

Agricultural Biotechnology

Opportunities and Challenges

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(This talk concerns largely plant biotechnology)

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The Opportunities

From the Green Revolution
To the Gene Revolution

The Future of Farming

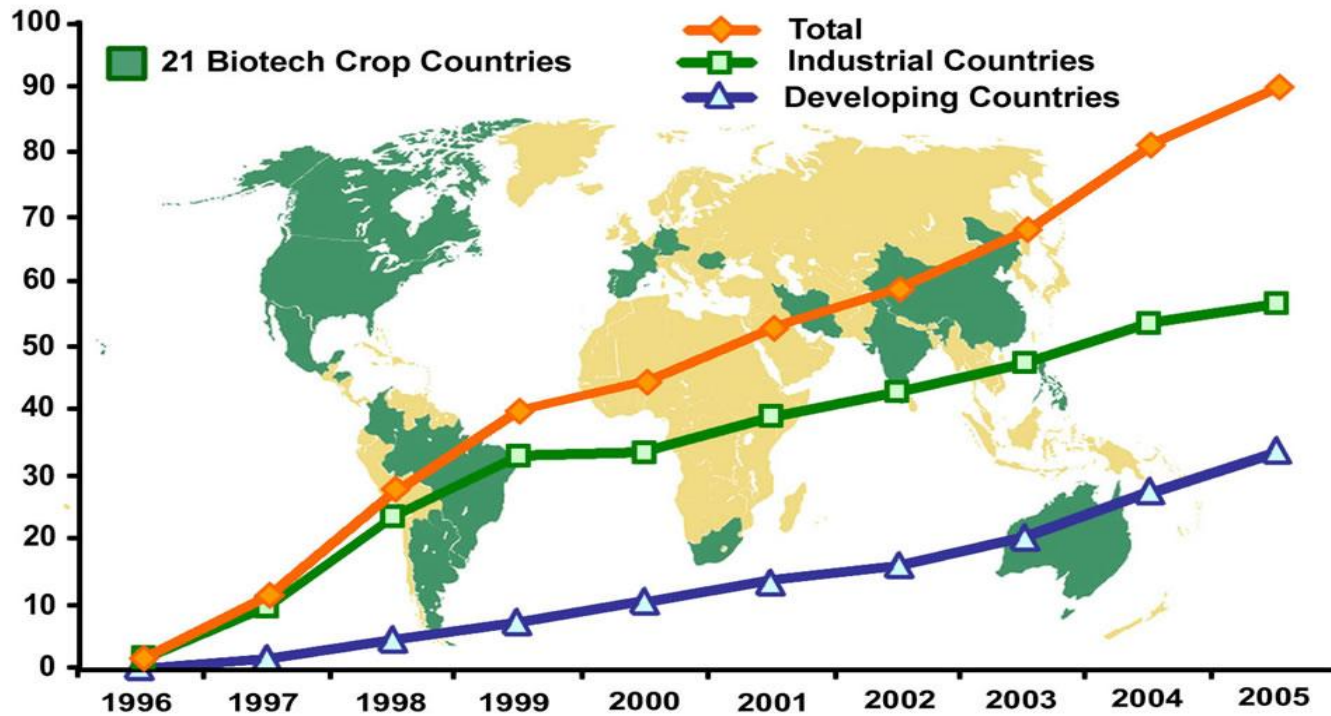
- Higher yield, less land use, lower costs, longer shelf-life
- GM food will provide immunity from disease
 - polio antigen embedded in banana (Africa)
 - “golden rice” supplies 10% of daily Vitamin A
- A fast-growing global industry
- Will the DR rise to the opportunity?

Global Overview

- Biotech crops valued at \$44 billion in 2003-2004 worldwide
- 90 million hectares of GM crop (222 million acres) in 2005
- 11 percent increase over 2004
- Double-digit growth each year from 1996
- Increase from 6 to 21 countries '96-'05
- 8.5 million farmers cultivating GM products
- Amount of land/water available for agriculture is in decline



Global Area of Biotech Crops Million Hectares (1996 to 2005)



Increase of 11%, 9.0 million hectares or 22 million acres between 2004 and 2005.

Source: Clive James, 2005

The Regional Breakdown

World Leaders in Production

- **USA**
More than 49 million hectares of GM crop annually
- **ARGENTINA**
17.1 million hectares, making it the regional leader in South America
- **BRAZIL**
9.4 million hectares of GM soybean
- **CANADA**
5.8 million hectares of GM maize, soybean and canola

The Regional Breakdown

Rising Players

- **CHINA**
Top producer of GM cotton with 3.3 million hectares
- **PARAGUAY**
Rising Star with 1.8 million hectares of GM soybean
- **INDIA**
Steady growth with 1.3 million hectares of GM cotton

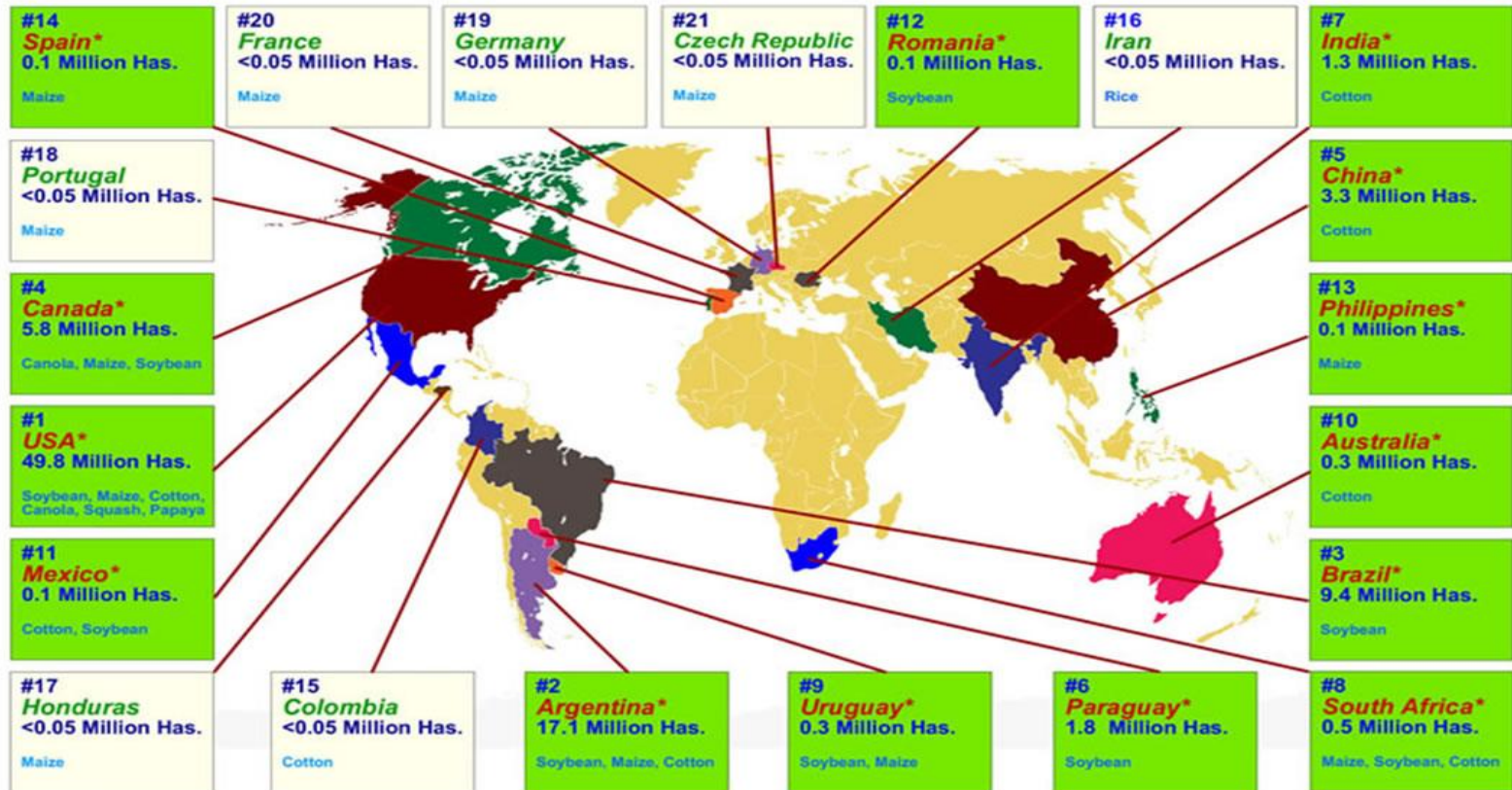
The Regional Breakdown

Start-Ups

- **SOUTH AFRICA**
0.5 million hectares of crop grown within last year, leading Africa's advent into GM crops
- **URUGUAY**
0.3 million hectares of GM soybean, maize
- **AUSTRALIA**
0.3 million hectares of GM cotton
- **MEXICO**
0.1 million hectares of GM maize and cotton

The Regional Breakdown

21 Biotech Crop Countries and Mega-Countries*, 2005



* 14 biotech mega-countries growing 50,000 hectares, or more, of biotech crops.

Source: Clive James, 2005

Agricultural Biotechnology Successes



- GM-derived Virus-Resistant Papaya
 - 1990s: ringspot virus decimated Hawaii's crop
 - \$17 million industry in danger of collapse
 - 1997: US introduced GM papaya resistant to the virus
 - Within 4 years production rebounded to pre-virus attack levels
 - state restored as the No. 1 provider of crop to the mainland

Source: National Center for Food & Agricultural Policy

Agricultural Biotechnology Successes

- GM Soybean (Brazil)
 - from Pioneer Hybrid International
 - soybean modified to improve the nutritional content
 - gene from the Brazil nut inserted into the DNA of soybean
 - gene improves the nutritional value
 - promotes efficient use of available land

The Challenges

Global & Technological

The Challenges

- Must dispel popular fears of GM products
 - Misconceptions about GM crops and “dangers”
 - Sudan – population refused to eat “golden rice” because of misconceptions
 - Misconceptions fueled by media
 - India, Sri Lanka initially banned all GM cultivation & products
 - Scientific community must work to educate public
- 6 billion world population and growing
 - 65 million more people by 2020, mostly in the developing world
 - 9 billion people by 2050
- Predicted food crisis in 10 years
 - Africa: Steady decline in food supply per capita over the past 15 years
- Must double food production over next decade while using fewer chemicals
 - Reduce dependency on fertilizers and pesticides

Regulatory Bodies

Setting Policies & Regulations

- World Trade Organization (WTO)
- UN Food and Agriculture Organization (FAO)
- US Dept of Agriculture (USDA)
- Food and Drug Administration (USFDA)
- The European Food Safety Authority (EFSA)
- Need greater worldwide understanding and agreement on GM issues

Issues of Safety & Ethics

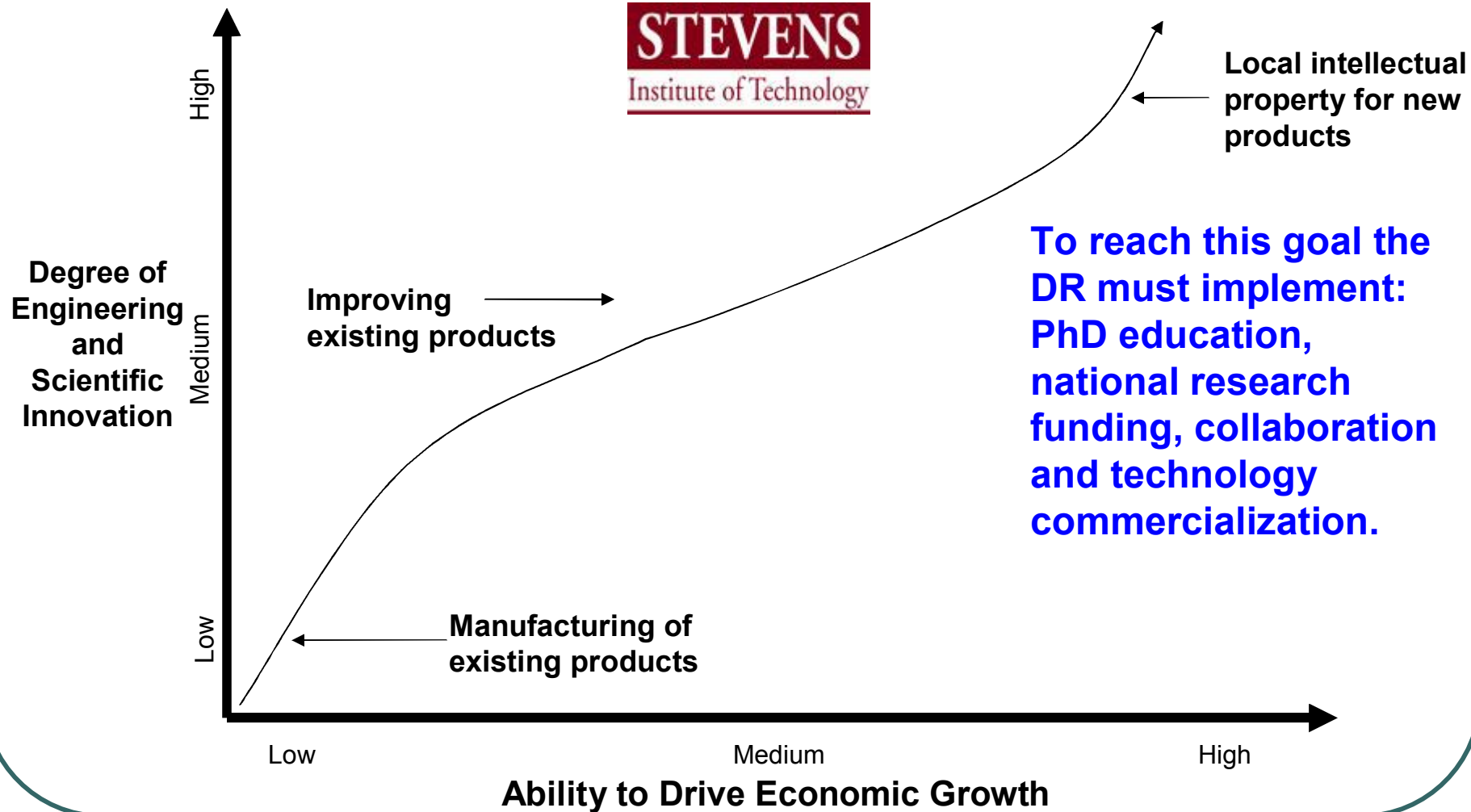
Guarding Against the Unintended

- GM crops can harm non-targeted insects
- Cross-pollination of GM to non-GM crops
- Overtaxing land resources
- New classes of human allergens?

Who Can Be Helped?

- The poorest and most populous nations
 - countries in the developing world
 - Africa, South Asia, East Asia, South America
- Land-scarce regions
- Lands in unfavorable climates
- Lands with scarce water supply

A Phased Approach to High Tech Research and Technology Commercialization in the Dominican Republic



Goal for the DR

Pioneers

XXX

Migrators

XXX

XXX

Settlers

XXX

**Existing Ideas
and Concepts**

**New Ideas and
Concepts**

**To reach this goal the
DR must implement:
PhD education,
national research
funding, collaboration
and technology
commercialization.**

Intellectual Property Activity (2002)

Rank by Granted to residents	Country	Total Applications	Granted Residents	Granted Non-Residents	Granted Total
1	Japan	486 906	108 515	11 503	120 018
2	USA	381 737	86 976	80 358	167 334
3	Republic of Korea	203 696	30 175	15 123	45 298
4	Taiwan	61 402	24 846	20 196	45 042
5	Germany	310 727	22 637	38 516	61 153
6	Russian Federation	120 364	15 140	2 974	18 114
7	France	182 015	10 899	42 516	53 415
8	China	181 256	5 868	15 605	21 473
9	United Kingdom	284 910	5 211	47 382	52 593
13	Australia	107 257	1 675	12 821	14 496
14	Austria	254 032	1 581	18 809	20 390
15	Italy	163 951	1 285	33 614	34 899
16	Canada	108 352	1 253	11 698	12 951
17	Spain	255 590	1 181	25 445	26 626
20	Brazil	101 746	674	4 066	4 740
	Dominican Republic		??		
37	Mexico	94 743	138	6 478	6 616
55	Colombia	87 911	12	360	372
58	Ecuador	85 303	6	15	21
59	Honduras	168	6	140	146
61	Uruguay	496	4	51	55

National Research and Development Expenditures

(as a percent of GDP 2002)

Rank	Country	%
2	Israel	5.0
3	Sweden	4.6
5	Japan	3.1
7	Korea, Rep. of	3
8	United States	2.8
10	Germany	2.5
11	France	2.2
13	Singapore	2.1
15	Canada	1.9
17	United Kingdom	1.9

Rank	Country	%
40	Cuba	0.6
43	Chile	0.5
47	Argentina	0.4
??	Dominican Republic	??
47	Mexico	0.4
47	Panama	0.4
61	Costa Rica	0.2
61	Colombia	0.2
72	Peru	0.1
72	Ecuador	0.1

* Source: UNESCO Institute for Statistics

National Status for Funding of Research and Technology Commercialization in the DR

Establish the National Office of Research and Technology Commercialization

- Reporting directly to the President of the Dominican Republic with Cabinet-level status
- International Board of Advisors
- Responsibilities:
 - Provide competitive funding for advanced research and doctoral research fellowships
 - Provide financial support for laboratory prototypes
 - Develop intellectual property protection
 - Sponsor investor workshops, and international visitors and conferences

Research and Technology Funding for the Dominican Republic (GDP \$55 Billion)

Ecuador \leq Dominican Republic \leq Chile
\$50 million \$250 million

Initial target:
Begin with \$20 million Annually

Future Directions for the DR in Agricultural Biotechnology

- Commodity products using GM - rice, corn, canola, cotton, cocoa, soybeans
- Possible niche markets
 - Cosmetics and personal care products using GM ingredients (e.g., GM papaya extracts)
 - GM floral products
- Pioneering new fruit and vegetable products from research and intellectual property in DR