WIPO-UPOV SYMPOSIUM ON INTELLECTUAL PROPERTY RIGHTS IN PLANT BIOTECHNOLOGY

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DISSEMINATION OF BIOTECHNOLOGY INTO AGRICULTURE

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Dissemination of Biotechnology into Agriculture

WIPO-UPOV Symposium on Intellectual Property Rights in Plant Biotechnology
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Dissemination of Biotechnology into Agriculture: Outline

• Introduction
• Global use of transgenics on farms
• Looking ahead
• Crops, Countries, Traits
• Intellectual Property Protection
• Conclusions
**Introduction**

- Agriculture is the original biotechnology
- Agriculture fundamental to culture, health, quality of environment, biodiversity
- Seed: a superb vehicle for disseminating innovation and underpinning benefits
- Effective IP critical to encourage investments and promote genetic diversity
- Biotechnology: far more than transgenes
- Development of improved germplasm critical

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**Yield Change**

**U.S. Average Corn Yields 1920 - 2002**

- Grain Yield Optimum Density (Bu/ac)
- Year of Release

<table>
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<th>Year</th>
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**OPV**
- Double Cross
- Three Parent Cross
- Three Parent Modified SC
- Single Cross (SC)
- SC-Transgenic

**y = 77.0 + 1.27x (r^2 = 0.94)**

**ERA Study of Pioneer Hybrids**

- Grain Yield Optimum Density (Bu/ac)

**Step Change in National Corn Growers Non-Irrigated Winns**

(Francis Childs winning years in Red)
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Global Area of Transgenic Crops, 1996 to 2002: Industrial and Developing Countries (million hectares)

Source: Clive James, 2002

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Global Use of Transgenics on Farm: Area by Country 2002

- Argentina - 39 M Ha (23%)
- USA - 39 M Ha (66%)
- Canada - 3.5 M Ha (6%)
- China - 2.1 M Ha (4%)
- South Africa 0.3 M Ha (1%)

(Source: ISAAA brief no. 27, Ithaca, NY)
Global Use of Biotechnology: By Small and Large-scale Farmers

• 75% of GM crops cultivated in developed countries, large-scale farms- US, Canada
• Significant use in Argentina, Brazil, China,
• 6,000,000 farmers grew GM in 2002
• >75% of farmers were resource poor, small-scale cotton farmers, China, S. Africa

(Source: James, C 2002 ISAAA brief no. 27, Ithaca, NY)

Global Use of Transgenics on Farms: % use by Crop 2002

Maize - 12.4 M Ha (21%)
Soybean - 36.5 M Ha (62%)
Cotton - 6.8 M Ha (12%)
Canola - 3 M Ha (5%)
Papaya - 0.1 M Ha (< 1%)
Squash - 0.1 M Ha (< 1%)

(Source: ISAAA brief no. 27, Ithaca, NY)
On-Farm Use of Transgenics:
Maize 2003-data from The Context Network West Des Moines IA

Argentina/Canada RR
1,400,000 acres (4%)

Argentina/Canada Bt
3,700,000 acres (12%)

Argentina/Canada LL
500,000 acres (1%)

US Maize RR 11% of crop
8,550,000 acres (27%)

U.S. Maize Bt-23% of crop
18,000,000 acres (56%)

On-Farm Use of Transgenics:
Soybeans 2003-The Context Network West Des Moines IA

Brazil RR 50% of crop
7,264,000 acres (8%)

Argentina 95% of crop
23,608,000 acres (28%)

US RR 75% of crop
54,800,000 acres (64%)
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Global Bt Cotton-The Context
Network West Des Moines IA

- US 36% cotton crop is Bt
- Bt cotton ranks 2nd to RR soy by global adoption
  - Close to 5 m. acres outside US
- China plants 90% of the total
  - Bollgard (40%?)
  - China’s own CASS Bt trait (60%?)
- Bollgard planted in 8 countries
  - India, 2002 launch
    - Excellent prospects, hybrid cotton
  - South Africa, Mexico, Argentina and the Philippines are minor users
- Australia launched in 1996/7
  - Different Lep. species, less effective

![BT Cotton - International Launches](chart)

Sources: Monsanto & industry comments

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Global RR Cotton-The Context
Network West Des Moines IA

- US 54% of crop is RR
- In Mexico, RR cotton has been planted on a small acreage from 1997 on
  - Mexico is a very minor cotton producer
- In South Africa, RR cotton was launched in the 1998-9 season.
  - The country has around 150,000 acres, but by 2001/2 RR/Bollgard stacked cotton had been adopted on 28% of that total.
- In Australia, RR cotton was commercialized in the 2001/2 season
- In Argentina, RR cotton was also approved ahead of the 2001/2 planting season.

![RR Cotton - International Launches](chart)

Sources: Totals: Monsanto; Country Shares: Industry Comments

Farm Labor Cost Issue

- Herbicide-tolerance traits for China, & India, Uzbekistan?
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Looking Ahead

- Climates change
- Farm cultivation/husbandry practices change
- Pests and diseases evolve
- Need more effective use of soil and water
- Need to increase productivity, including in harsh environments
- Un-ending need for better adapted varieties
- Improved germplasm and traits are needed

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Looking Ahead

- Capitalizing on scientific discovery in cultivar development—new tools facilitate access
- Adds complexities and costs to Research and Product Development
- IP is a prerequisite to support trait and germplasm development
- Encourage use of new genetic diversity rather than repeated narrowing use of old base
- Compulsory licenses (e.g. breeder exemption under patent law) undermine research investments, narrow genetic base
Future: Lepidopteran pests

- ECB
  - France, Italy
  - Romania 1.5 M ac.
  - S Africa 6.5 M acres
- Southwestern CB
  - NE Mexico
  - Southern USA

- Fall Armyworm
  - Mexico
  - Argentina 4.9M ac.
  - Brazil 19 M acres
- Corn Earworm
- Cotton Bollworm
  - N and S America

Future: Coleopteran pests

- Rootworm insecticides on 14.5 M ac. USA
  - MON 863 USDA approved
  - Dow/PHI 149B1-2005
  - Brazil-insecticide use on 12M ac.

- Western rootworm in Serbia 1990s
  - Very rapid dispersal
  - 1 M ac. 1997
  - By 2001 spread to Hungary, Ukrainian border, Romania, Italy, France
The Challenge

- Population: 2000 - 6 billion, 2050 - 9 billion. 98% of projected growth will be in the developing countries.
- Malnutrition/Poverty: 840 million people suffer from chronic malnutrition, 1.3 billion afflicted by poverty.
- Cultivable Land per capita: 0.45 ha. in 1966, 0.25 ha. in 1998, 0.15 ha. in 2050.
- World grain yields grew at 2.1% in 1980s, but at less than 1.0% per annum in 1990s.
- World consumption of meat tripled in last 40 years.
- Must double food production sustainably on same land area (1.5 billion ha) by 2050.

Biotechnology Potential for Developing Countries: Crops

- Banana
- Beans
- Cassava
- Cocoa
- Coffee
- Cotton
- Cucurbits
- Groundnut
- Maize
- Millet
- Papaya
- Potato
- Rice
- Sorghum
- Sweet Pepper
- Sweet Potato
- Tomato
- Wheat
Biotechnology Potential for Developing Countries: Traits

- Acid soil tolerance
- Apomixis
- Disease diagnosis kits
- Drought resistance
- Edible vaccines
- Fungal resistance
- Genetic maps
- Genomics
- High lysine
- Insect resistance
- Low soil nutrients
- Marker assisted selection
- Nematode resistance
- Starch quality
- Striga resistance
- Tissue culture
- Transformation technology
- Virus resistance
- Weed control

Biotechnology for Developing Countries: Organizations

- **CGIAR**: (e.g.) CIAT, CIP, CIMMYT, ICRISAT, IPGRI, IRRI
- **Foundations**: African Agricultural Technology Foundation, Rockefeller, Danforth Institute, others
- **Governments**: USAID
- **NARS**: EMBRAPA, Brazil, USDA, numerous others in many countries
- **NGOs**: Harvest Biotech Foundation International, Kenya, others
- **Private sector**: Dow, Garst, Monsanto, Mycogen, Pioneer, Syngenta, others
- **Public sector**: many universities in numerous countries
Intellectual Property Protection

• Application of biotechnology requires investments into basic and applied research hitherto not undertaken in crop improvement
• New abilities to characterize, isolate and modify genes/germplasm allow additional IP on crop genetics research and enabling technologies
• IP protection an absolute prerequisite to encourage private sector investments

Intellectual Property Protection

• N. America – private sector investments in plant breeding increased from $50m (1960) to $500m (1997)
• Public sector investments in field crops level from late 70’s; declined since mid 90’s ($600m)
• Globally: Private sector $3.4 billion food and agriculture research annually; much more than public sector
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**Intellectual Property Protection**

- Public sector does not have all the financial, germplasm or technical resources needed to move basic research into products on farms
- No single private sector player has all the technology or germplasm needed to meet farmer needs
- Public sector can reach areas not currently commercially viable for private sector
- Key roles for public and private sectors

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**Intellectual Property Protection: Bt Maize: an Example**

- **Gene ownership**
  - Cry1F
  - PAT marker gene
- **Enabling technologies**
  - Microprojectile bombardment
  - Herbicide selection
  - Backcrossing
  - Production of fertile transgenic
- **Enhanced expression**
  - Chimeric genes using viral promoters
  - Enhanced expression
  - Enhanced transcription efficiency
  - Selective Gene expression
- **Elite maize inbreds and hybrids**
From Research to the Farmer’s Field: IPP Issues Bt Maize

- Recent agreements among major players allow forward movement in plant biotechnology
- Cross-licenses
  - Dow licenses RR YG
  - Monsanto licenses Herculex 1
  - Pioneer licenses RR for corn, soybean, canola
  - Pioneer germplasm issues with Monsanto resolved
- Matured from competing on developing basic technologies to most effective use of technologies to create improved products
- Payment for technology/germplasm research is ultimately dependent on farmer purchases of seed

Intellectual Property Protection-Germplasm Development

- Breeders should have option of same level of IP as any other field of invention
- Development of germplasm and traits; key
- Patents should be available as an alternative
- Patents should not have compulsory license or breeder exemption
- New technologies facilitate access; recalibrate IP-access balance; Revise UPOV
- Increase incentives to develop new germplasm versus encourage repeated use of widely used varieties
Conclusions and Future Prospects

- Increase knowledge and capabilities through research
- Increase productivity and positive environmental impacts of agriculture
- Need strong public and private sectors
- More effective IP for germplasm development
- Bridge gaps between research plots and farmers fields
- Conservation and evaluation of genetic resources for future use

Dissemination to Culture and the Human Spirit

- “When I got home I heard John Barbirolli conducting Beethoven’s Seventh Symphony. What was agriculture for except that such a thing as that symphony and the playing of it should be made possible? To make bread so that it shall be possible for mankind to have more than bread; to listen to a Beethoven, a Sibelius, a Tchaikovsky, uttering some far message of paradox and joy”.

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