



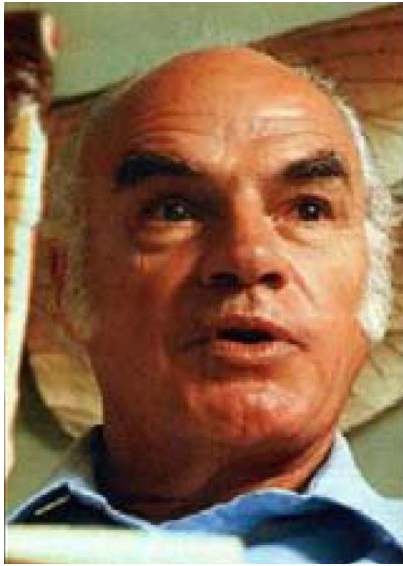
# The ecological reasons why hybrid Bt cotton failed in India

Andrew Paul Gutierrez<sup>1,2</sup> & Luigi Ponti<sup>3</sup>

<sup>1</sup> CASAS Global (Center for the Analysis of Sustainable Agricultural Systems), Kensington, CA 94707 <http://cnr.berkeley.edu/casas>

<sup>2</sup> Division of Ecosystem Science, University of California, Berkeley, CA 94720

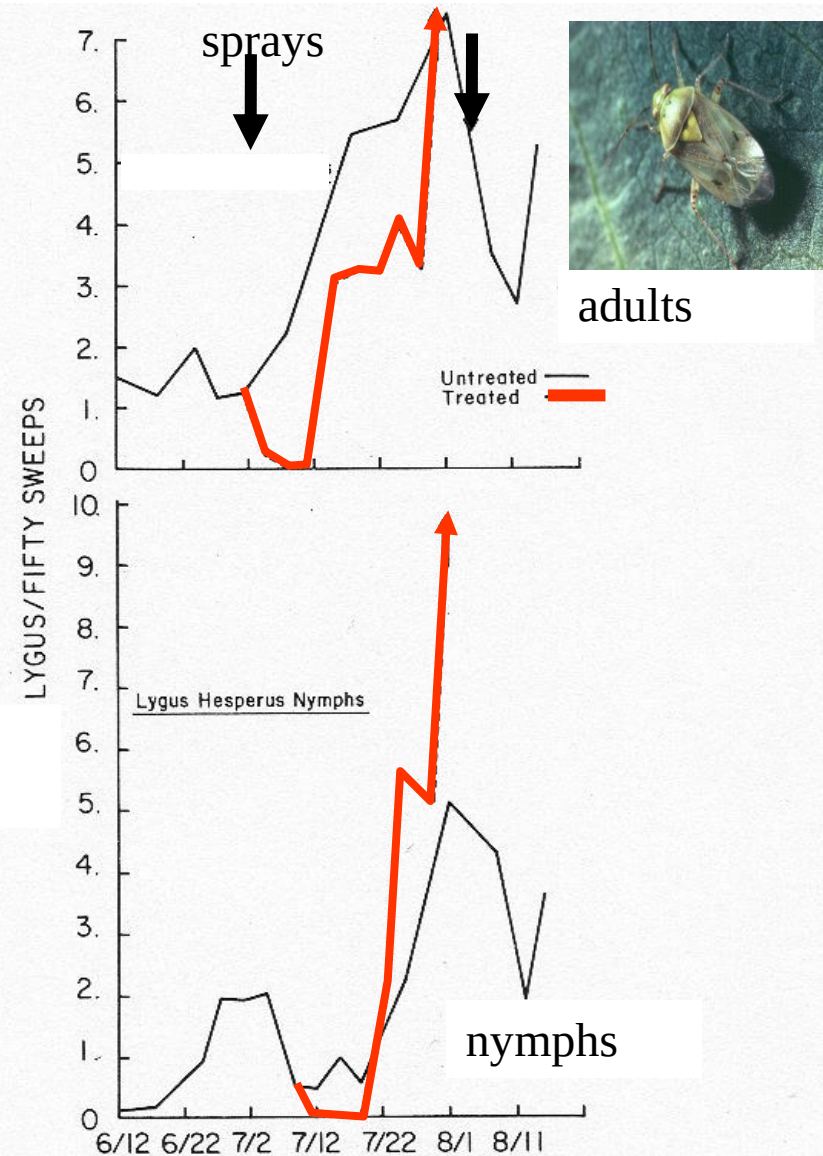
<sup>3</sup> Agenzia Nazionale per le Nuove Tecnologie, l'Energia e lo Sviluppo Economico Sostenibile (ENEA), Centro Ricerche Casaccia, Via Anguillarese 301, 00123 Roma, Italy.



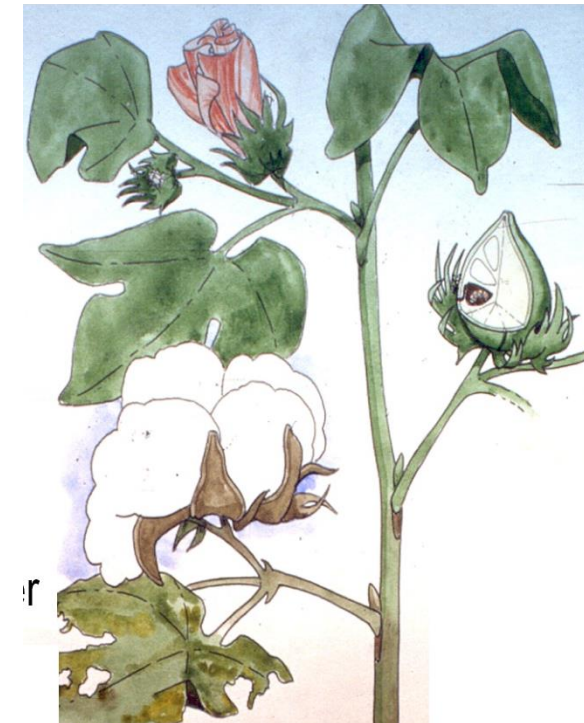
Prof. Robert van den Bosch  
1922-1978

Can India learn from  
the mistakes of  
others?

## 260 ha experiments



San Joaquin Valley, California  
(1960-70s)



Gutierrez, A. P., L. A. Falcon, W. B. Loew, P. Leipzig and R. van den Bosch. 1975. An analysis of cotton production in California: A model for Acala cotton and the effects of defoliators on its yields. *Env. Ent.* 4(1): 125-136.





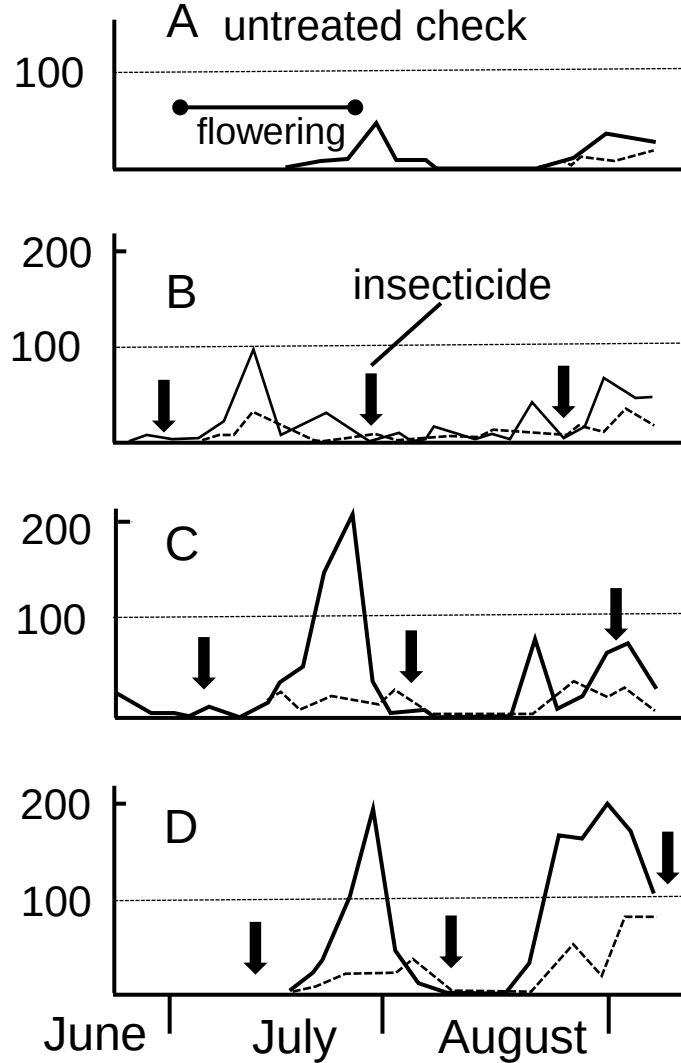
Instars  
I-III ———  
IV-V - - - -



Farmers were  
spending  
money on pest  
control to lose  
money!

1<sup>st</sup> documented  
case of market  
failure!

beet armyworm larvae/ 32m row



Gutierrez, Falcon et al. 1975

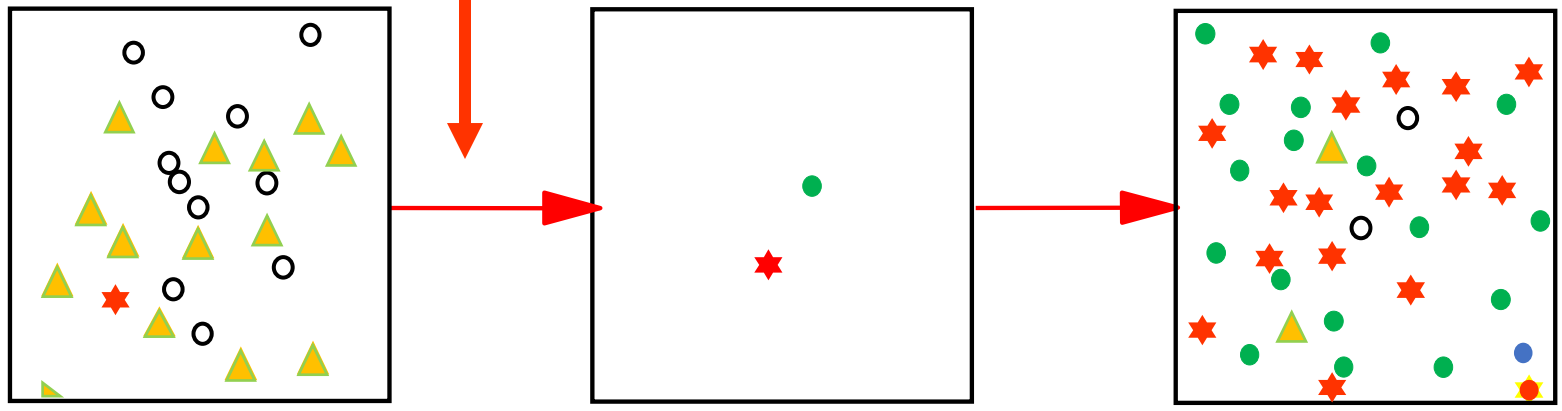


# Insecticide induced pest outbreak

***insecticide  
application***

- Plant bug
- Secondary pests
- ▲ Predators

## Secondary Pest Outbreaks



Time →



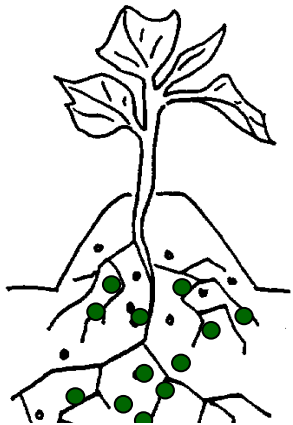
some important generalist predators



some important generalist predators



# Indian cotton



pink bollworm



bollworm

verticillium wilt



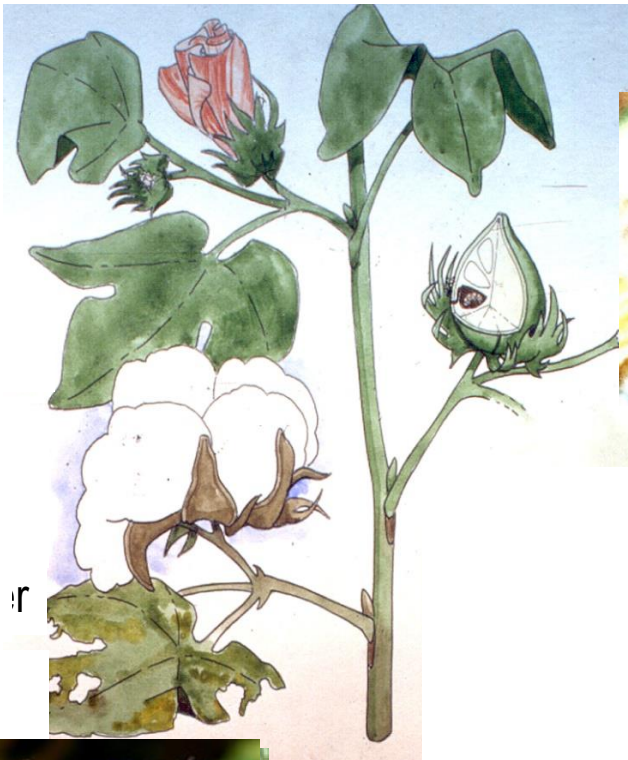
armyworms



jassid



whitefly



spotted bollworm



plant bug



cotton mealybug



thrip

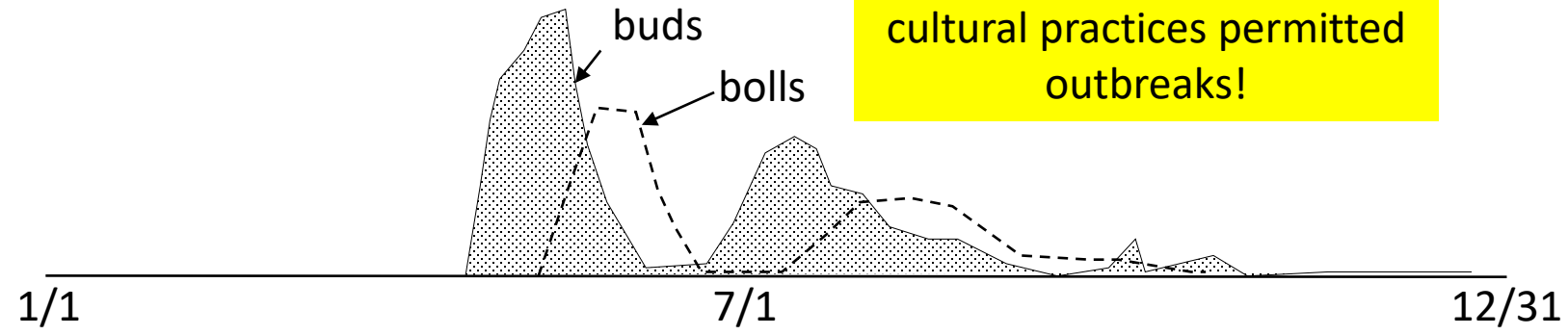
## Natural enemies





Yavatmal, Maharashtra, India

irrigated long season hybrid  
cotton before Bt:  
cultural practices permitted  
outbreaks!



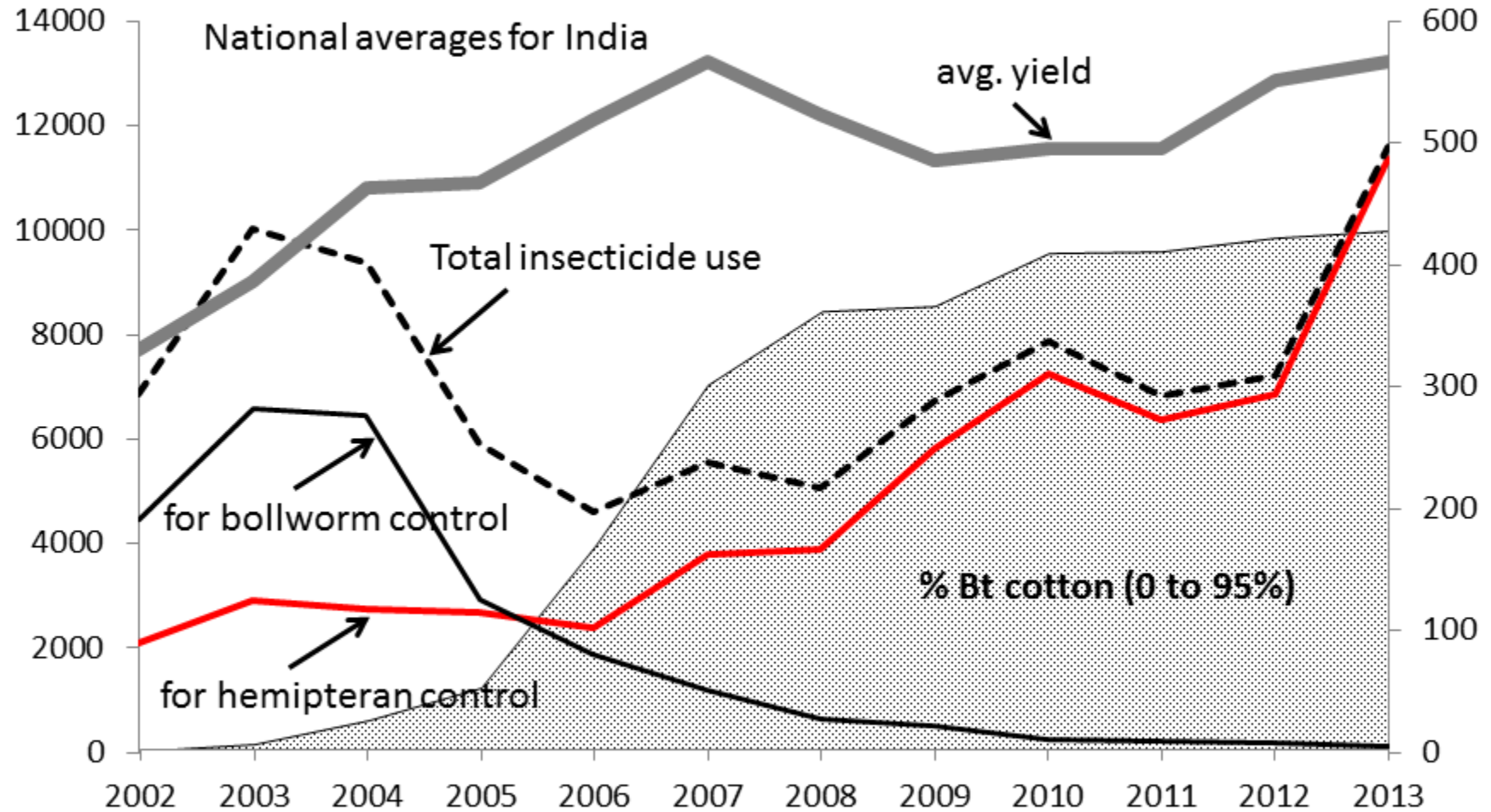
Solution:  
Bt Hybrid cotton  
????



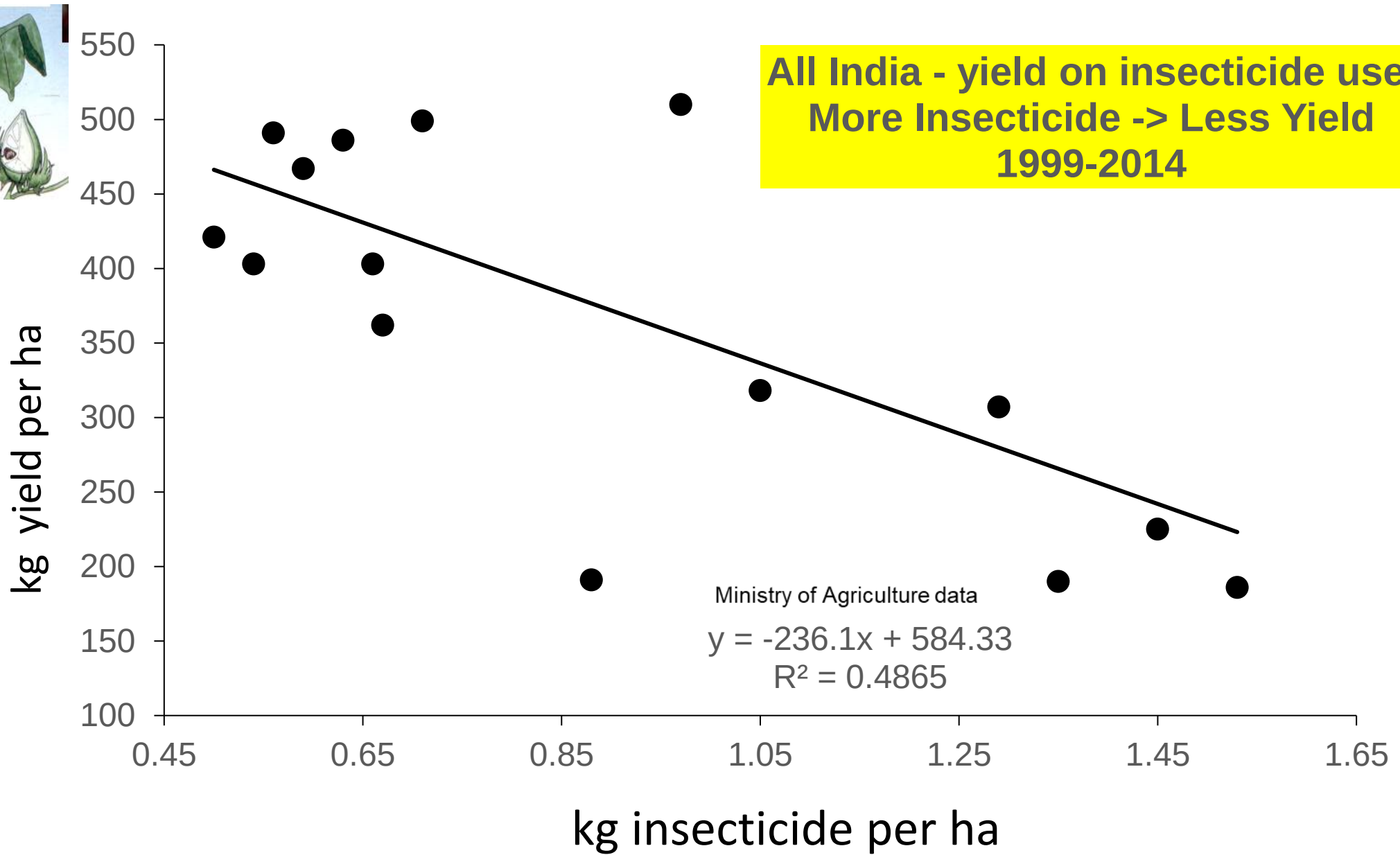
# Biotech and insecticide treadmills

metric tons  
of insecticide

kg/ha

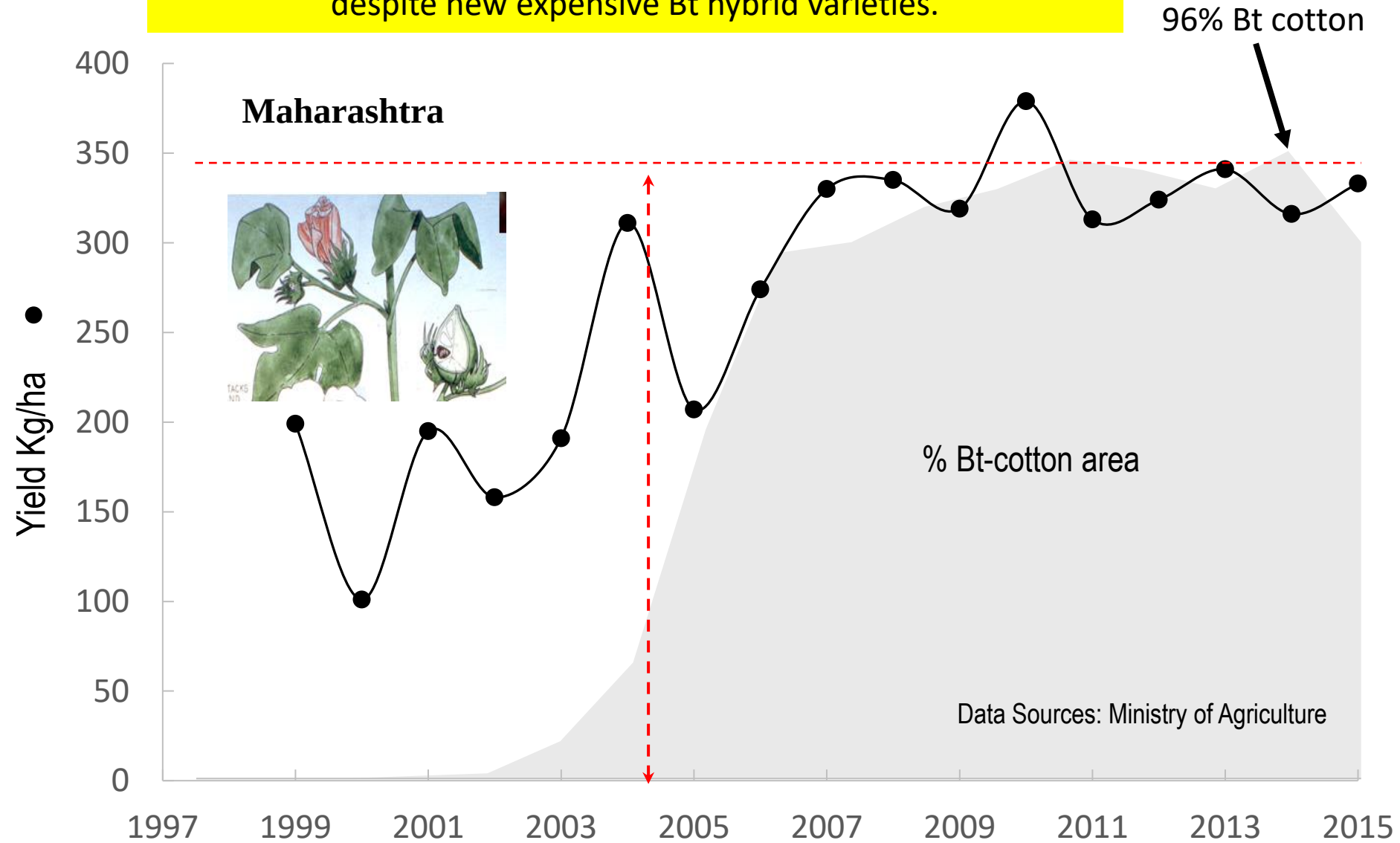


**Indian farmers were spending money on pest control to lose money!**  
**The Indian case of market failure!**

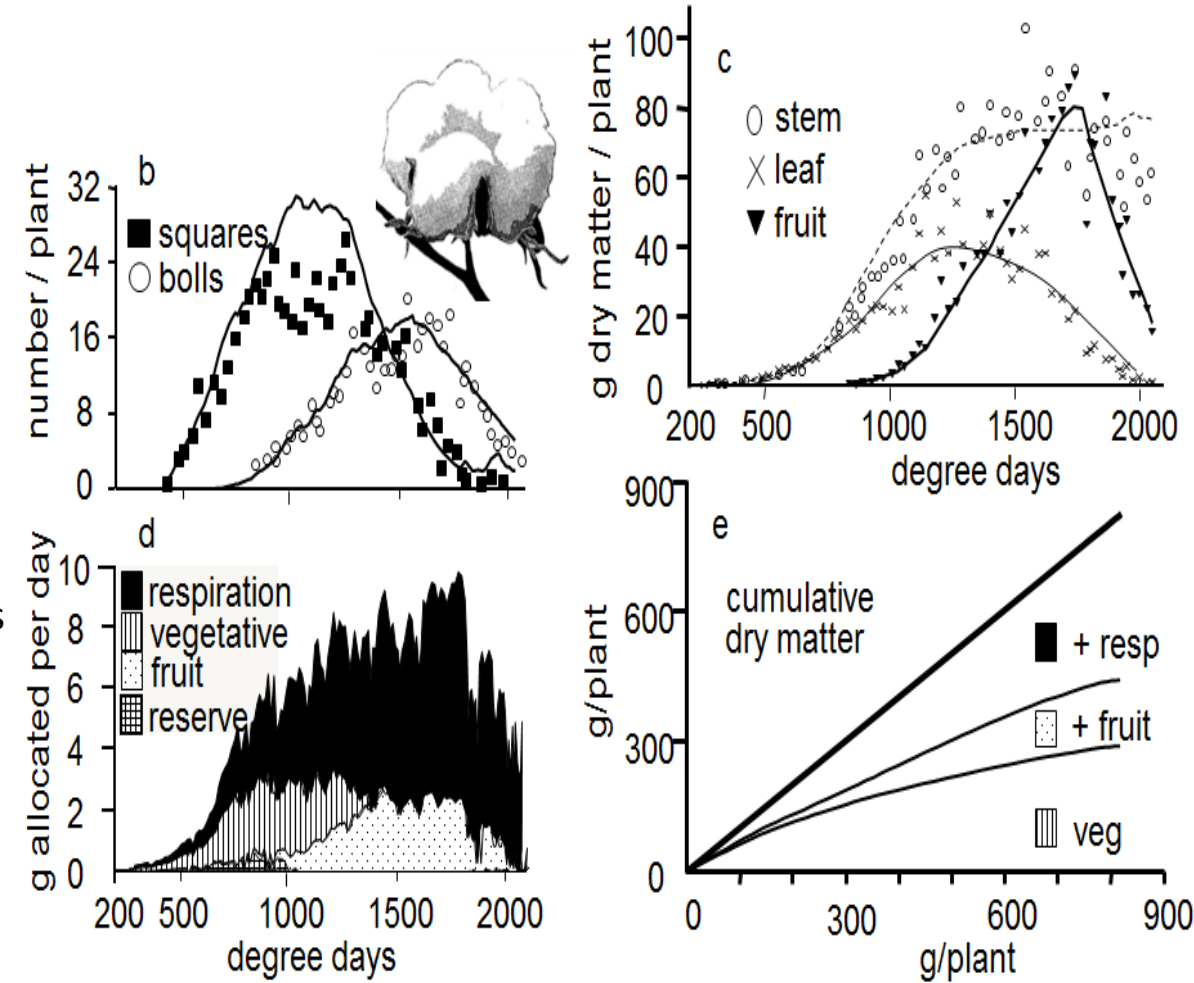
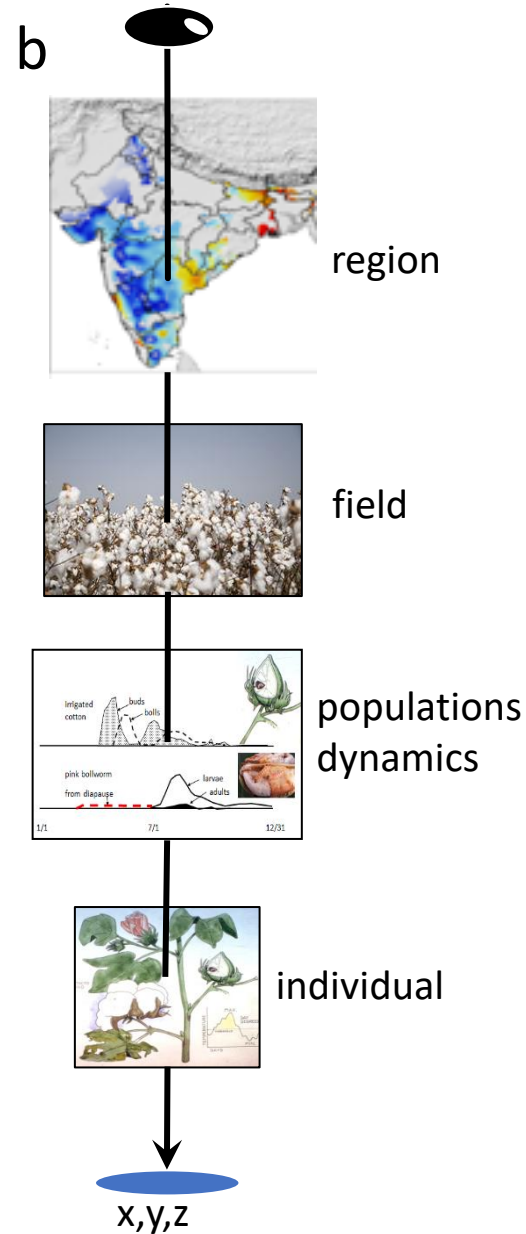
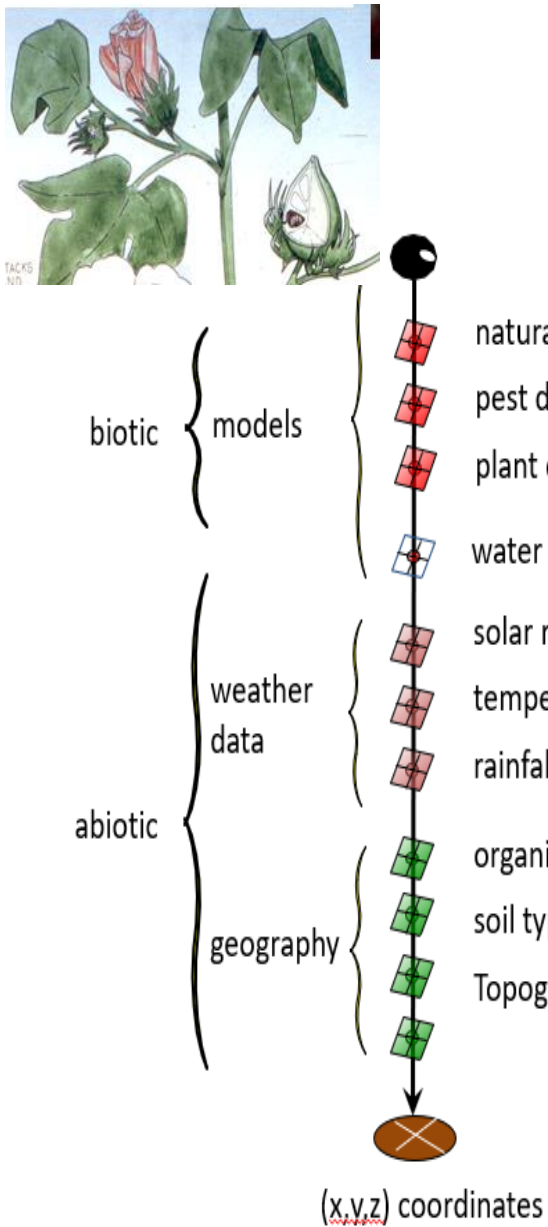




Cotton yield (production /ha) goes up before Bt... Then stagnates despite new expensive Bt hybrid varieties.

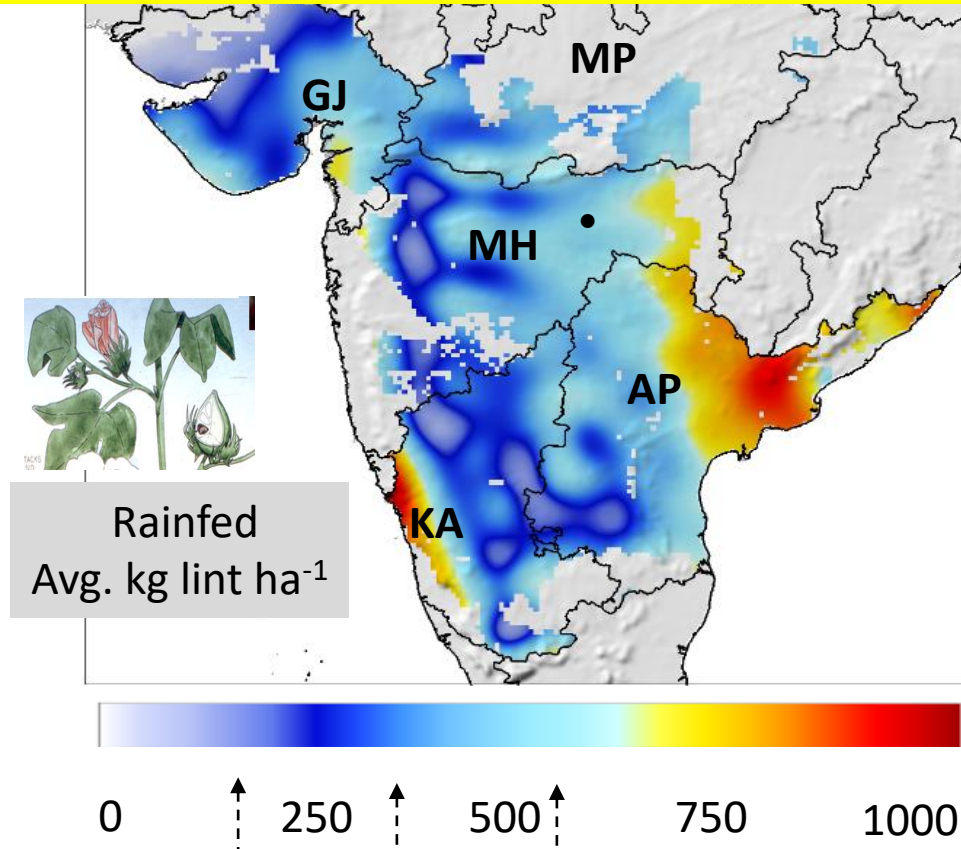


# Bioeconomic analysis of Indian cotton

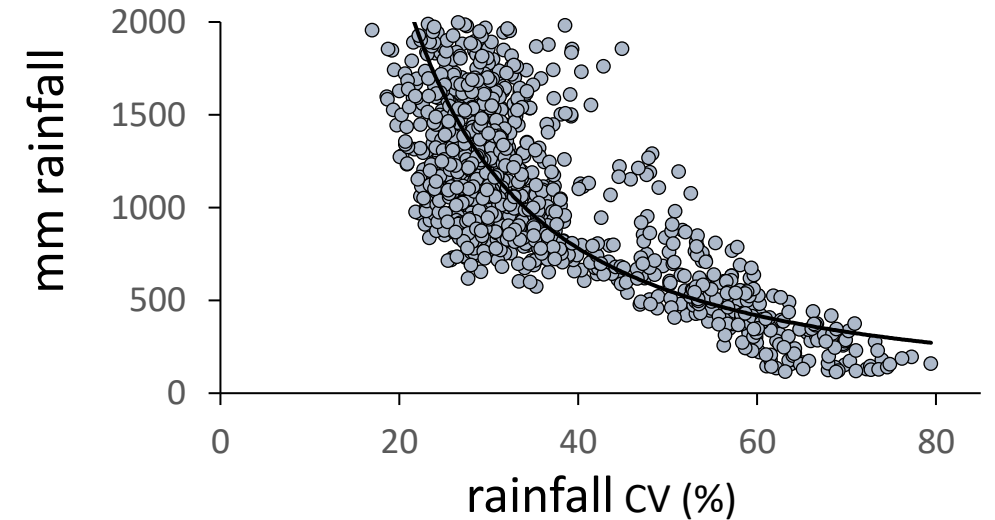
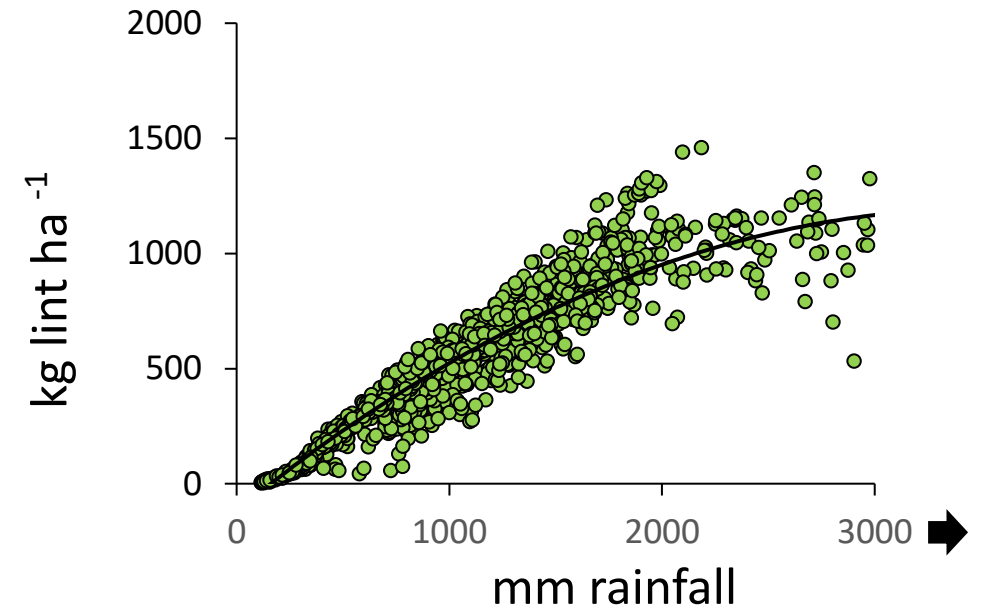


**Local weather-driven plant demographic simulation model (lines). Field Data (dots)**

Historical Weather-driven cotton yields from 2,800 GIS grid locations  
1980-2010.



Low average rainfall AND High variation  
in rainfall LOWER Yields





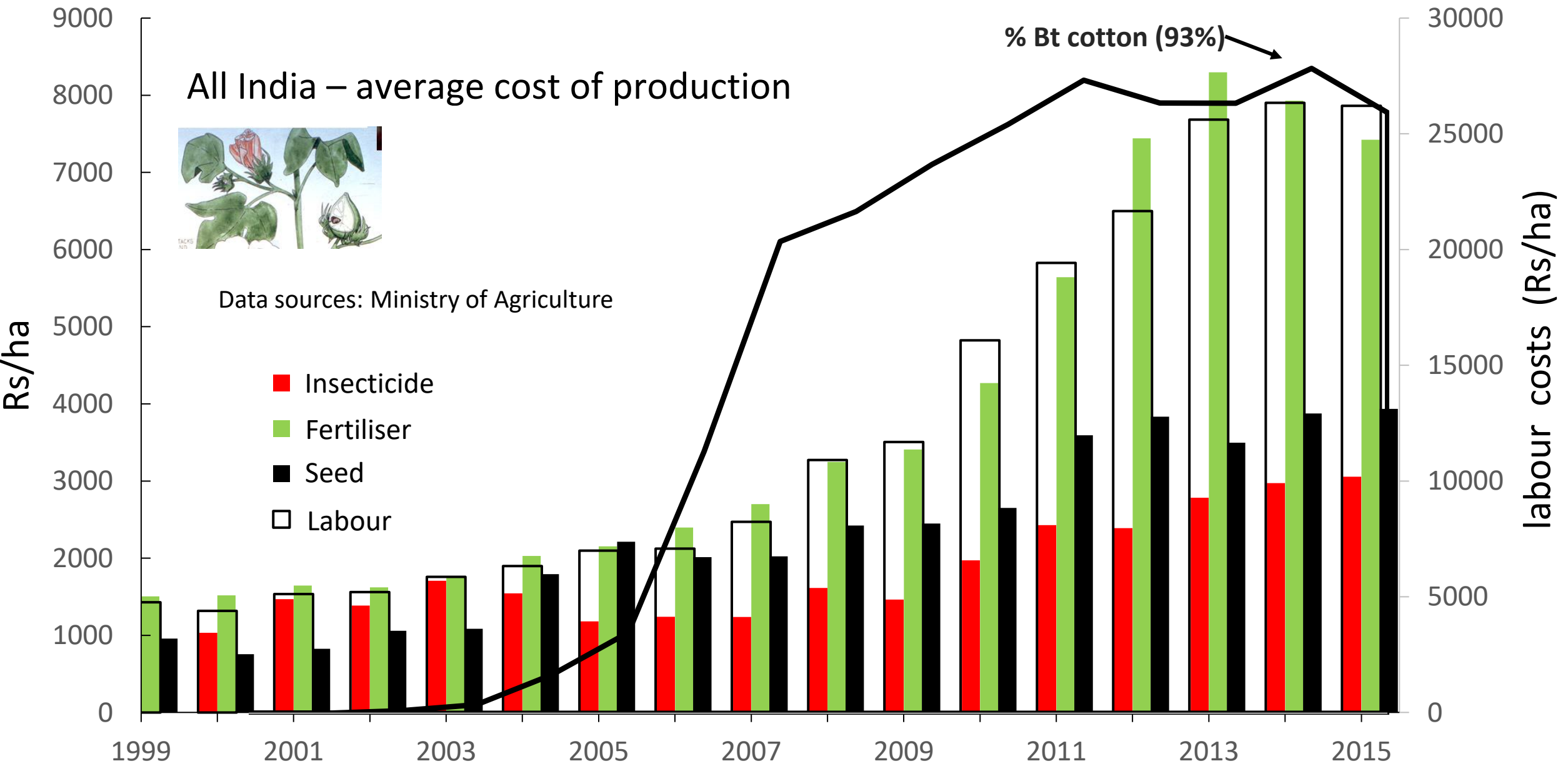
# All India – average cost of production



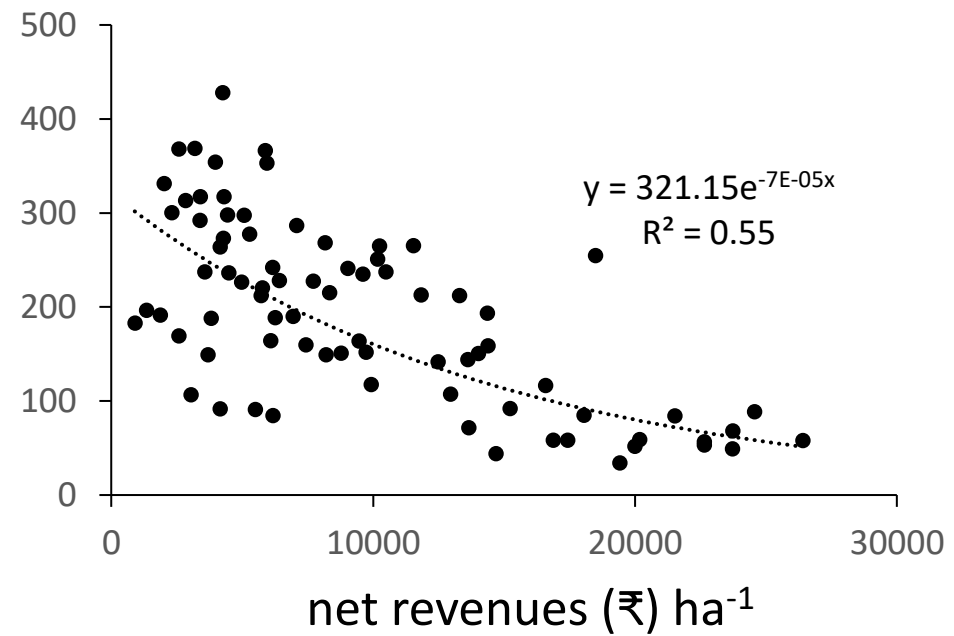
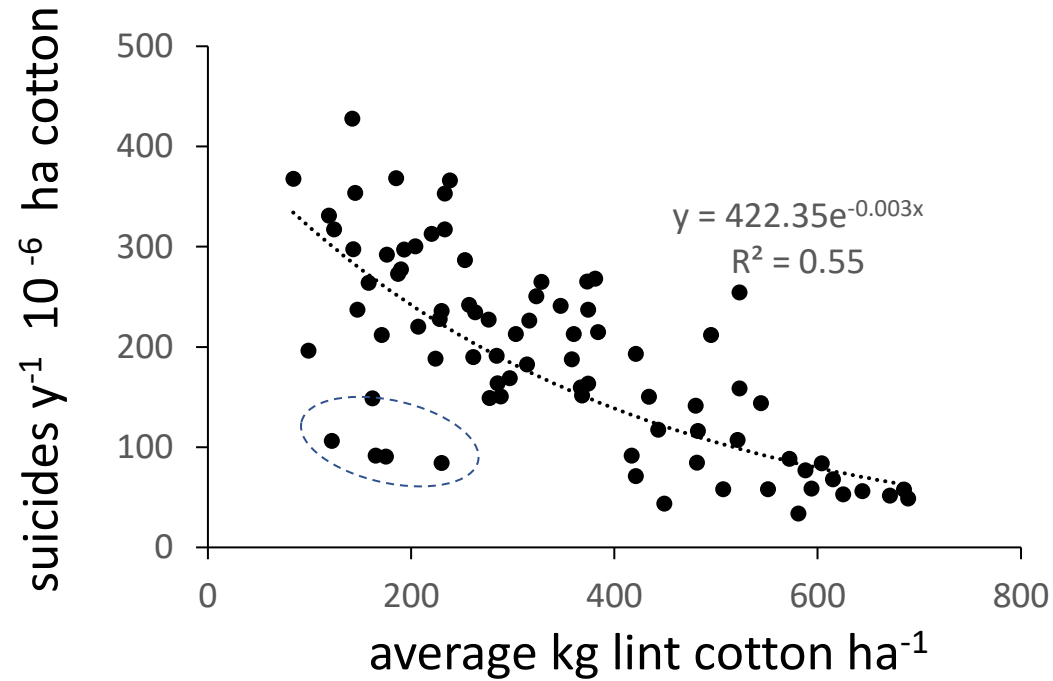
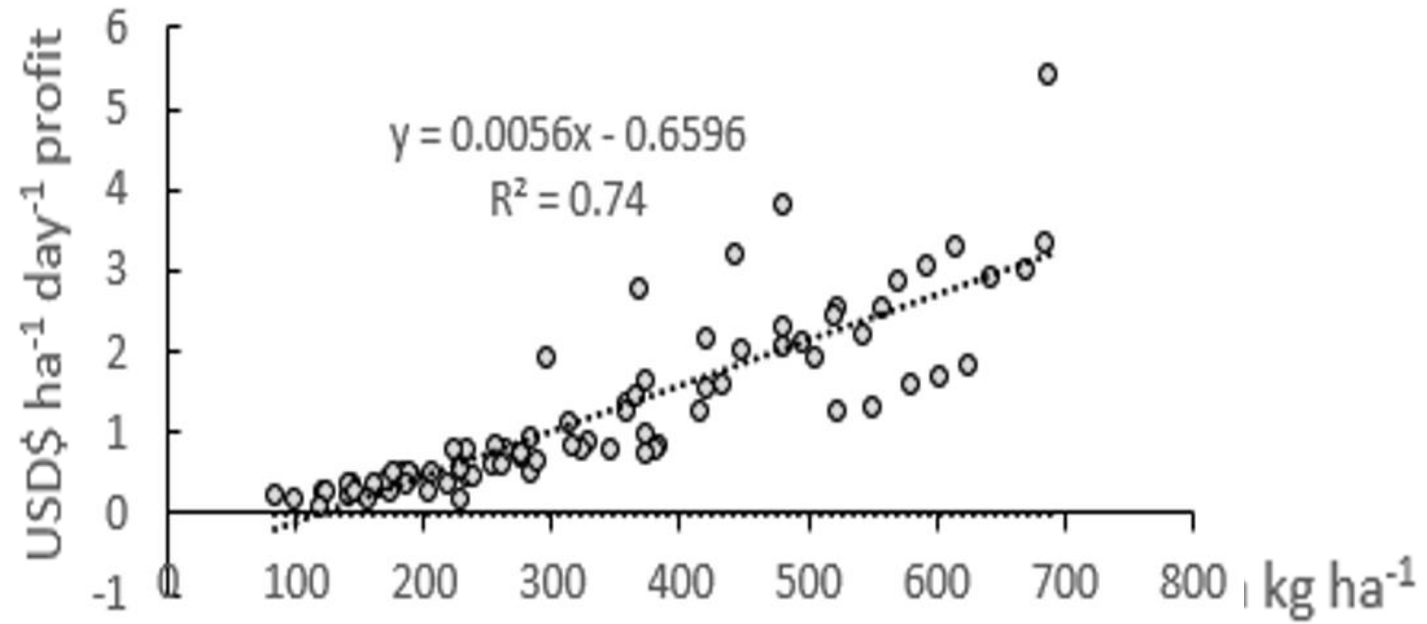
Data sources: Ministry of Agriculture

- Insecticide
- Fertiliser
- Seed
- Labour

% Bt cotton (93%)

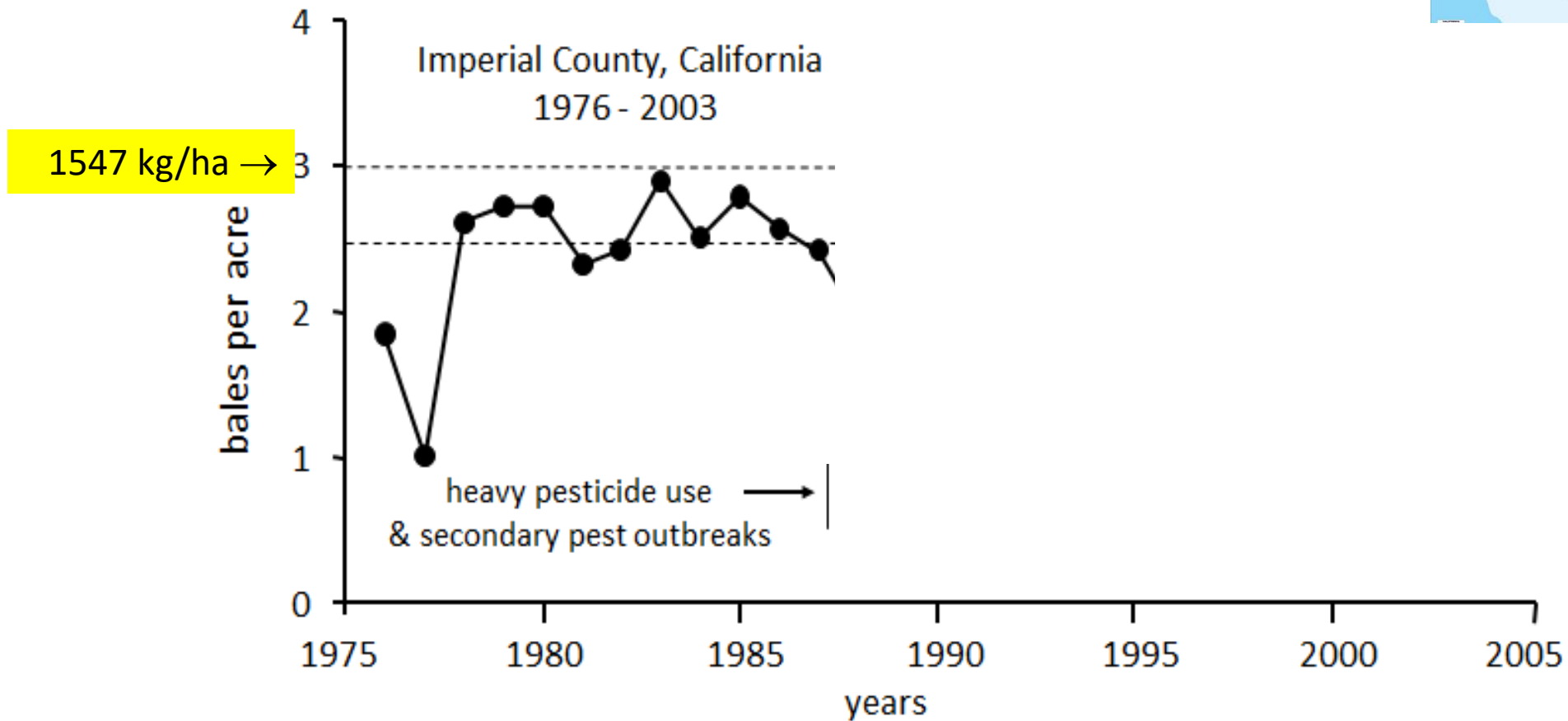


The question of suicides





How short season  
high density cotton  
save the industry in  
Southern California

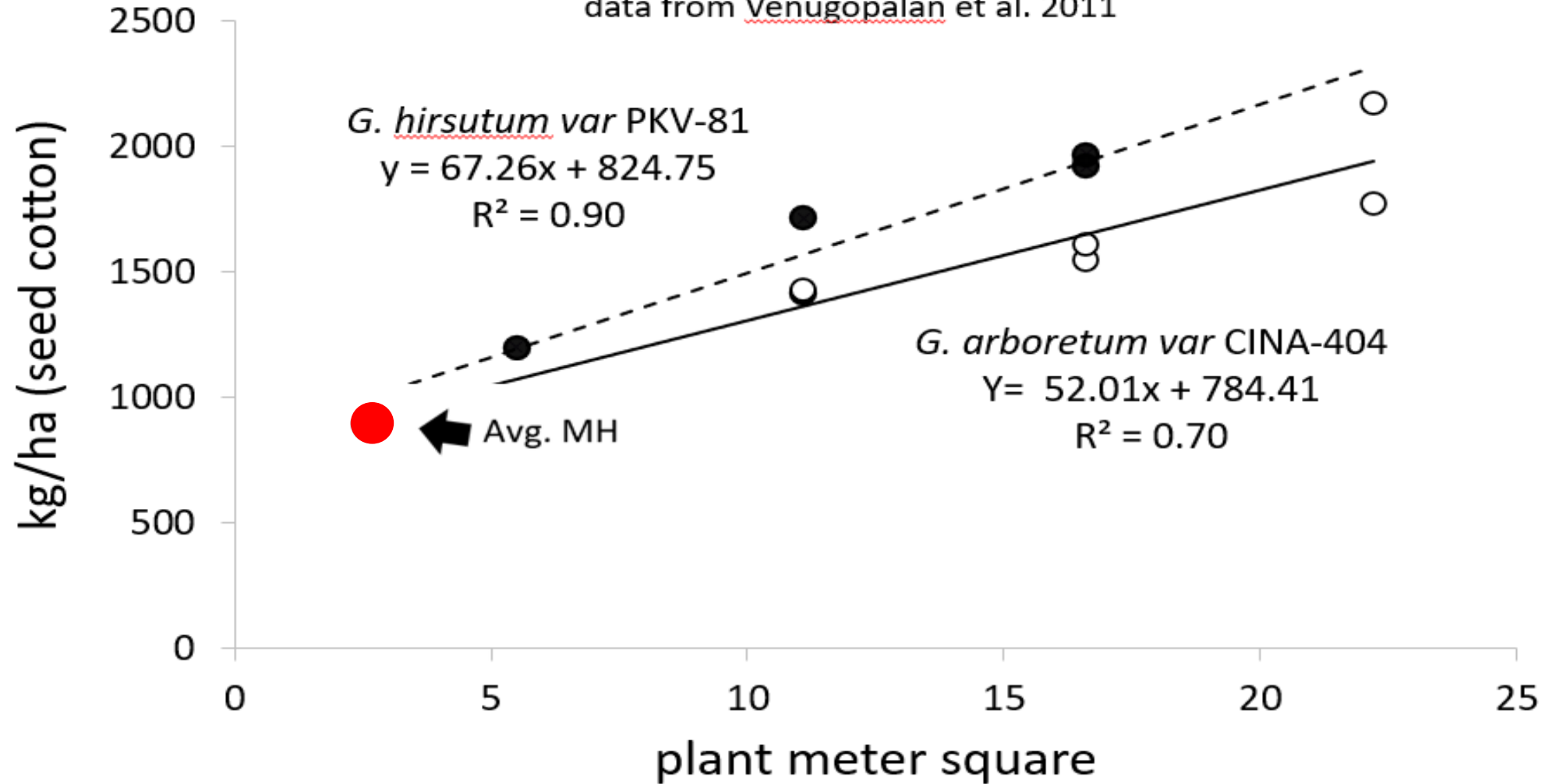






## Non-hybrid non- Bt high density short-season cotton in India

high-density short-season pure line rainfed cotton – CICR, Nagpur, MH  
data from Venugopalan et al. 2011



How HD-SS non GM non hybrid cotton would work in India?

pink bollworm

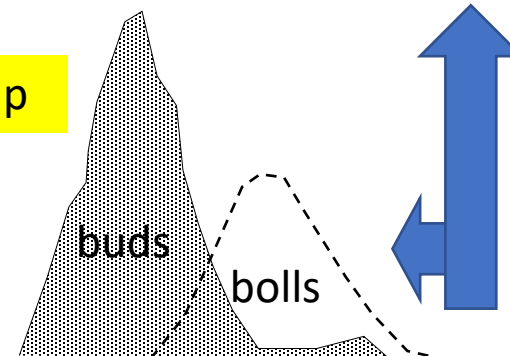


emergence from dormancy



rain fed HD-SS cotton

little overlap



1/1

7/1

12/31

Bt technology not needed!

Inherent conflict between irrigated and rainfed cotton

## High Density Short Season pure line rainfed cotton (CICR Nagpur 2011)

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- Non-GM, Non-Hybrid
- > 2x yield or more
- > 2.5x net income or more
- Promotes seed saving
- Greatly reduces insecticide use
- Disrupts the current value capture mechanism of hybrid cotton
- Ameliorates the gamble of the monsoon – better use of water



