Plant Genetics and the Future of Food

Vancouver Food 3000
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Ronald participation supported by Monsanto
Pesticides are used widely

Slide courtesy of R. Nelson
Compounding the challenges facing agricultural production are the predicted effects of climate change.

DROUGHT
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
- Disease
- Environmental stress

30-60% of yield is lost to pests, diseases and environmental stress.
Why genetically alter food crops?

Taste

Nutrition

Beauty
How common is genetically altered food?

A typical Vancouver meal

scones with butter
pomegranate jelly
yogurt
nectarine
tea

Virtually everything we eat is genetically altered

Pacific Salmon
Greek salad
wild mushroom-risotto
chardonnay

crackers with humus
apples
cheeses
We have genetically altered food crops for 10,000 years.
GE and precision breeding differ from conventional breeding:

• One to few well-characterized genes introduced
Papaya infected with papaya ringspot virus

- 1950s: Oahu crop destroyed by PRSV
- 1992: Virus is discovered in Hawaii
- 1995: Production plummets
Dennis Gonsalves engineers papaya for resistance

Kapoho Field trial 1995 Steve Ferreira
Cotton engineered to contain a protein called Bt.
In Arizona, Bt-cotton fields used half the insecticides; increased beneficial insect biodiversity

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.

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.

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.

The Story of Flood Tolerant Rice
25% of the world’s rice is grown in flood-prone areas. In Bangladesh and India alone, 4 million tons of rice, enough to feed 30M people, is lost every year to floods. An old rice variety, highly tolerant to submergence, was found in Eastern India.
Sub1A confers submergence tolerance to highly intolerant rice

K. Xu, X. Xu and P. Ronald

Photos by Takeshi Fukao

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

2008, Gotha, UP, India
3-5 fold yield increase

Swarna

Eastern UP, 2007

Swarna-Sub1

Rangpur, Bangladesh 2008
“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

Arabidopsis genome sequence:
2000: 7 years, $70 million, 500 people
2013: 2-3 minutes, $99

source: Joe Ecker

D’Hont et al., 2012
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 (GENERAdA)
Over 600 independently-funded risk assessment studies

http://www.biofortified.org/genera/studies-for-genera/
The three pillars of sustainable agriculture

- Social
- Economic
- Environmental
For a productive and sustainable global agriculture, we need everyone at the table.