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Economic Consequences of Golden Rice and other Genetically Modified Crops

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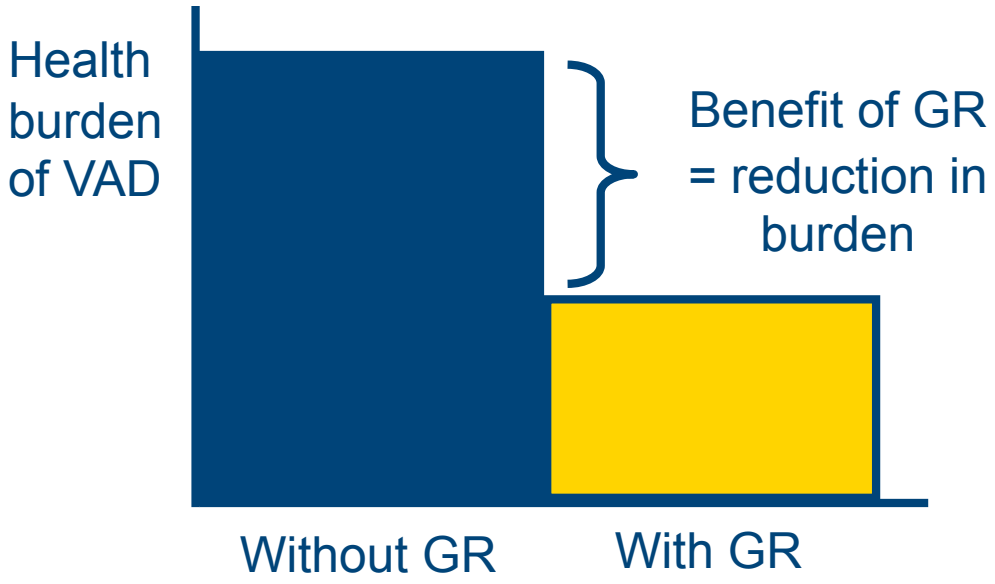
EMBO Science and Society Conference
6-7 November 2009, Heidelberg

Potential benefits of Golden Rice (GR)

- Unlike for new crops with improved agronomic traits, GR will not entail direct income effects for farmers.
- Rather, GR is likely to reduce nutrition and health problems of vitamin A deficiency (VAD) among consumers.

Problems of VAD:

- Higher child mortality
- Susceptibility to infectious diseases
- Eye problems



How to quantify the health burden?

The DALYs approach (disability-adjusted life years)

Measures annual health burden by combining mortality and morbidity within a single index (widely used by WHO).

$DALYs_{lost}$ = *Years lost due to mortality*

\+ *Years with disability* x *Disability weight*

Benefits of GR:

(DALYs lost without GR) − (DALYs lost with GR)

= *DALYs saved through GR*

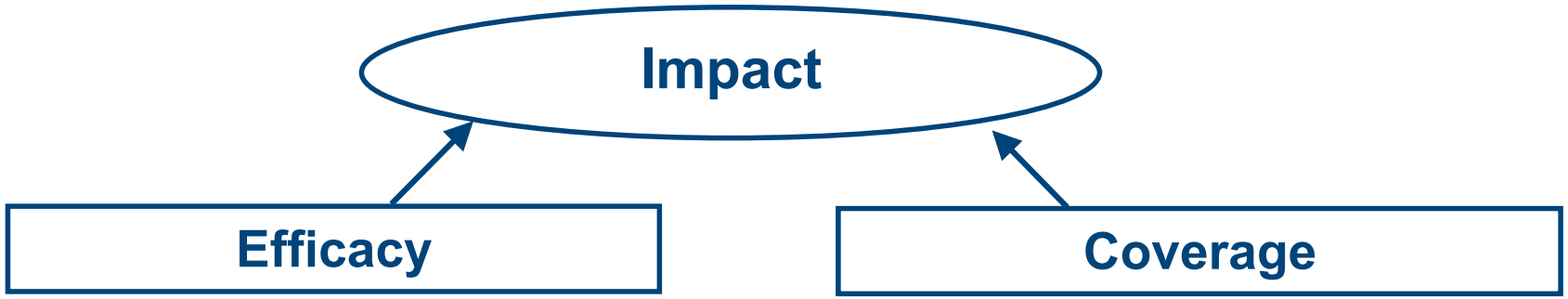
Empirical study for India

Annual health burden of VAD without GR

Functional outcome	Cases attributable to VAD	DALYs lost
Child mortality	71,625	2.04 million
Night blindness	4.2 million	0.19 million
Blindness	3,663	0.07 million
Measles	0.8 million	0.02 million
Total		**2.32 million**

Source: Stein et al. (2008).

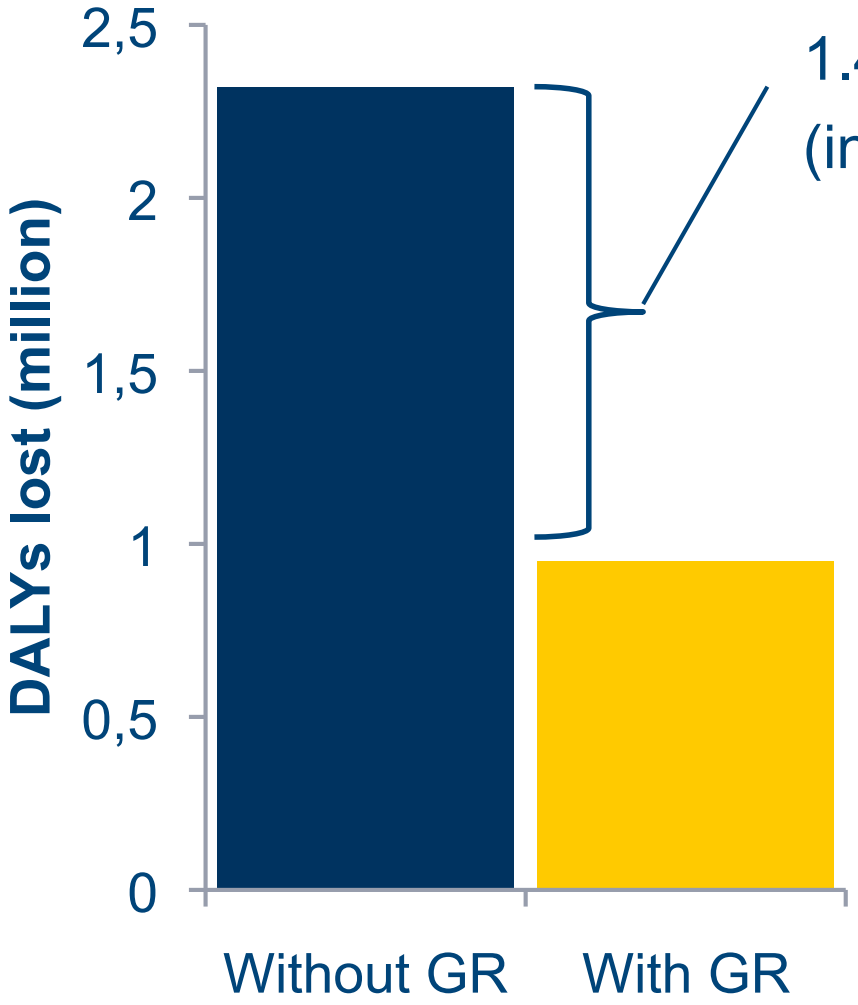
Factors affecting the impact of GR



- Beta-carotene content
- Beta-carotene retention
- Bioavailability

- Farmer adoption
- Consumer acceptance

Effects of GR in India: simulation results



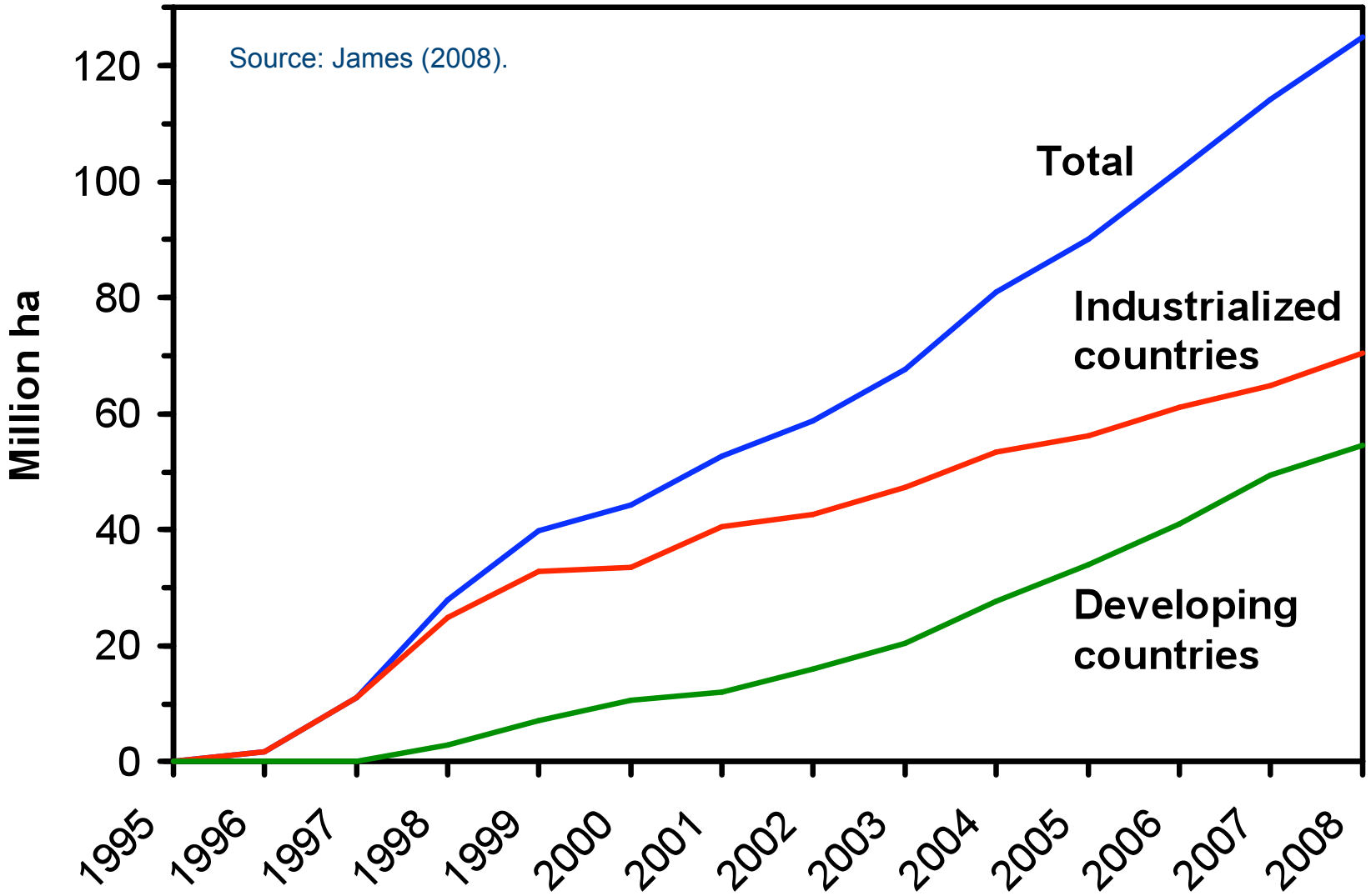
1.4m DALYs saved: 60% reduction
(incl. 40,000 child death per year)

Cost effectiveness
(cost per DALY saved)

Golden Rice:	$3.1
World Bank standard:	$200
VA supplementation:	$134
VA fortification:	$84

Source: Stein et al. (2008).

Impact of commercialized GM crops

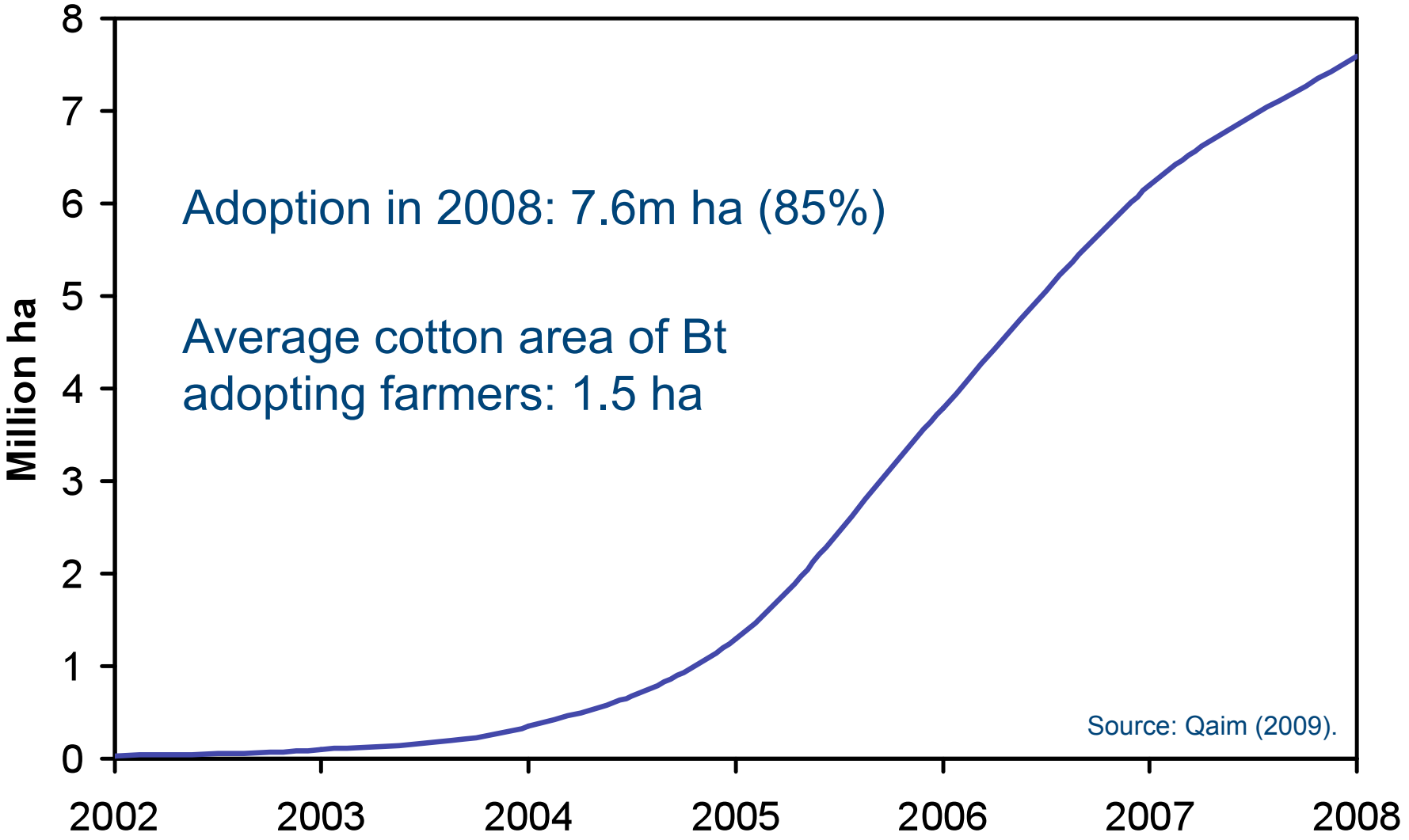


Insect-resistant Bt cotton

Gene from the soil bacterium *Bacillus thuringiensis* (Bt) makes the plant resistant to the cotton bollworm.

- Technology developed by US company Monsanto.
- Since 1997/98: US, China, Argent., S. Africa, Mexico.
- In India, Bt cotton was approved in 2002/03.

Bt cotton adoption in India



Farm level effects of Bt cotton in India

Panel data from 375 farms in central and southern states

	2002-03	2004-05	2006-07	Average
Insecticide use	-50%	-51%	-21%	**-41%**
Yield	+34%	+35%	+43%	**+37%**
Seed cost	+221%	+208%	+68%	**+166%**
Profit	+69%	+129%	+70%	**+89%**
Profit gain in $/ha	+111	+142	+152	**+135**

Source: Sadashivappa and Qaim (2009).

An average profit gain of $135/ha implies a total gain of $1.0 billion for the 7.6 million ha of Bt cotton in India.

Impact variability

Effects of Bt cotton in 2002-03

	Maharashtra	Karnataka	Tamil Nadu	Andhra Pradesh
Insecticide use	-46%	-62%	-78%	-34%
Yield	+32%	+73%	+43%	-3%
Per-ha profit gain	$92	$270	$247	-$69

Source: Qaim et al. (2006).

Factors influencing Bt cotton impacts:

- Local bollworm pressure
- Crop management practices
- Local suitability of varieties into which Bt is incorporated

Yield effect = (Bt gene effect) + (variety effect)

Bt cotton impacts: international evidence

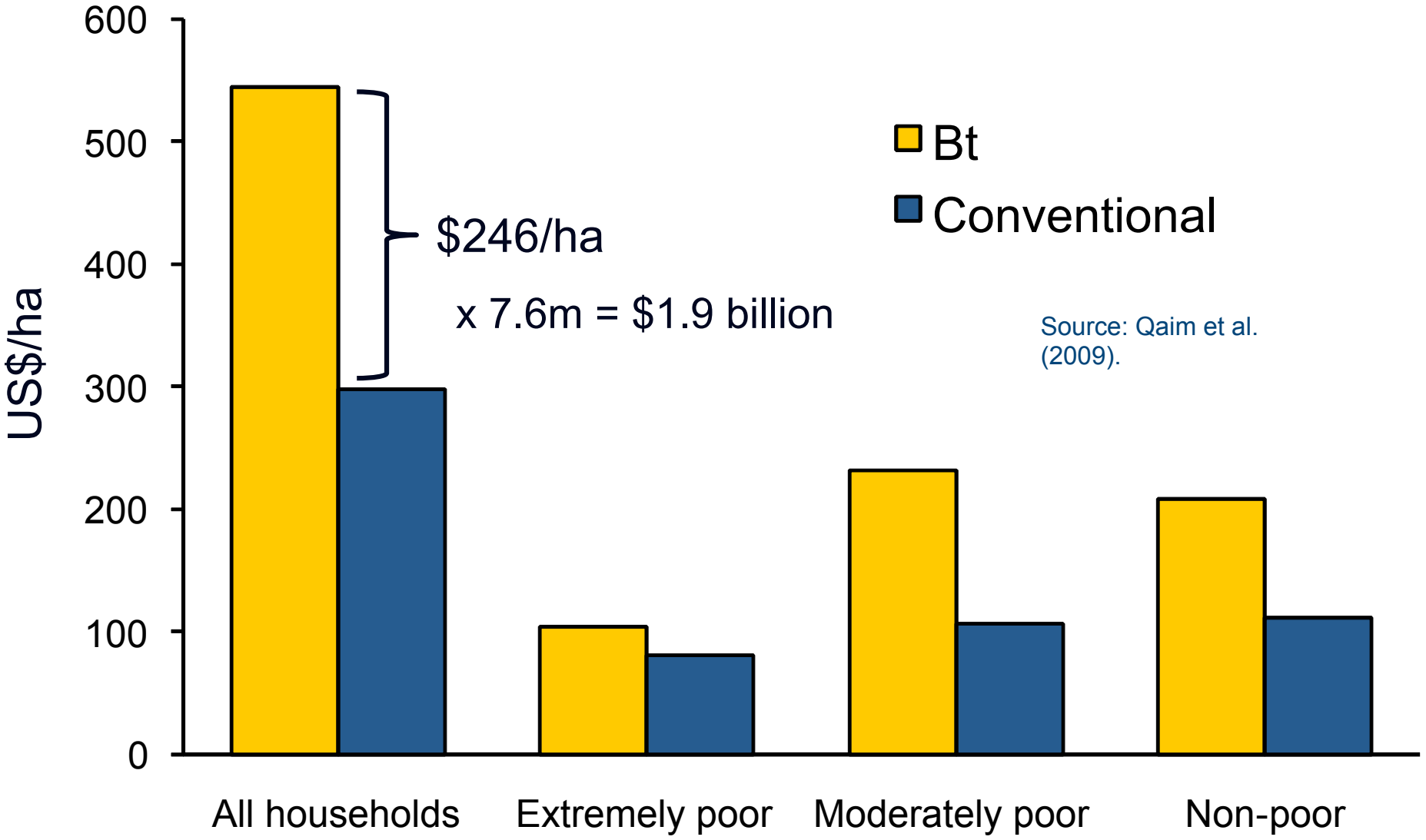
	India	China	South Africa	Argen-tina	Mexico	USA
Insecticide use	-41%	-65%	-33%	-47%	-77%	-36%
Yield	+37%	+24%	+22%	+33%	+9%	+10%
Profit gain per ha	+$135	+$470	+$91	+$23	+$295	+$58

Sources: Qaim (2009), Pray et al. (2002), Morse et al. (2004), Traxler et al. (2003).

Wider socioeconomic effects of Bt cotton at the village level

- Beyond direct effects on cotton profits, a new technology like Bt can have spillovers to other local markets (e.g., labor markets) and sectors.
- Analyzing such indirect effects is important to understand the poverty and rural development impacts.
- We have collected census data in one typical village in the Indian state of Maharashtra, capturing all market transactions over a period of 12 months.
- Based on these data, we developed a model of the village economy, in order to analyze the direct and spillover effects of Bt cotton adoption.

Household income effects per ha of cotton



Bt maize

International evidence of farm level impacts

	Argen-tina	Philip-pines	South Africa	Spain	USA
Insecticide use	0%	-5%	-10%	-63%	-8%
Yield	+9%	+34%	+11%	+6%	+5%
Profit gain per ha	+$20	+$53	+$42	+$70	+$12

Source: Qaim (2009).

Bt eggplant has recently been approved in India. Bt rice is likely to be commercialized soon in China and elsewhere.

Conclusions

- GM crops hold great potentials to contribute to poverty reduction, better nutrition, and sustainable development.
- Concrete effects depend on (i) type of technology, (ii) agronomic conditions, (iii) institutional conditions.
- Golden Rice promises to reduce VA malnutrition problems in a highly cost-effective way.
- Bt crops are suitable for small farms, contributing to pesticide reductions and higher yields and incomes.
- Public support is needed to ensure that promising technologies are available and accessible for the poor.
- Complex regulations introduce a bias against small crops, small countries, and small research organizations.