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Measuring the Economic Impacts of Bt Cotton on Farms in Developing Countries During the First Decade

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Outline

I. Approach for review
II. Summary of case study evidence
III. Methodological limitations
IV. Future research directions

Approach

- Systematic review of applied economics literature about the impacts of transgenic crops in developing agriculture
- 1997-2007
- Focus on methods
  - Previous reviews of findings
  - Methods influence findings
  - Identify “good practices”
- bEcon

Search Criteria

- Set specific criteria
  - Stated economics method
  - Applied to farm or field data
  - Peer-reviewed
  - English, Spanish, French
- Focused on major questions
  - Impact on farmers
  - Impact on consumers
  - Impact on industries or sectors
  - Impact on international trade

Search Findings

In the first decade,

- Impact on farmers foremost concern
- Bt cotton the most studied crop-trait combination
- China, India and South Africa most represented countries
- 49 of 63 Bt cotton articles on farm impacts; 14 on industry and trade impacts

Impact Question	*No.*
Farmer	67
Consumer	27
Sector	27
Trade	26
Total 1996-2007	137

1 article may treat more than on question

Crop-trait	*No.*
Cotton (IR)	63
Maize (IR)	14
Rice (HT,IR)	16
Soybeans (HT)	16
Other Crops	22
GE-General	20

Other crops: bananas, potatoes, sweet potatoes, cassava, wheat, oilseeds, eggplant, mustard, coarse grains

Research Question

What are the economic advantages of Bt cotton with respect to:

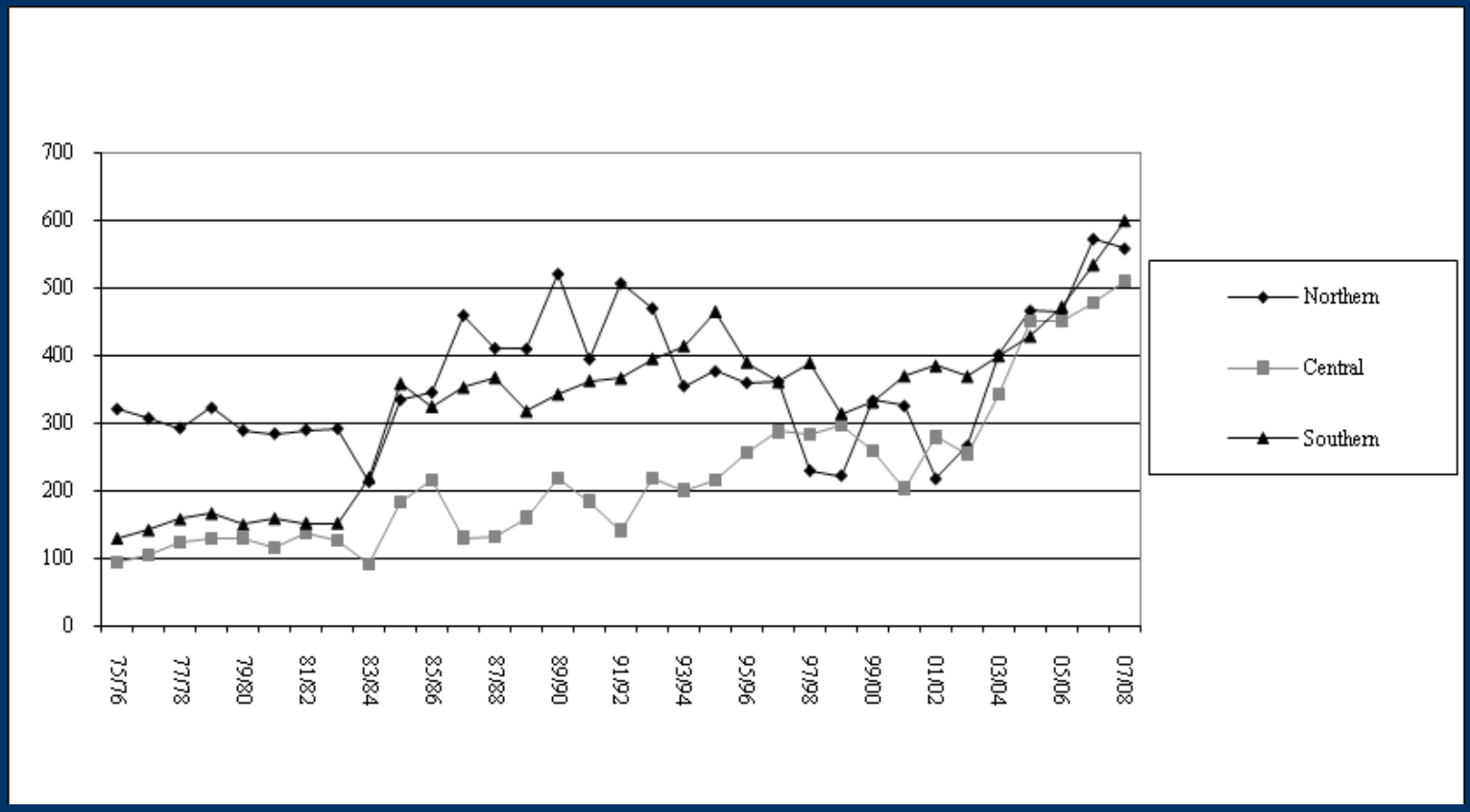
- **yield**
- **insecticide use**
- **labor use**
- **profits**

Country case summary

Aspects of Impact	India	China	South Africa (Makhathini Flats)	Argentina
Adoption	Regional disparities Wide range of germplasm	Large scale Wide range of germplasm	Atypical zone; Supply-driven	Limited by transfer fee
Economic benefits	Generally positive with exceptions	Generally positive	Generally positive but farmers vulnerable	Limited magnitude
Reduction in pesticide use	Highly variable depending on the zone	Strong reduction	Debated	Evident
Social and economic sustainability	Too early to say	Since 1999	Institutional problems	Yes, but impact insignificant
General conclusion	Most debated case	Most successful case	Least representative case	Least relevant case

Average cotton yields, India 1975-2007

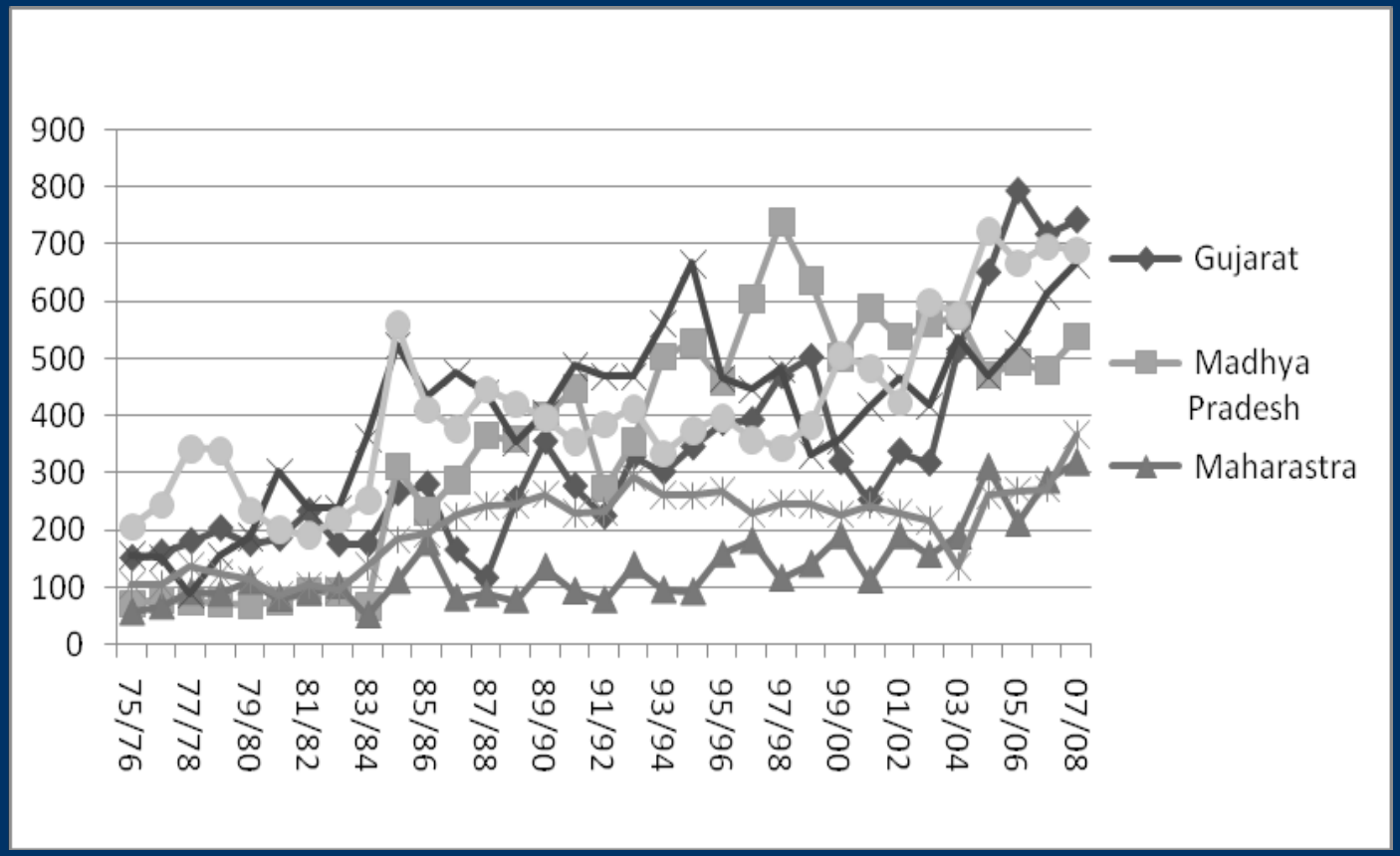
G. Gruere



Bt cotton likely played a role in record yields observed from 2002

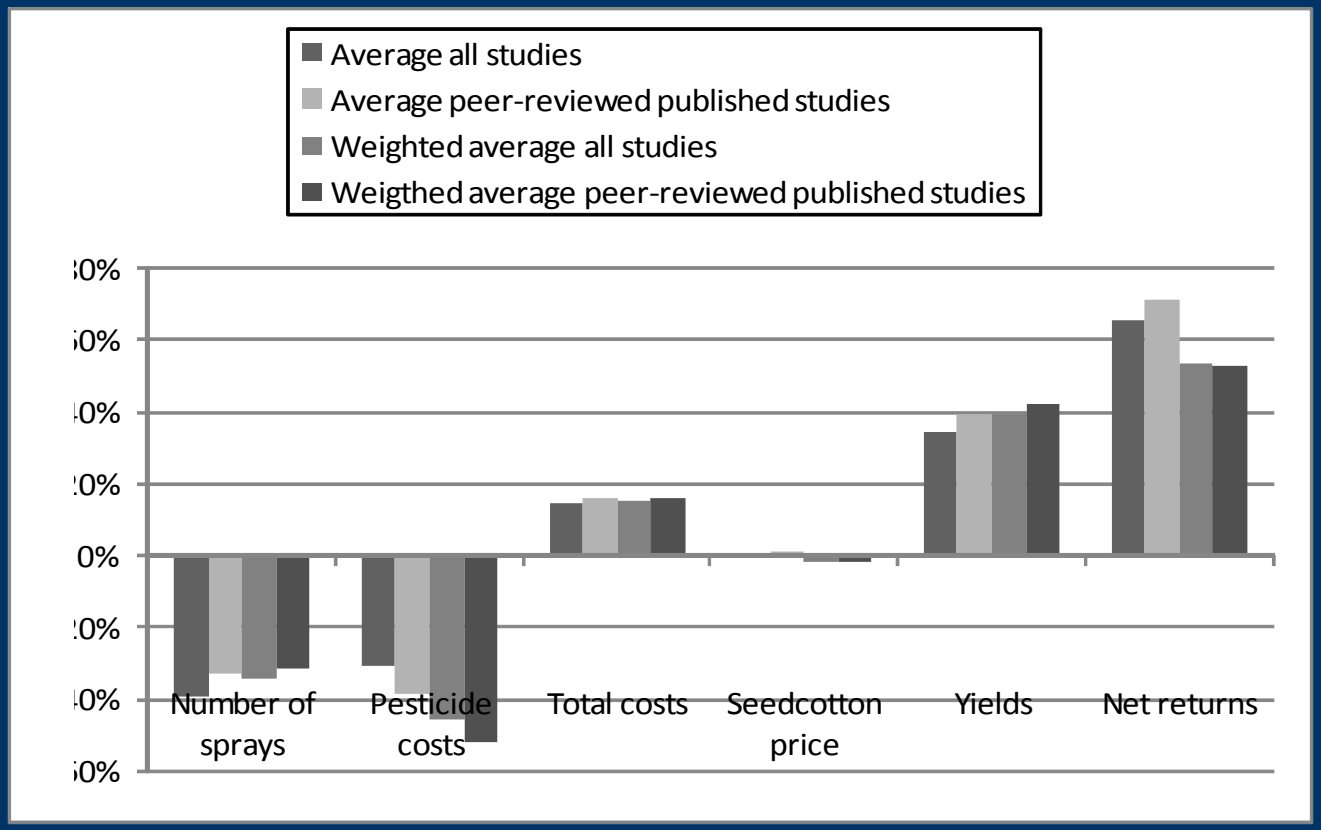
Average cotton yields, India 1975-2007

G. Gruere



Yield impacts are heterogeneous over time and space

Average economic impacts of Bt cotton in India, 2002/03-2004/05



Bt cotton raises costs but increases net returns on average, considering peer-reviewed and other studies; selection bias overstates net returns.

Methods

- Data sources:
  - farmer survey, trial data, farm records
- Farm budget analysis (49 articles)
  - Stochastic simulation
- Production models (20 articles)
  - Production function (with damage abatement)
  - Input use function
  - Data envelope analysis, stochastic production frontier
- Stated and/or revealed preferences models of variety choice(2 articles)

Methods challenges

Selection bias	▪ placement, sample selection ▪ counterfactuals • producer (self-selection) • cultivar • input use
Measurement bias	▪ farmer recall vs. monitoring ▪ toxin expression
Estimation bias	▪ budgets partial ▪ household farm models missing ▪ rare treatment of risk & uncertainty ▪ damage abatement ▪ endogeneity (adoption, input use)

Methods challenges

- Agronomic/biophysical protocols must be carefully considered when evaluating economic impacts of biotech crops that abate damage; they are expensive to scale-up
- Random sampling of farms difficult
  - Political sensitivity
  - Company lists
  - Community wariness
- Weather shocks, conflict—single period cross-sectional data are not representative

Exemplary approaches

- Shankar, B., and C. Thirtle. 2005. Pesticide productivity and transgenic cotton technology: The South African smallholder case. *Journal of Agricultural Economics* 56 (1): 97-116.
- Qaim, M. and A. de Janvry 2005. Bt cotton and pesticide use in Argentina: Economic and environmental effects. *Environmental and Development Economics* 10 (2): 179-200.
- Pemsl, D., H. Waibel, and A. P. Gutierrez. 2005. Why do some Bt-cotton farmers in China continue to use high levels of pesticides? *International Journal of Agricultural Sustainability* 3 (1): 44-56.Crost et al. (2007)
- Hofs, J.-L., M. Fok, and M. Vaissayre. 2006. Impact of Bt cotton adoption on pesticide use by smallholders: A 2-year survey in Makhatini Flats (South Africa). *Crop Protection* 25 (9): 984-988.
- Huang, J., R. Hu, C. Fan, C. Pray, and S. Rozelle. 2002a. Bt cotton benefits, costs, and impacts in China. *AgBioForum* 5 (4): 153-166.
- Crost, B., B. Shankar, R. Bennett, and S. Morse. 2007. Bias from farmer self-selection in genetically modified crop productivity estimates: Evidence from Indian data. *Journal of Agricultural Economics* 58 (1): 24-36

Conclusions

- On average, profitable—but averages mask variability by agro-climate, cultivar, farmer

- Few cases/authors—should not be generalized to other countries

- One decade is not long enough to observe impacts, and especially health, environmental, and poverty impacts

Future Directions

- Improve methods by drawing on broader economics literature and better field protocols
- Shift from “first-round” impacts to health and environmental externalities, impacts on poverty and inequality