



PDF 2007: Session III

Rural Economy: Drivers of Growth

Green to Gene Revolution – through Demand Driven Research

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Sector Goals

Making Pakistan's Agriculture:

- **Productive**
- **Profitable**
- **Competitive &**
- **Sustainable**

Agriculture Development Strategy

- **Science-based Agriculture Development**
- **Diversification into High Value Agriculture**
- **Value Addition and Market Connectivity**
- **Integrated Farming System Approach for Smallholders**
- **Demand Driven Research and Extension**
- **Linking Farmers with Markets**
- **Bio-Safety and Sanitary Phyto-Sanitary Measures**
- **Development of Resource Conservation Technologies**
- **Enhanced National and International Partnership**

Agricultural Research: New Challenges

- **Green Revolution to Gene Revolution**
- **Resource Conservation Technologies (Hybrid, Transgenic Crops, Zero Tillage, Bed Planting, Band Placement of Fertilizer, High Efficiency Irrigation System)**
- **Staying Ahead with Emerging Technologies**
- **Competitiveness and Globalization**
- **Consumer Safety and Changing Preferences**
- **Stress on Natural Resources**
- **Climate Change Impact**

Evolution of Plant and Animal Biotechnology

Traditional	Late 19 th Century	Selection of plants and animals, classical breeding method.
Conventional	1930s	Development of commercial hybrids.
	1940s to 1960s	Use of mutagenesis, tissue culture, identification of genes.
	1970s	Advent of gene transfer techniques in plant breeding and artificial insemination in animal reproduction.
Modern	1980s	Tissue culture in plants and embryo transfer in animal production.
	1990s	Genetic fingerprinting and field testing, Commercial release of GMOs, Genetically engineered vaccines and hormones and cloning of animals.
	2000s	Bioinformatics, genomics, proteomics, metabolomics etc.

Green Revolution (1970-2000)

- **Cereal production more than doubled on the same area under wheat and rice as in 1970. In other words, had cereal yields stayed at the 1970 levels, it would have now taken twice the area to produce the same amount.**
- **Food availability per capita increased by 20 percent despite 134 percent increase in Pakistan's population with the addition of over 80 million people.**
- **The portion of Pakistan's population living in absolute poverty declined by one third between 1970 and 2000.**
- **Average life expectancy increased from 50 to 64 years.**

Major Challenges for Agricultural Research in 21st Century

- **Crop yields need to be increased beyond the spectacular gains of the 20th century to meet increasing demand.**
- **Resources required for intensive agriculture, such as land, labor, capital, energy, water and agro-chemicals need to be reduced.**
- **Crops need to be developed that can flourish in harsh conditions (e.g. drought, heat, cold, and other stresses).**
- **The environmental impacts of agriculture resulting from the use of pesticides, herbicides, and fertilizers need to be reduced.**

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- **Food crops need to be fortified with vitamins, essential amino acids, and proteins for better human health and nutrition.**
- **Novel energy crops need to be developed that are high yielding and that can be used as a renewable source of biomass for fuels to limit our dependence on a petroleum-based energy system.**
- **Engineer specialty plant that can be used as factories to produce chemicals and proteins for industrial and medical applications (e.g. vaccines to combat human and animal pathogens).**

Gene Revolution: Research Paradigm

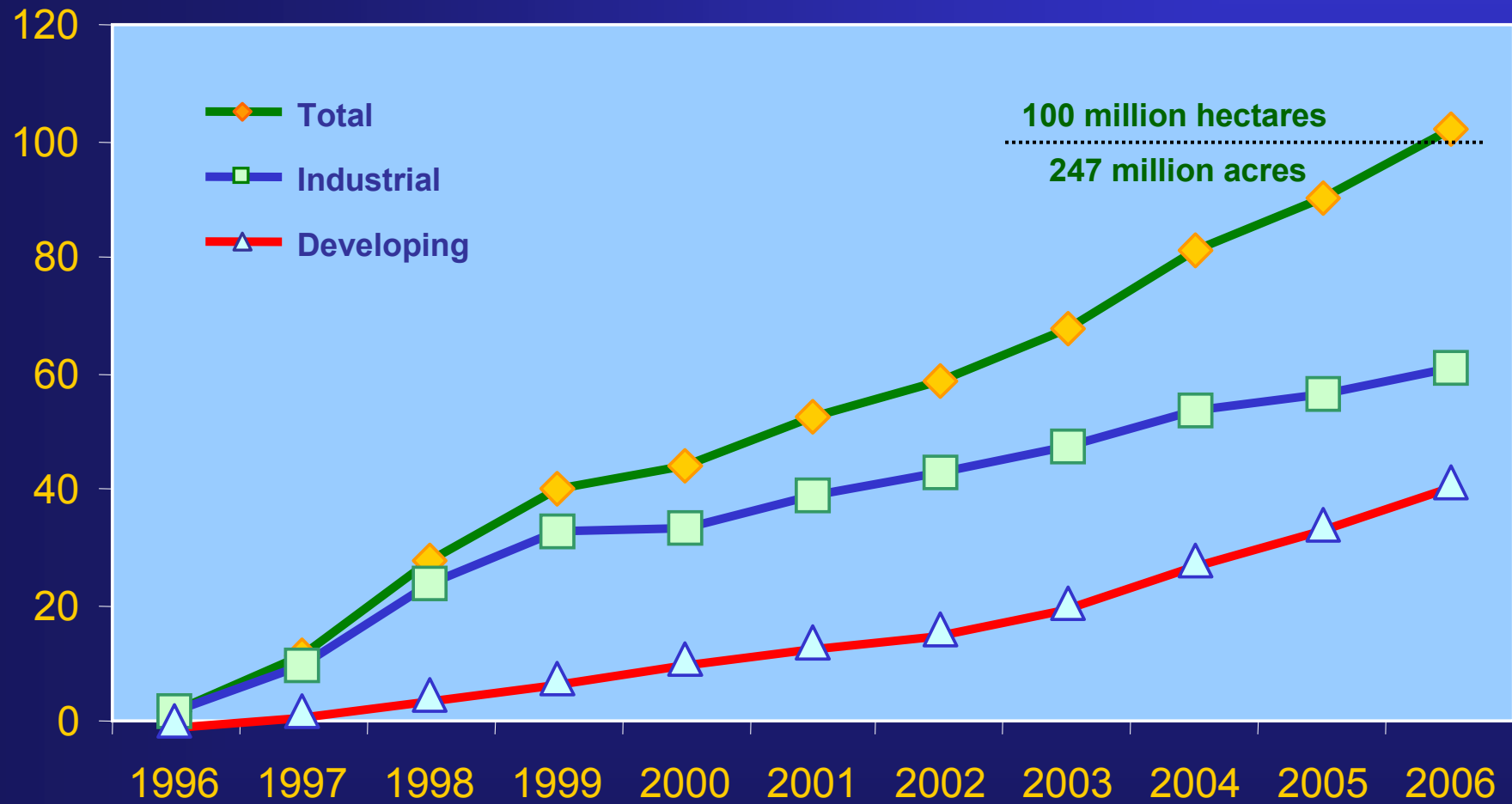
1. Resource Conservation through Input Replacement (e.g., GMO crops resistant to insect pests, herbicides and more efficient in nutrient uptake, etc.).
2. Rehabilitation of Marginal and Degraded Lands (GMO crop varieties (e.g. rice, wheat, maize and other plant species) tolerant to salinity, drought, iron deficiency etc.
3. Stabilizing Yield Potentials under Abiotic Stresses (e.g., drought, salinity, cold, heat).
4. Improved Postharvest Shelf Life (e.g., tropical fruits, vegetables, flowers).
5. Improved Nutritional and Medicinal Quality – through metabolic engineering to manipulate plant nutrients for human health or allergenic properties in food.
6. Reduced Environmental Pollution and Improved Forest Productivity.
7. Production of renewable resource-based biofuels to reduce dependency on fossil fuels, and contribute to a cleaner and safer environment with lower levels of greenhouse gases (e.g. bioethanol from maize, crop residues and other biomass).
8. Improved Animal Husbandry (e.g. molecular based diagnostic, disease detection, vaccine production, etc.).

Global Area of Biotech Crops, 1996 to 2006

	Hectares (million)	Acres (million)
1996	1.7	4.3
1997	11.0	27.5
1998	27.8	69.5
1999	39.9	98.6
2000	44.2	109.2
2001	52.6	130.0
2002	58.7	145.0
2003	67.7	167.2
2004	81.0	200.0
2005	90.0	222.0
2006	102.0	252.0
Total	576.6	1,425.3

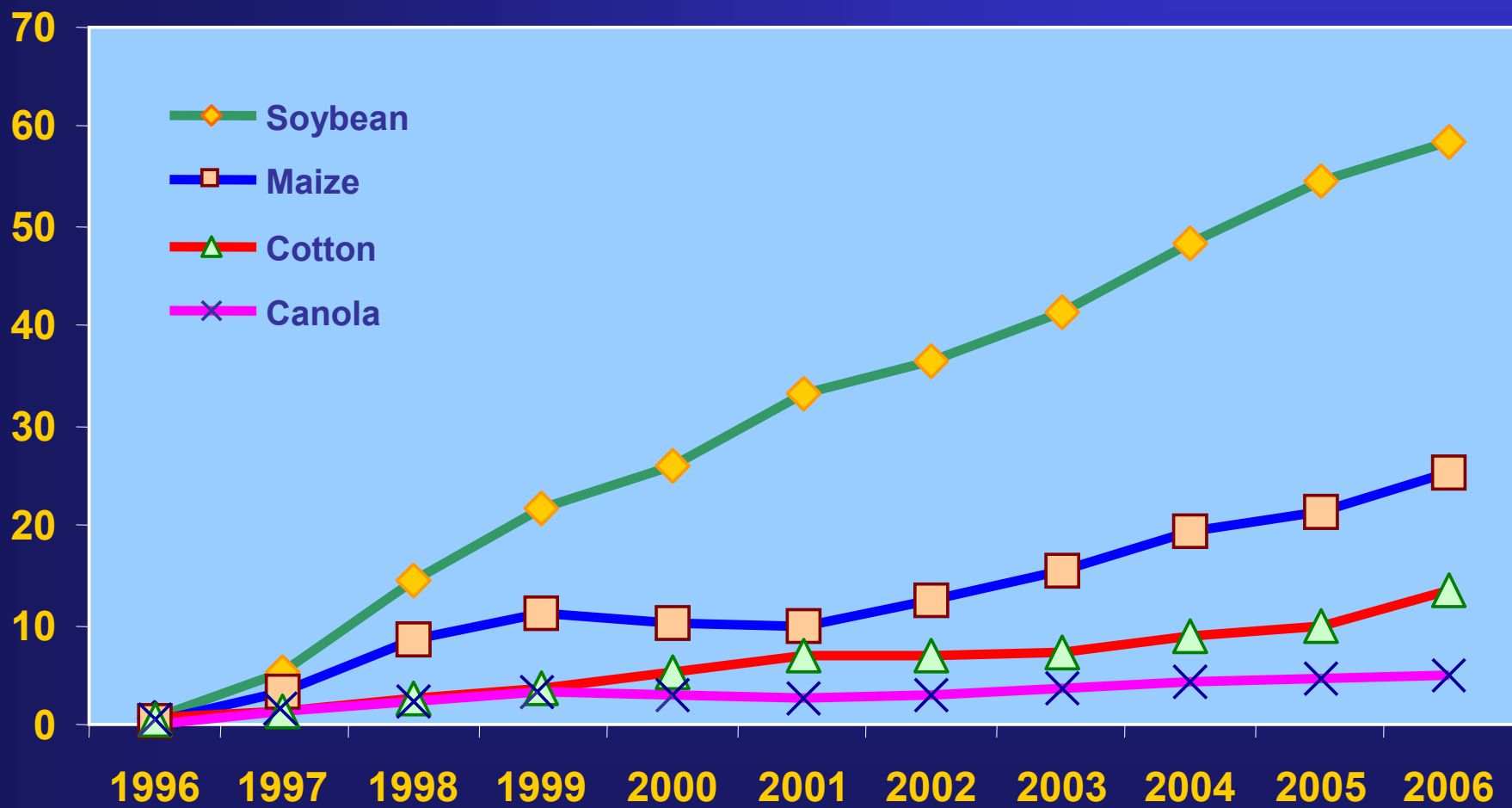
Increase of 13%, 12 million hectares or 30 million acres between 2005 and 2006.

Global Area of Biotech Crops, 1996 to 2006: Industrial and Developing Countries (Million Hectares)



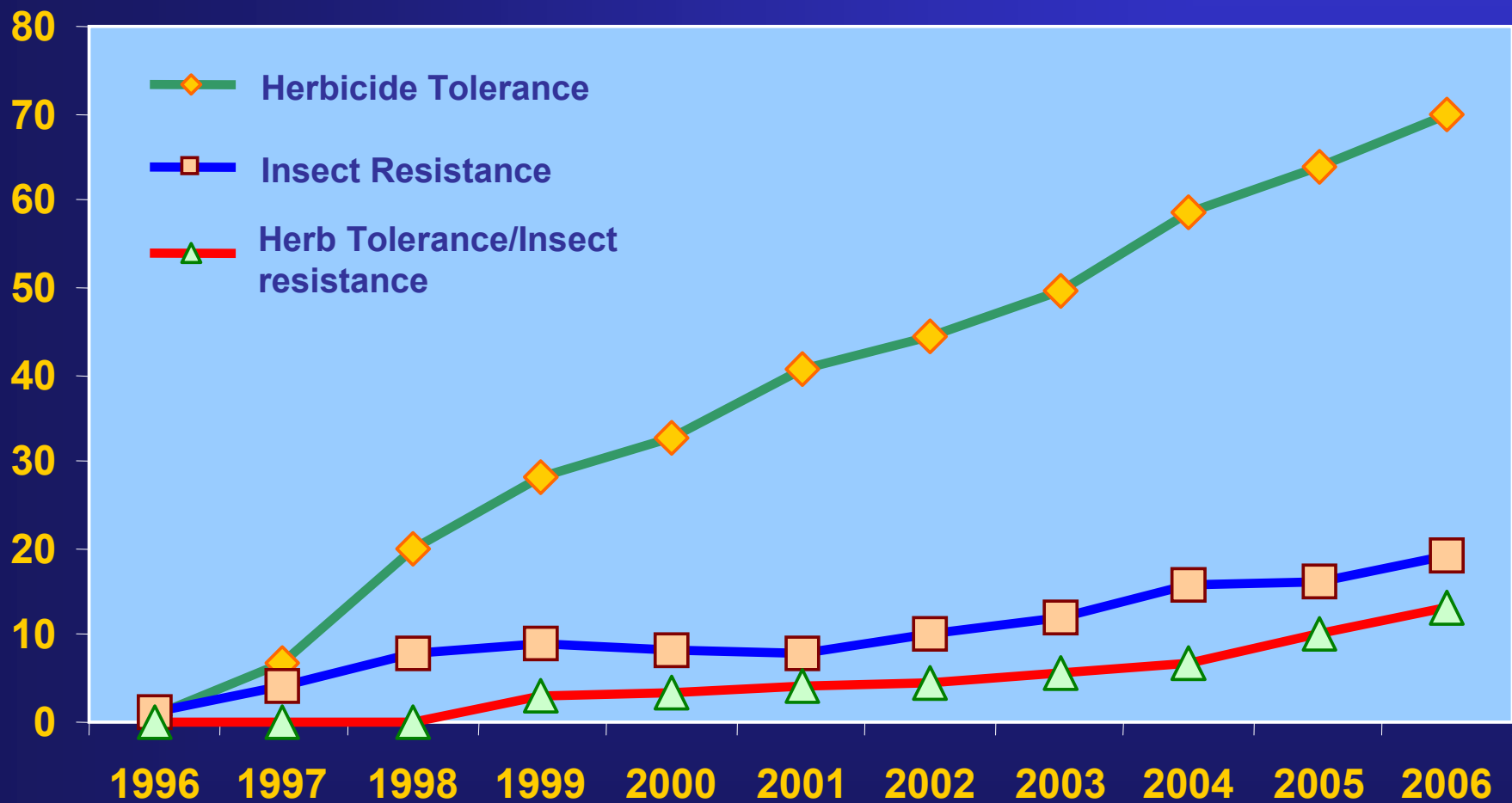
Source: C.James, ISAAA. 2006

Global Area of Biotech Crops, 1996 to 2006: By Crop (Million Hectares)



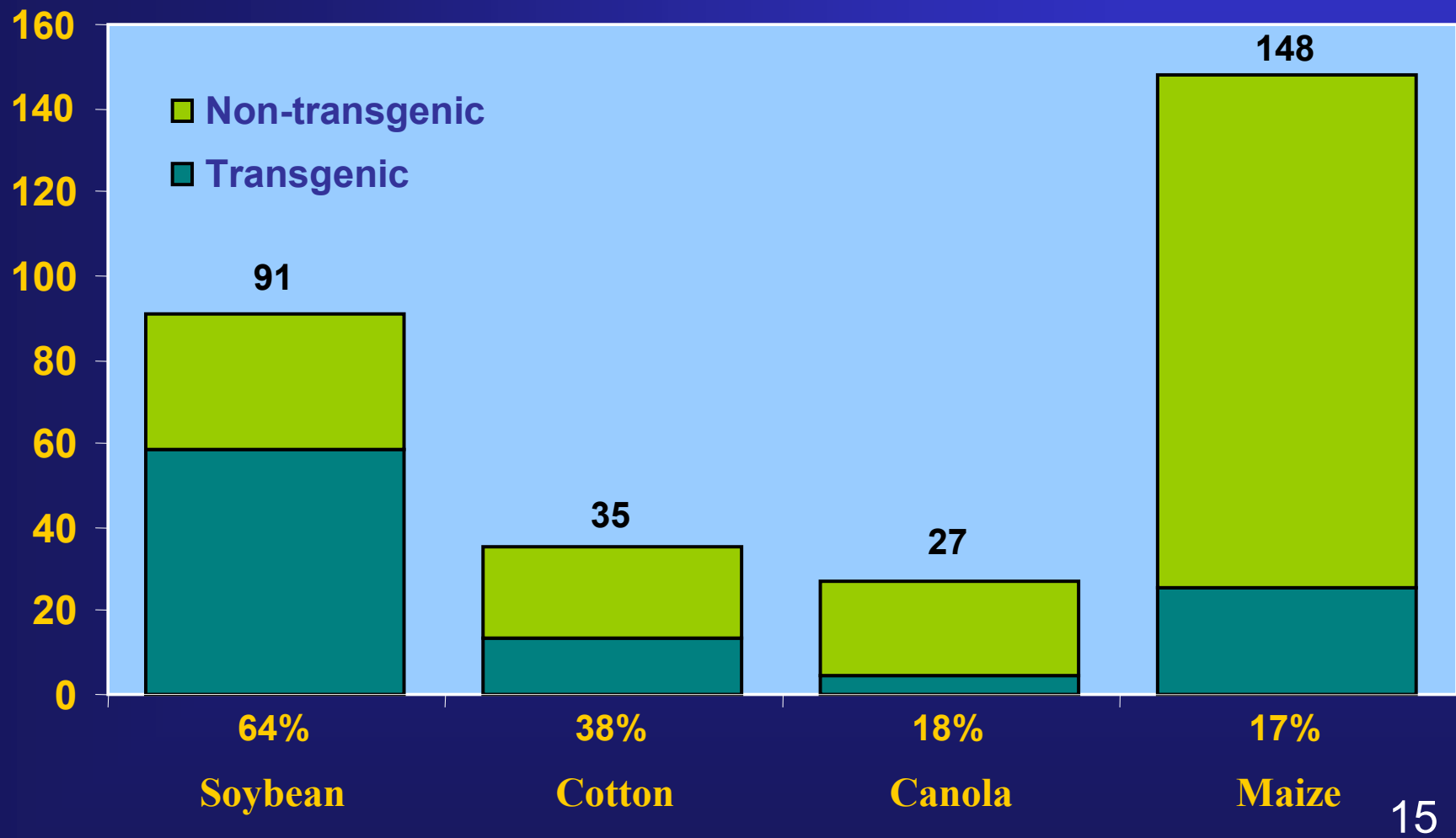
Source: C.James, ISAAA. 2006

Global Area of Biotech Crops, 1996 to 2006: By Trait (Million Hectares)



Source: C.James, ISAAA. 2006

Global Adoption Rates (%) for Principal Biotech Crops (Million Hectares)



Source: C.James, ISAAA. 2006

2006 Highlights --- A Milestone Year

- **102 million hectares in 22 countries**, up from 90 million hectares in 21 countries in 2005
- **> 500 million hectares planted globally since 1996**
- **More than 10 million biotech farmers** – 10.3 million- up from 8.5 million in 2005- 90% or 9.3 million are resource poor farmers in developing countries
- **Of 6.5 billion global population more than 50%, 3.6 billion, live in the 22 biotech countries in 2006**

Source: Clive James 2007

2006 – Major Growth on all Continents

- **In North America, US growth soars by 4.8 million ha – largest absolute growth for any country in 2006**
- **In South America, Brazil- biotech soybean & cotton (new in 2006) grows by 22% to 11.5 million hectares**
- **In Asia, India triples area of Bt cotton to 3.8 million ha compared with China at 3.5 million ha**
- **South Africa triples biotech crop area to 1.4 million ha, with major increase in maize for food and feed**

Source: Clive James 2007

Code of Conduct on Biotechnology for Food and Agriculture

- **Bio-Safety:** Environmental and Health Risk Assessment of GMOs as Prescribed under the Cartagena Protocol on Bio-Safety.
- **IPR Regime:** Legal Framework for Intellectual Property Rights, Plant Breeders Rights to Biotechnology Products and Processes.
- **Public Awareness:** Relating to Bio-Safety Issues, Environment and Health Risks, Management Practices and Protocols for Production and Marketing of GMO Crops.
- **Capacity Building:** Of Public Sector Institutions to Develop Appropriate Biotechnologies for Small Farmers and General Public.

Thank You

Gene Revolution: Research Paradigm

- Increasing crop / livestock productivity, profitability and environmental sustainability through application of biotechnology.
- Conserving biodiversity, as a resource saving technology capable of higher productivity on the current arable land, and thereby precluding deforestation and protecting biodiversity in forests and in other *in-situ* biodiversity sanctuaries.
- More efficient use of external inputs, thereby contributing to a safer environment and more sustainable agriculture system.
- Increasing stability of yield and production against biotic and abiotic stresses particularly drought and salinity.

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- **Improvement of economic, health and social benefits, food, feed, and fiber security and the alleviation of abject poverty, hunger and malnutrition for the rural population dependent on agriculture.**
- **Production of renewable resource-based biofuels to reduce dependency on fossil fuels, and contribute to a cleaner and safer environment with lower levels of greenhouse gases.**
- **Provide significant and important multiple and mutual benefits to producers, consumers and global society.**