The adoption of draught tolerant varieties (DTV)

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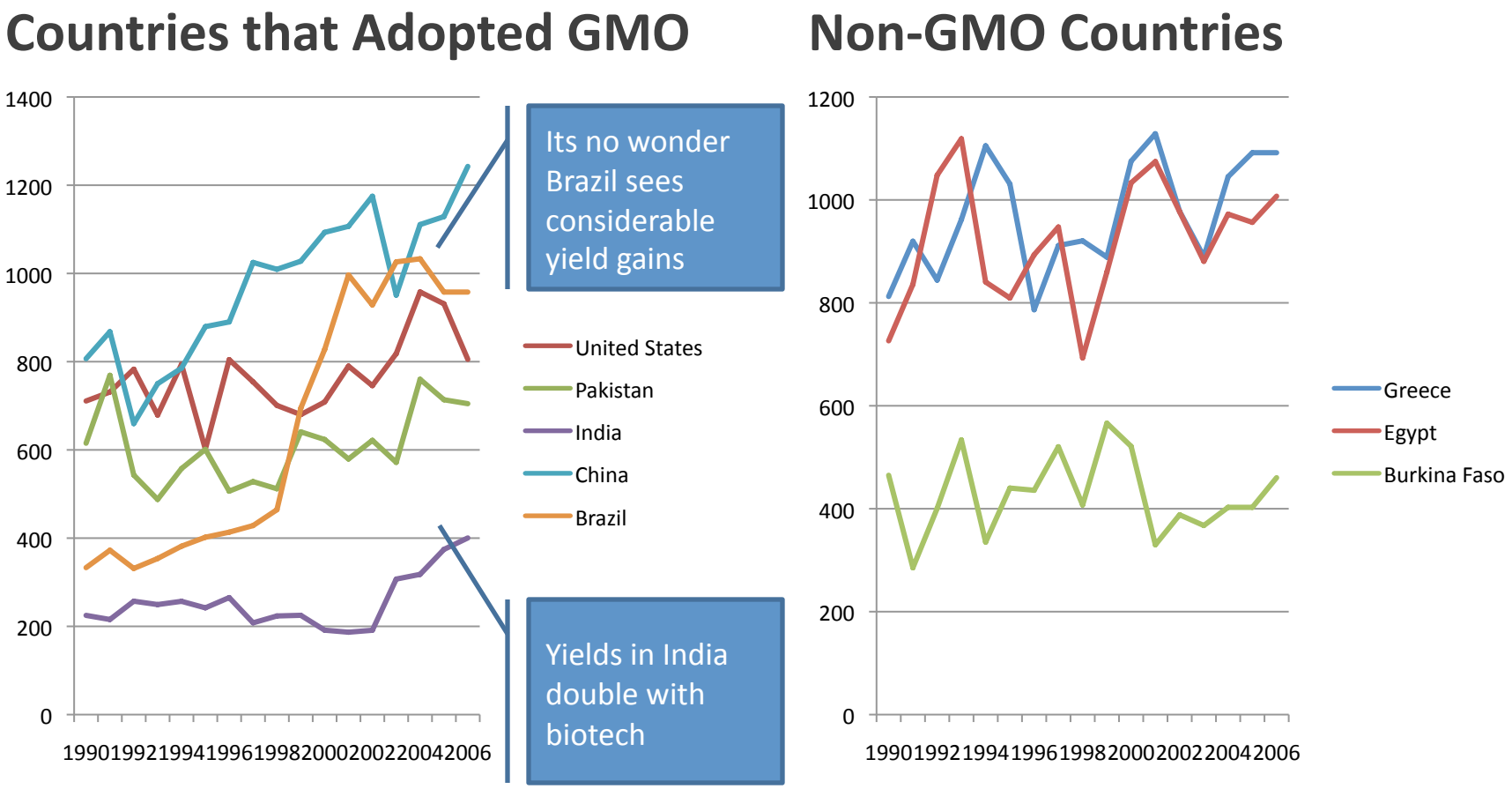
Lessons of adoption literature

- Complementarity
- Extensive margin
- Perception vs reality
- Imortance of distribution

Complementarity

- $Y=f(Z)(1-D(j))h(r,i)$
- Output Y depends is a product of potential output f(Z) times 1 minus pest damage times rain contributions
- Z is fertilizer
- A profit maxmizing farmer will use more fertilizer if pest damage or draught damage are lower
- Yield effect of GMO are very high in the field – more than in trial- complementarity matters

Greater Productivity Growth In Top-Producing Countries That Adopt GMO



Yield gains from Gm varieties compared to non GM

variables	Cotton	Maize	Canola	Soybeans
All Countries	65%	45%	25%	12%
Developed Developing	23% 110%	15% 56%	25%	7% 30%

Draught tolerant varieties will lead to investment on pest control and chemical
As they increase expected yield

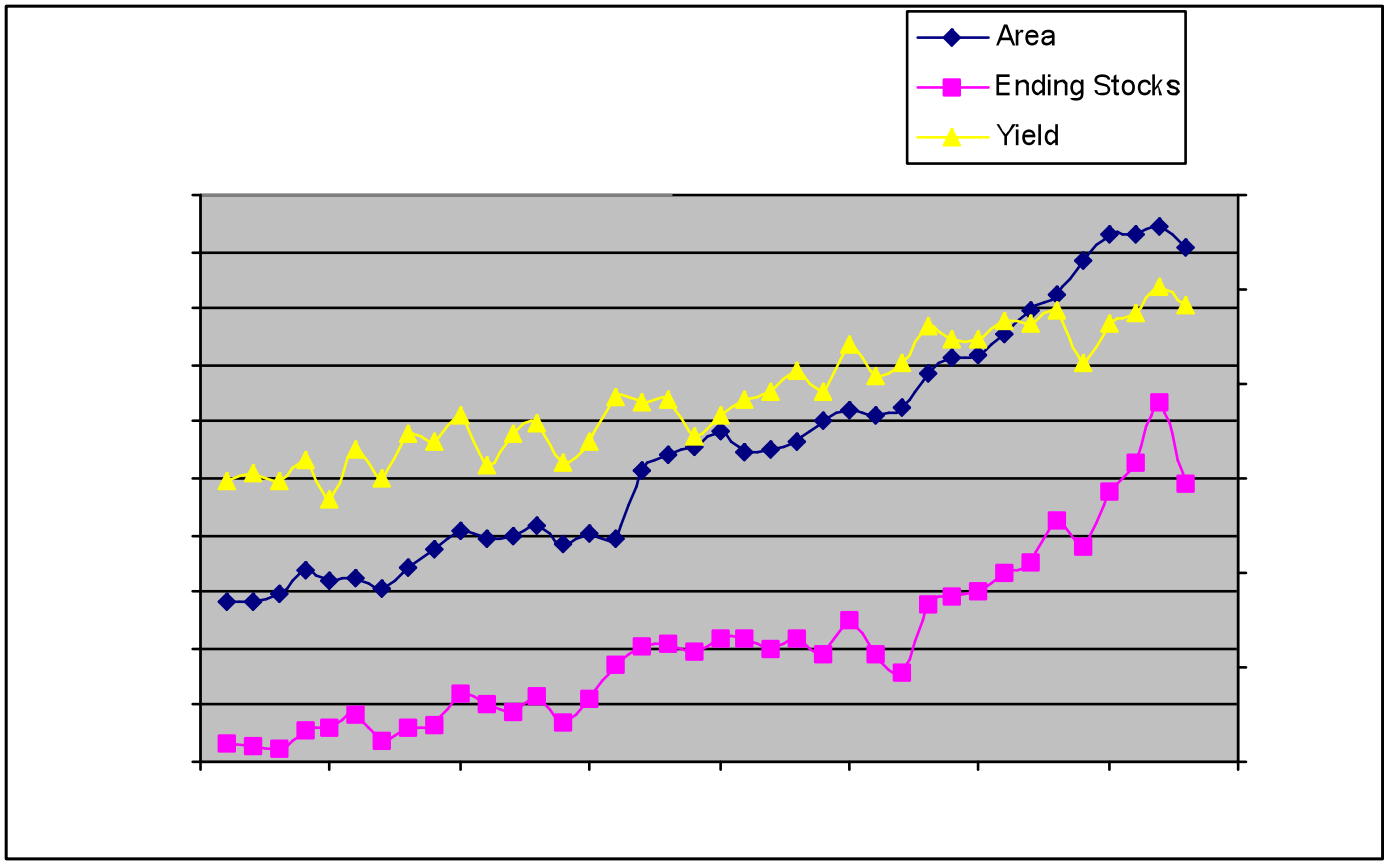
Extensive margin

- The Threshold model explain the shaped diffusion curve by heterogeneity among potential adopters. Some farmers or regions adopt early than other
  Sometimes new technology lead to expand acreage to regions not utilized before.
- Modern irrigation is one example it is land quality augmenting it is adopted on low quality lands

Adoption of of irrigation technologies

- Water use efficiency of gravitational technology is. 2-.8 depending on soil conditions
- Sprinkler increases efficiency to.5-.8
- Drip may reach .95
- Modern technologies are more expensive
- They are likely to be adopted on sandy soil steep hills and when water or output prices are high
- Drip was expanded acreage of avocado and grapes to the foot hills in California central valley and the deserts in California and elsewhere

Soybean has benefited from GMO the main impact was expansion

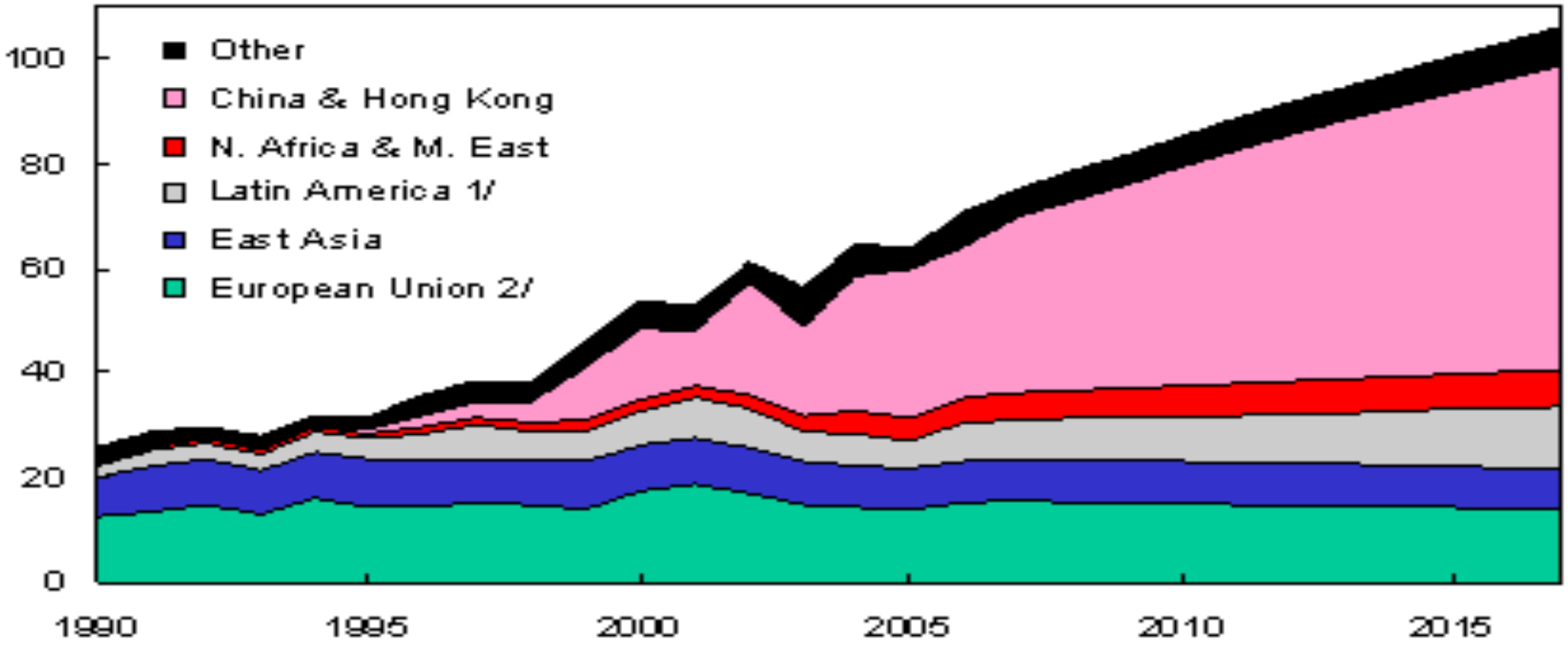


Despite rise in acres yield per acre increased- Gm enable to grow soybeans in Argentina addressing endof season weeds

People were concern about – who will feed china, especially given its growing demand for soybeans

Global soybean imports

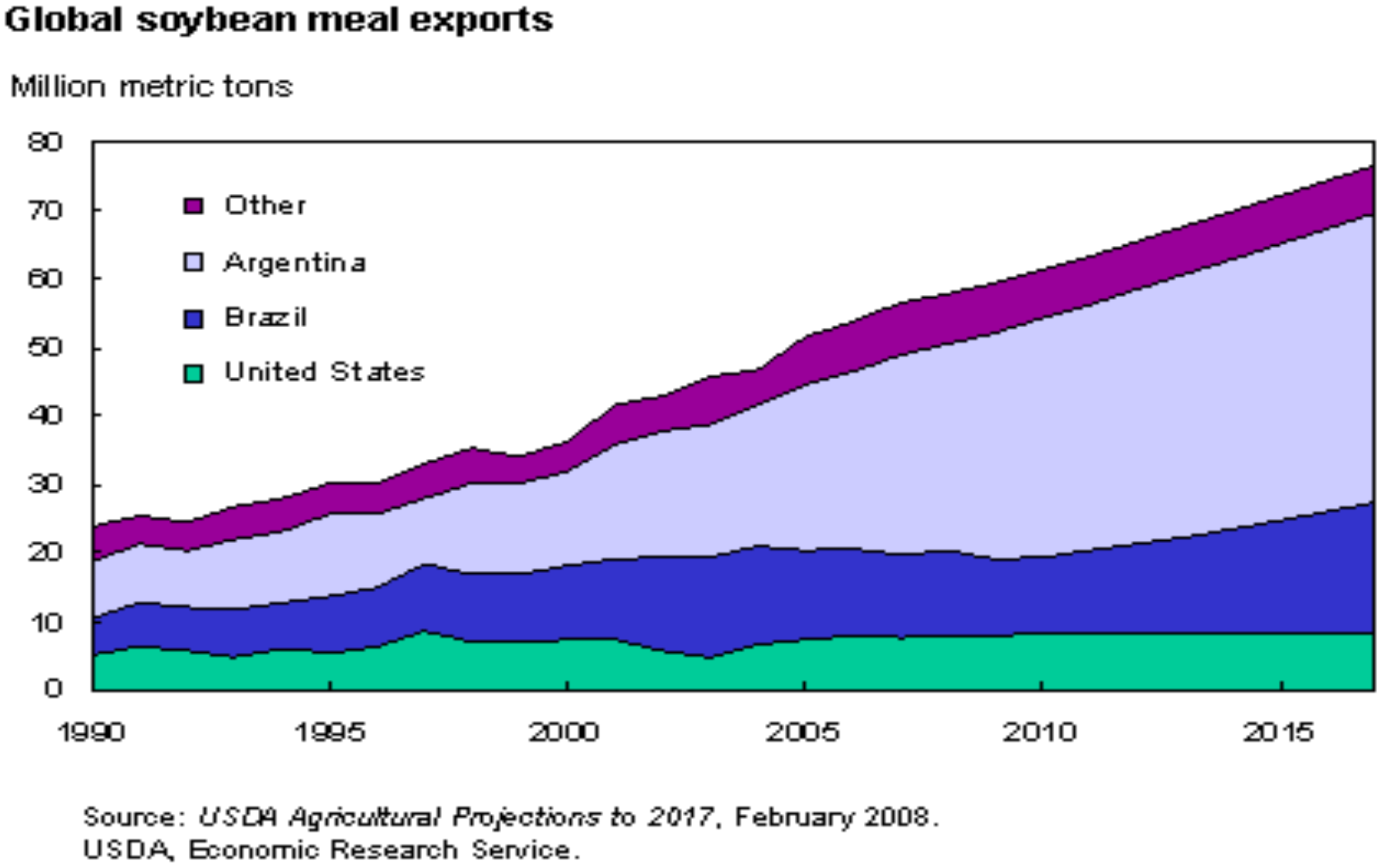
Million metric tons



1/ Includes Mexico. 2/ EU-27 excludes intra-trade after 2002, EU-15 intra-trade before 2003, Slovenia before 1992.

Source: *USDA Agricultural Projections to 2017*, February 2008.
USDA, Economic Research Service.

The increase production in Argentina allow to meet the growing demand in China



DTV are likely to increase arable acreage

- There are significant acreage where rainfall is on the margin of viability with current patterns (300 mm rainfall -400 mm rainfall)
- If draught tolerant can enhance the probability of survival and yield in these regions- acreage can rise
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example

- If cost are equivalent to .6 ton/hctre
- Yield/hctr –now
  - 2 wp .2
  - 1 wp. .4
  - 0 wp .4
- Yield/hctr –DT
  - 2 wp .2
  - 1.2 wp .4
  - .8 wp .3
- Expected yield
  - .8 tons/hctr
  - 1.12 ton /hctr
  - The main difference are in the tail – if you need .6 /hctr to survive and take a safety rule approach probability of not meeting target declines from .4 to.1

Importance of distribution pattern

- The driver of adoption is learning from experience
- The distribution of impacts will affect adoption of DTV
- If DTV affect outcomes wp .2 then one can not detect impact in 4 out of 5 years.
- Adoption is limited if benefit are delayed and uncertain - payment for insurance is limited
- Adoption will require subsidies and public action
- Timing of introduction will be critical – studies of draughts suggest that they are periods of change
- Adoption may start after draughts

Lessons of California Response to 1988-92 Draught

- Water storage matters. The storage facilities enabled California to survive the 3 early years of the drought with minimal impacts or changes, and the later years with mild effects.
- Multiple Responses to Reduced Water Supply.

  - 1/3 from ground water pumping,
  - 1/3 from conservation (adoption of drip etc),
  - 1/3 from land fallow.

More lessons

- Conservation makes a difference.. After 1992,
  - more than 50% of tree crops in the state used drip,
  - sprinkler in cotton and alfalfa exceeded 40% in major areas.
- Trading was introduced through water bank

Perception vs. reality

- There is a growing perception that
  - first generation biofuel did not help the poor.
  - They help farmers but do not increase yield
  - DTV is perceived as yield increasing and poor friendly
- Reality
  - True- the poor have not adopted much GMO except cotton grower in India and
    - It is mostly regulations
  - But GM technology increased yields-especially in developing countries
- Draught tolerant can really increase yield
- Pest control GM helps to address climate change

But the impacts of DTV may be less significant than that of a BT variety

- Suppose Y=(1-D)h
- H= 1 wp .8 D=.3
- .5 wp .2
- Y= .7 wp .8
- .35 wp .2
- DTV eliminates draught loss
- Expected gain of DTV=.1
- Expected gain of pest control .27
- It is a more frequent threat

DTV is promoted because it is acceptable

- Pest control GM has bigger economic potential
- But political constraints lead to introduction of DTV first
- The technology will require extra support

The right location and right crops are important

- Drip and sprinkler adoption was delayed by wrong location
- The desire is to introduce DTV to help the poor
- But technologies diffusion tend to trickle down
  - Consistent with Threshold model
  - Golf courses were used to refine irrigation technologies
- May-be start or work in parallel with high value crops-
  - drip was designed for cotton- adopted with tomatoes and avocado

DTV can expand crops area to hotter zones

- The ability to survive dry period may lead to utilization of DTV to expand climatic range of crops
- This is a desired property even without climate change
- Having high frequency of benefits will lead to expanded likelihood of adoption

conclusion

- DTV present challenges
  - It is not easy to design
  - Vary in importance among periods
    - Require tailor made strategy for introduction
  - May be useful as mechanism to introduce BT or other pest control GMV
  - Value may be higher for adaptation to high temperature