Plant Genetics and the Future of Food

Vancouver Food 3000

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Tomorrow's Table

Organic Farming, Genetics, and the Future of Food

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Nairobi Feb, 2008


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Slide courtesy of R. Nelson

Compounding the challenges facing agricultural production are the predicted effects of climate change

DROUGHT

Flooding

The people of Bangladesh get two-thirds of their total calories from rice

2008, Intergovernmental Panel on Climate Change

The Power of Genetically Altered Seed

Why genetically alter food crops?

Tolerance to stress

30-60% of yield is lost to pests, diseases and environmental stress

Why genetically alter food crops?

Taste

Beauty

Nutrition

How common is genetically altered food?
A typical Vancouver meal

scone

butte

pome

yo

ne

te

everything we eat is genetically altered

crackers with humus

Pacific Salmon

wild mushroom-risotto

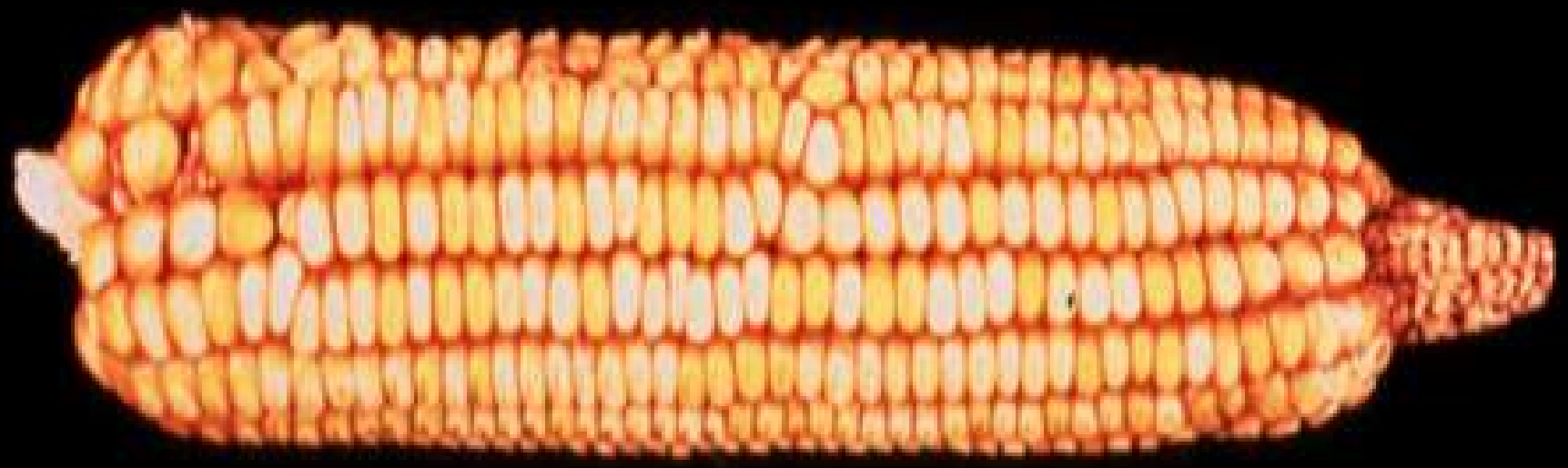
apples

cheeses

chardonnay

We have genetically altered food crops for 10,000 years

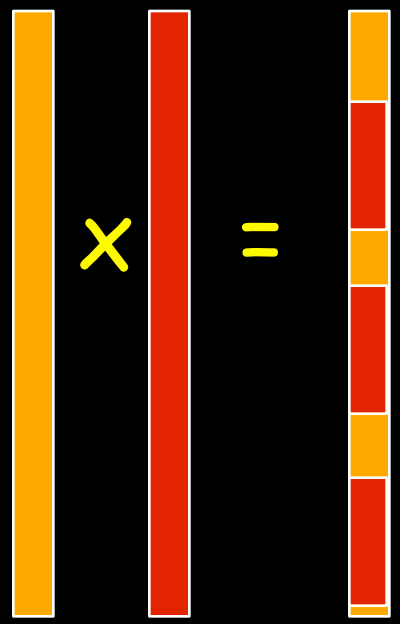
Yield



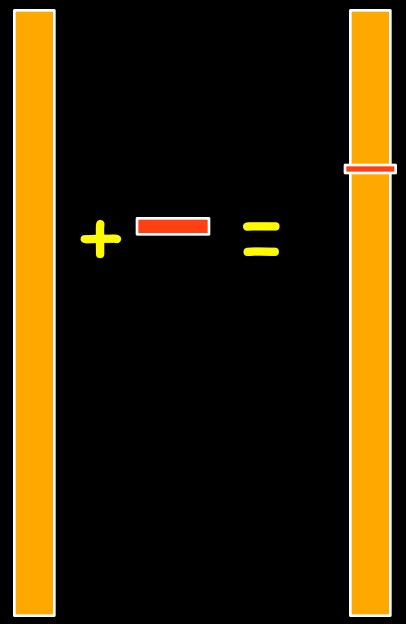
GE and precision breeding differ from conventional breeding:

- One to few well-characterized genes introduced

Conventional



GE and precision breeding



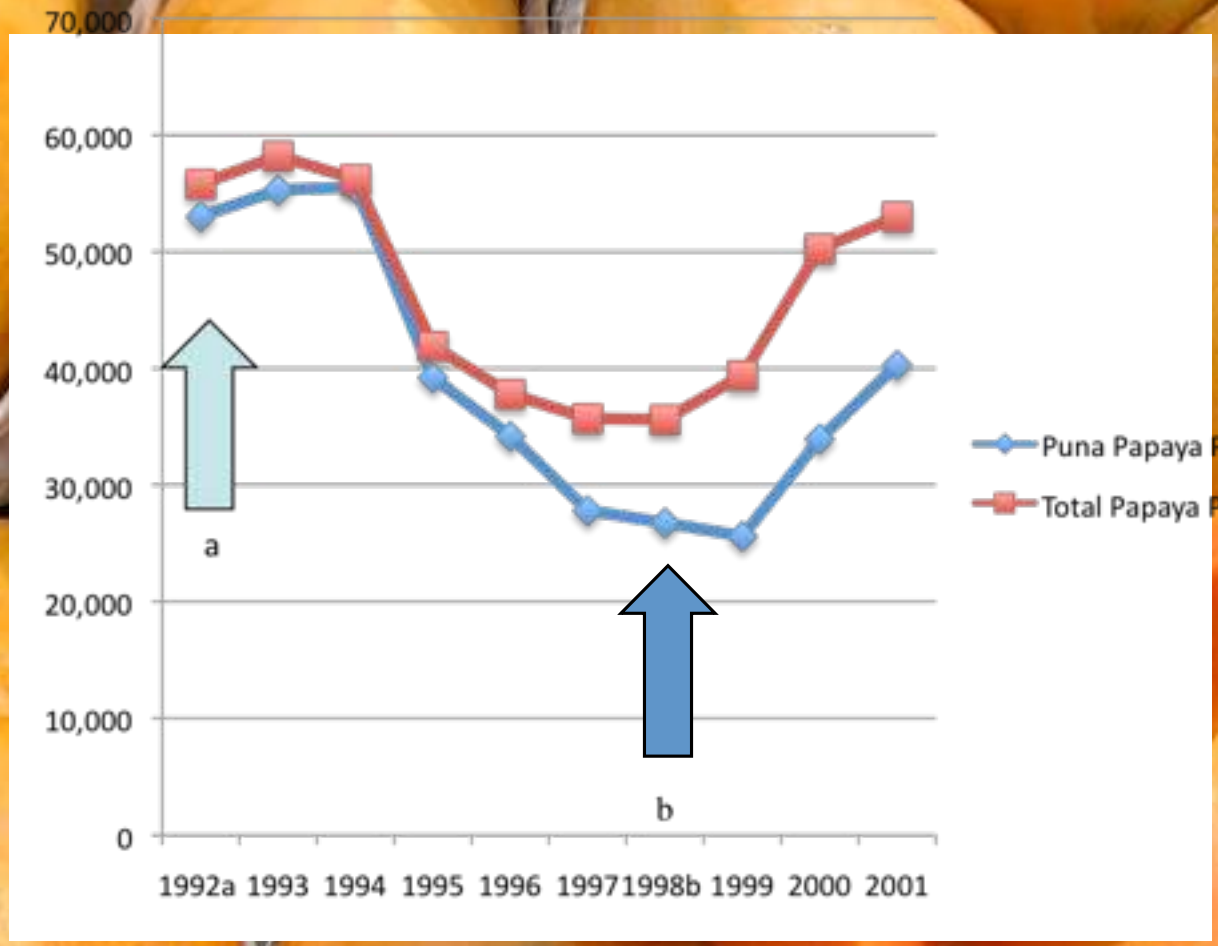
Papaya infected with papaya ringspot virus

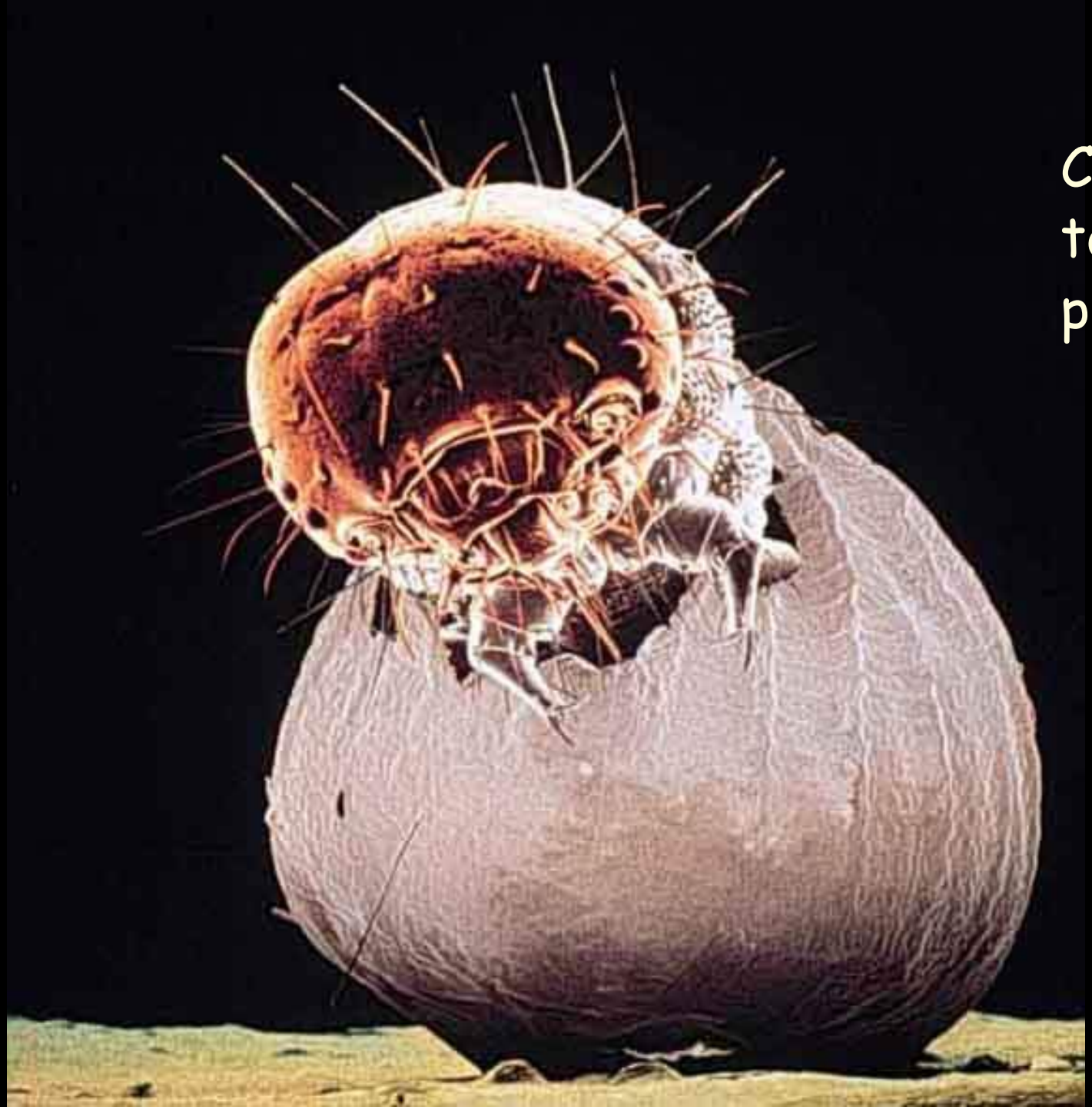
1995: Virus disease appeared in Hawaii

1990s: Industry destroyed by PRSV

Dennis Gonsalves engineers papaya for resistance

Kapoho Field trial 1995 Steve Ferreira





Cotton engineered to contain a protein called Bt.

Cotton bollworm

In Arizona, Bt-cotton fields used half the insecticides; increased beneficial insect biodiversity

Tabashnik, 1993. Annual Review of Entomology 39:47.

In India,

- 37% increase in yield
- 41% reduction in insecticides
- $135/ha profit gain

Data from 375 farms in central and southern states, 2002-2007
Source: Sadashivappa and Qaim, Annual review of Resource Economics, 1:655 (2009)

- In China, insecticide use fell by 156 million pounds after introduction of Bt cotton

Huang et al. 2005. Insect-resistant GM rice in farmers' fields: Assessing productivity and health effects in China. Science 308:688.

BT technology does not control all insects

Developing more productive seeds is just one element of an effective strategy

After seven years of reduced insecticide use in China, populations of other insects increased so much that farmers resumed spraying other pesticides.

Tabashnik et al 2008, Nature Biotechnology, 26:199. Science 2010; NRC report 2010

Relying on seed alone is not sufficient to enhance sustainable agriculture

No matter how powerful the seed technology, the seed must still be integrated with other strategies to manage the diverse spectrum of diseases and pests that attack a crop

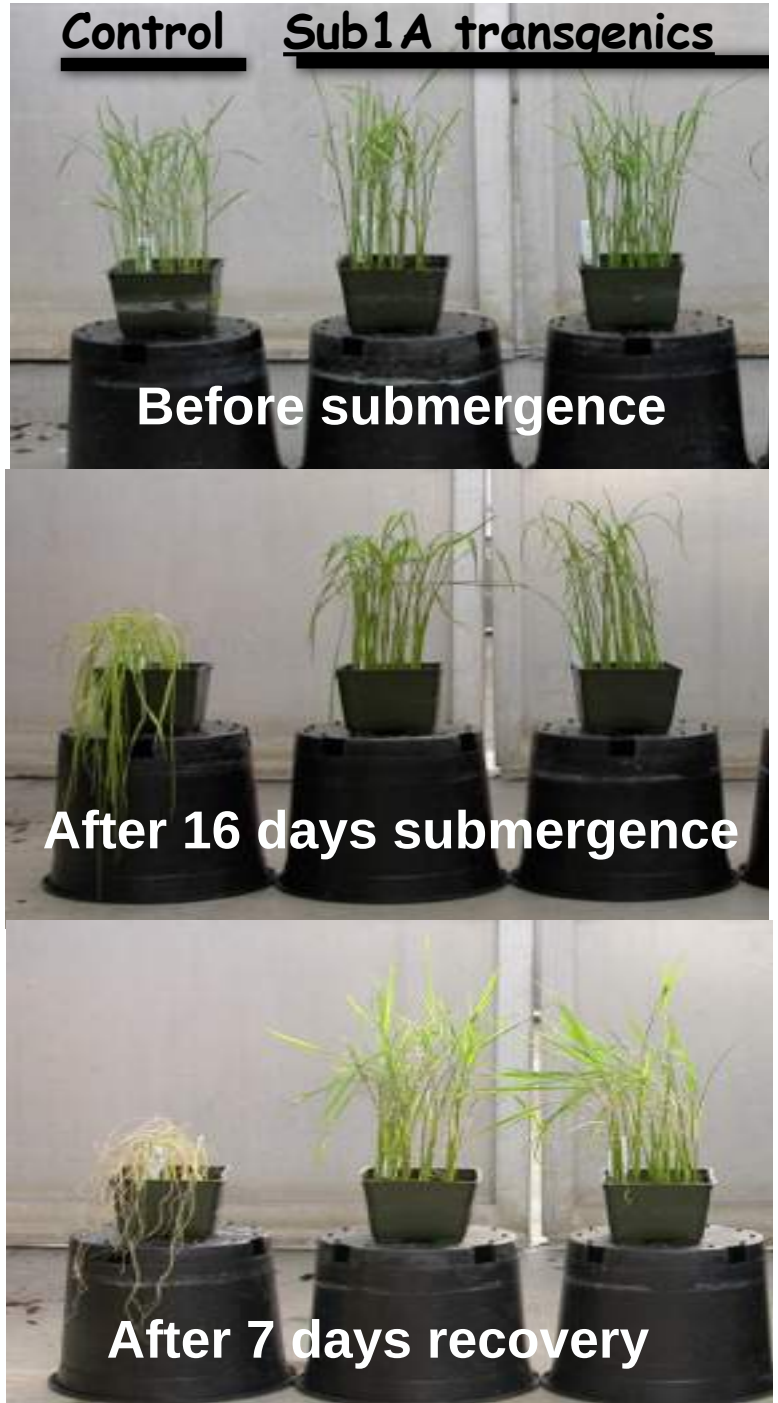
Tabashnik et al 2008, Nature Biotechnology, 26:199. Science 2010; NRC report 2010

The Story of Flood Tolerant Rice

25% of the world's rice is grown in flood-prone areas

An old rice variety, highly tolerant to submergence, was found in Eastern India

In Bangladesh and India alone, 4 million tons of rice, enough to feed 30M people, is lost every year to floods



Sub1A confers submergence tolerance to highly intolerant rice

K. Xu, X. Xu and P. Ronald

Photos by Takeshi Fukao

Xu et al. Nature, 442:705 (2006)

Marker assisted breeding to engineer submergence tolerant rice for farmers

David Mackill and colleagues in the Philippines, India and Bangladesh

Sub1 Time-lapse sequence
IR64 + Sub1 vs. IR64

14 June to 16 October 2007
IRRI ES Plot G14

Performance of Swarna-Sub1 in farmers' fields

"I was surprised and happy when I saw that the Sub1 rice survived the flood"

Harir Danga farmer, Bangladesh

Video courtesy of Gene Hettel IRRI

Dramatic advancements in plant genetics

D'Hont et al., 2012

Arabidopsis genome sequence:
2000: 7 years, $70 million, 500 people

2013: 2-3 minutes, $99

source: Joe Ecker

The processes of genetic engineering, precision breeding and conventional breeding present similar risks

>1 billion acres of GE crops planted

-20 years of GE crops: Not a single case of adverse health or environmental impacts

GENetic Engineering Risk Atlas (GENERA)

Over 600 independently-funded risk assessment studies

- http://www.biofortified.org/genera/studies-for-genera/

The three pillars of sustainable agriculture

For a productive and sustainable global agriculture, we need everyone at the table