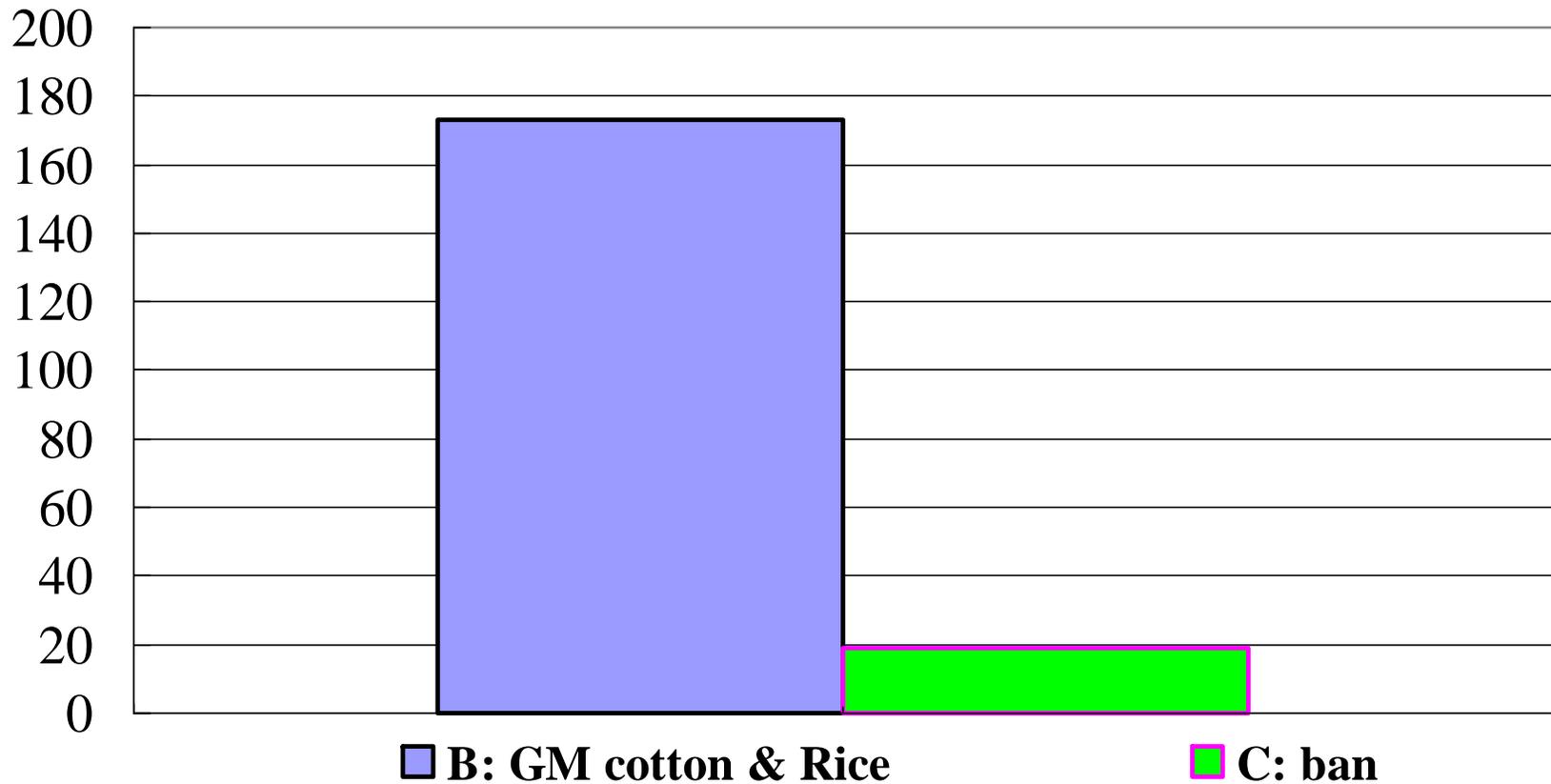
Scenario B: Bt cotton + GM rice

Impacts on *Welfare* (EV, million US\$) in 2010



Comparing scenarios B and C

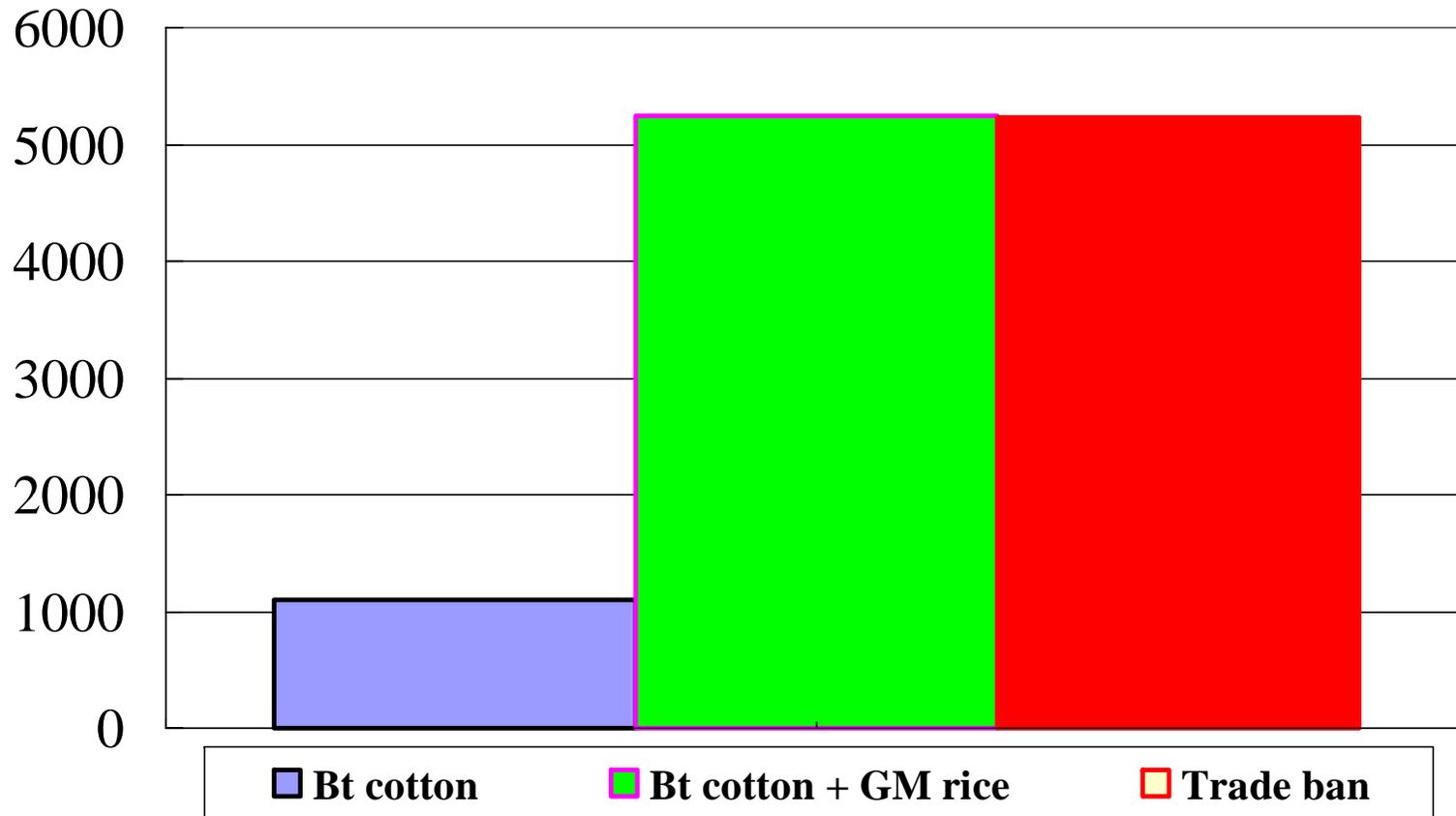
Rice *net export* changes (million US\$, relative to baseline)



But share of export is only about 1% of production

Comparing Scenarios A, B, and C

Impacts on *Welfare* (EV, million US\$) in 2001



Also other concerns about sustainability of gain:
e.g, Bio-safety and IPR

- IPR issues:
 - Much higher seed price from Monsanto/CAAS varieties. What is impacts of IPR?
 - Farmers income
 - Biosafety
 - Bt cotton seed sales of life science firms are less than 20% of sown area
 - All GM rice varieties being bred with hybrids in order to avoid some of these problems (even though conventional varieties are sometimes more in demand by farmers).

- UC Davis-CCAP study on effect of bio-safety and IPR improvement on farm sector
- In our analysis we seek to measure the economic impact of building an effective set of institutions to manage Bio-safety and IPRs
- Do so, using our Bt Cotton dataset

Approach

Pesticide Use or Yields =

f (Prices
 Plot characteristics
 Farmer characteristics
 ----- plus -----
 IPR measures
 Bio-safety measures
 Seed industry reforms)

Regression results for pesticide use and cotton yields in China.

	Pesticide Use (kg/ha)	Log(Yield)
Bt Seed source:		
Seed company:		
Legitimate MDP	-39.77***	0.26***
Illegitimate MDP	-30.57**	0.13***
Legitimate CAAS	-41.45***	0.19***
Illegitimate CAAS	-33.52***	0.01
Unapproved	-38.53***	0.08
Traditional channels:		
Ag Extension Station	-34.68***	-0.004
Cotton office	-30.19***	-0.01
Self-saved	-33.29***	0.15***
Seed production base	-34.88***	0.20***

Summary of Findings

- Improvements to IPR
- Improvements to Bio-safety management
- Improvements to Seed Industry

ALL LEAD TO BETTER VARIETIES IN THE HANDS OF

- FARMERS → LOWER PESTICIDE USE , HIGHER YIELDS AND HIGHER INCOME GAIN...

Concluding remarks

- **China has gained significantly from commercialising Bt cotton through its direct impact on cotton sector and indirect impact on textile industry**
- **China could even gain much more from commercialising GM food crops (i.e. GM rice)**
- **Most of the gains from Chinese biotech are realised independently from foreign trade**
- **Gains would be higher with a more effective biosafety system in place domestically**

[internationally, China's biosafety regulation is better]

Concluding remarks

- **Will China continue to promote biotech and commercialize its GM food?**

- **Almost certainly.**

- **Not spending \$1 billion per year for nothing**

Also: large gains from agricultural biotech development?

- **US\$ 5 billion in 2010**

- **(1 from bt cotton and 4 from GM rice)**

Plus health effects

Effect of trade restrictions on GM products are small