World Agricultural Biotechnology: Transgenic Crops, a new study from The Freedonia Group, provides you with an in-depth analysis of the major trends in the world market for agricultural biotechnology -- critical information to help you with strategic planning.

This brochure gives you an indication of the scope, depth and value of Freedonia’s new study, World Agricultural Biotechnology: Transgenic Crops. Ordering information is included on the back page of the brochure.

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Study Highlights

- World demand for transgenic seeds is projected to advance 12 percent annually through $3.8 billion in 2006.

- Cultivation of transgenic crops will continue to be dominated by the United States, with Argentina, Canada and China generating the largest demand among other countries.

- The most significant new product introduction will be nutritionally enhanced GM rice. Plantings in China, India and other Asia/Pacific countries will account for most growth as GM rice assumes a major role in alleviating food shortages in that region.

- In overall seed sales, soybeans are expected to remain the largest transgenic crop through 2011, largely due to its increasing popularity with US, Brazilian and Argentine farmers and widespread food and non-food uses.

- Major players Aventis CropScience (in the process of being acquired by Bayer -- Germany), Delta and Pine Land, DuPont, Monsanto and Syngenta have all actively engaged in merger, acquisition and/or spin-off activities during 1998-2001.
Global Sales of Transgenic Seed
(million US dollars)

<table>
<thead>
<tr>
<th>Item</th>
<th>1996</th>
<th>2001</th>
<th>2006</th>
<th>2011</th>
<th>01/96</th>
<th>06/01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Domestic Product (bil US$)</td>
<td>36630</td>
<td>43420</td>
<td>52250</td>
<td>63810</td>
<td>3.5</td>
<td>3.8</td>
</tr>
<tr>
<td>$ transgenic seed/mil $ GDP</td>
<td>2.5</td>
<td>51.3</td>
<td>73.6</td>
<td>142.9</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Transgenic Acres (million)</td>
<td>4.5</td>
<td>13.0</td>
<td>18.4</td>
<td>40.0</td>
<td>96.0</td>
<td>7.2</td>
</tr>
<tr>
<td>$/acre</td>
<td>20.4</td>
<td>17.1</td>
<td>20.9</td>
<td>22.8</td>
<td>-3.5</td>
<td>4.1</td>
</tr>
<tr>
<td>Transgenic Seed Sales (mil US$)</td>
<td>92</td>
<td>2228</td>
<td>3845</td>
<td>9120</td>
<td>89.2</td>
<td>11.5</td>
</tr>
<tr>
<td>Soybeans</td>
<td>11</td>
<td>1090</td>
<td>1550</td>
<td>2650</td>
<td>150.7</td>
<td>7.3</td>
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<tr>
<td>Corn</td>
<td>15</td>
<td>544</td>
<td>765</td>
<td>1660</td>
<td>105.1</td>
<td>7.1</td>
</tr>
<tr>
<td>Cotton</td>
<td>35</td>
<td>480</td>
<td>1110</td>
<td>1930</td>
<td>68.8</td>
<td>18.3</td>
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<tr>
<td>Other</td>
<td>31</td>
<td>114</td>
<td>420</td>
<td>2880</td>
<td>29.8</td>
<td>29.8</td>
</tr>
</tbody>
</table>

Sample Table

% Annual Growth

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Tables and Charts are featured for each region and country. Historical data and forecasts are presented for 1996, 2001, 2006 and 2011.

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MARKET ENVIRONMENT

Crop Planting Trends

Global crop planting trends shape potential demand for transgenic seeds. More than two-thirds of the world’s major crop acreage is devoted to feed and cereal grains (e.g., wheat, corn) and oilseeds of these crops is expected to persist, given their broad utility in production of foodstuffs and animal feed. In most countries, cereal grains are a dietary staple. Therefore, world population growth will increase utilization and consumption. However, fluctuations in crop planting acreages often occur as a result of anticipated changes in climate, trade issues, and global grain and livestock prices.

Soybeans will continue to be the leading worldwide oilseed crop planted. This trend will reflect advantages related to nutritional value and versatility. While most soybeans are used for production of cooking oils and livestock feed, new emerging applications are increasing the level of plantings. Among these new applications are soy ink (currently being used in a significant percentage of newspapers in the US and other countries), soy-blended biodiesel fuel, and recyclable soy-based containers and building products. Soybeans are also building demand in both health and processed foods, which incorporate large quantities of soy protein. The US is the leading grower and producer of soybeans.

Increasing applications are also leading to above average worldwide growth in canola plantings. Canola is a genetic variant of rapeseed (oilseed rape), the seeds of which contain 40 percent oil. Canola oil is employed in applications such as cosmetics and printing inks, while canola meal is used as a feed for livestock and as a fertilizer. Canola oil is considered to be healthy because of its low levels of saturated fatty acids and high levels of essential fatty acids, such as oleic acid, which lowers plasma cholesterol levels. Canola also contains linoleic and linolenic acids, which convert to hormone-like substances (eicosanoids). Eicosanoids have...
These Sections highlight the key issues that have affected the global transgenic crop market and summarize contributing growth factors.

This information helps you:

- Focus your sales and marketing efforts on high growth areas.
- Propose new areas for development.

### Stacked Traits

Global sales of stacked (i.e., multiple trait) GM seeds are forecast to advance at an annual rate of nearly 30 percent, reaching $670 million in 2006. This rapid growth will reflect favorable agronomic benefits versus single trait products. As a result, stacked seeds will attract the strong interest of farmers in GM crop-growing countries, especially in the United States.

The fastest sales gains for stacked seeds will exist in insect-protected-herbicide-tolerant corn and cotton. In the intermediate term, new GM products containing stacked input traits -- including canola and soybeans -- will siphon off market share from single-trait seeds. Output traits, such as high oil content, will also begin to make an impact in the marketplace before the end of the decade. Another potential benefit of stacked seeds involves the combating of pest resistance. For example, the inclusion of two or more toxins in one seed reduces the possibility that an insect or weed will become resistant due to exposure to more than one destruction trait.

Despite the auspicious outlook for stacked GM seeds, two factors will limit overall market growth. Very limited demand will evolve outside of the US and Canada. Economic problems and softening export opportunities will hold down sales in Argentina. Second, the insertion of multiple traits into crops poses technical obstacles which will lengthen the commercialization timetable for more advanced traits.

Since the early 1990s, most of the major ag biotech/seed companies have succeeded in bringing stacked seed to market. Aventis offers glufosinate-tolerant and insect-resistant (Bt) corn and has also introduced glufosinate-tolerant canola and corn featuring male sterility or fertility-restoration genes. Monsanto and/or its subsidiaries sell bromoxynil-tolerant and Bt cotton, glufosinate-tolerant and Bt corn, glyphosate-tolerant and Bt cotton, and glyphosate-tolerant and Bt corn. Syngenta markets Bt and glufosinate-tolerant corn and sweet corn.

### World Transgenic Seed Sales by Country

(million U.S. dollars)

<table>
<thead>
<tr>
<th>Item</th>
<th>1996</th>
<th>2001</th>
<th>2006</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transgenic Cotton Acres (million)</td>
<td>1.8</td>
<td>16.8</td>
<td>35.0</td>
<td>56.0</td>
</tr>
<tr>
<td>$ seeds/acre</td>
<td>19.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transgenic Cotton Seed Sales</td>
<td>35</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td></td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Argentina</td>
<td>neg</td>
<td>neg</td>
<td>neg</td>
<td>neg</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% cotton</td>
<td>38.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total World Transgenic Seed Sales</td>
<td>92</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
These Sections analyze demand trends and consider the threats and opportunities in ten countries.

ARGENTINA

Transgenic Acreage

Acres planted with transgenic seed in Argentina are expected to reach 28 million in 2006, reflecting an average annual gain of four percent. Argentine farmers have readily accepted agricultural biotechnology. Soybeans, accounts for significant plantings and the adaptation of transgenic technology to additional applications is expected to remain limited due to pressures from major export markets (i.e., Brazil, China and the European Union) for conventional crops.

Soybeans will remain the dominant GM crop in Argentina, accounting for nearly 90 percent of transgenic acres through 2006. Cotton and corn for non-food uses will account for the largest plantings among other agricultural biotechnology products. Argentina will account for a decreasing percentage of transgenic crop acreage over the next decade. In the short term, economic problems will preclude the agricultural sector from adapting biotechnology to new products. In the long term, exports markets will likely prompt farmers to focus increased attention on conventional crops. However, due to the impact of GM soybeans, the percentage of total Argentine crop acres planted with transgenic seed will rise steadily.

Canada - Transgenic Seed Sales
(million US dollars)

<table>
<thead>
<tr>
<th>Item</th>
<th>1996</th>
<th>2001</th>
<th>2006</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Canadian Seed Sales</td>
<td>455</td>
<td>567</td>
<td>680</td>
<td>800</td>
</tr>
<tr>
<td>% transgenic</td>
<td>1.1</td>
<td>23.8</td>
<td>35.3</td>
<td>70.0</td>
</tr>
<tr>
<td>Transgenic Seed Sales</td>
<td>5</td>
<td>135</td>
<td>240</td>
<td>560</td>
</tr>
<tr>
<td>Canola</td>
<td>5</td>
<td>99</td>
<td>175</td>
<td>325</td>
</tr>
<tr>
<td>Corn</td>
<td>neg</td>
<td>22</td>
<td>28</td>
<td>38</td>
</tr>
<tr>
<td>Soybeans</td>
<td>neg</td>
<td>13</td>
<td>22</td>
<td>40</td>
</tr>
<tr>
<td>Wheat</td>
<td>--</td>
<td>--</td>
<td>4</td>
<td>55</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>11</td>
<td>102</td>
<td></td>
</tr>
<tr>
<td>% Canada</td>
<td>5.4</td>
<td>6.1</td>
<td>6.2</td>
<td>6.1</td>
</tr>
<tr>
<td>Total World Transgenic Seed Sales</td>
<td>92</td>
<td>2228</td>
<td>3845</td>
<td>9120</td>
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</table>

Canada - Transgenic Canola Acreage & Seed Sales

<table>
<thead>
<tr>
<th>Item</th>
<th>1996</th>
<th>2001</th>
<th>2006</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Canola Acreage (million)</td>
<td>8.5</td>
<td>11.9</td>
<td>13.7</td>
<td>17.0</td>
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<tr>
<td>% transgenic</td>
<td>4.7</td>
<td>50.4</td>
<td>70.1</td>
<td>88.2</td>
</tr>
<tr>
<td>Transgenic Canola Acreage (million)</td>
<td>0.4</td>
<td>6.0</td>
<td>9.6</td>
<td>15.0</td>
</tr>
<tr>
<td>US$/acre</td>
<td>12.5</td>
<td>16.5</td>
<td>18.2</td>
<td>21.7</td>
</tr>
<tr>
<td>Transgenic Canola Seed Sales (mil US$)</td>
<td>5</td>
<td>99</td>
<td>175</td>
<td>325</td>
</tr>
<tr>
<td>% Canada</td>
<td>100.0</td>
<td>93.4</td>
<td>67.3</td>
<td>54.2</td>
</tr>
<tr>
<td>World Transgenic Canola Seeds (mil US$)</td>
<td>5</td>
<td>106</td>
<td>260</td>
<td>600</td>
</tr>
</tbody>
</table>

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**Industry Structure**

Gain a better global understanding of your competition and analyze your company’s position in the industry with information about:

- market share
- competitive strategies
- manufacturing requirements
- licensing & related agreements
- marketing & distribution
- mergers & acquisitions

**INDUSTRY STRUCTURE**

**Competitive Strategies**

Early competitive strategies in the agricultural biotechnology industry typically involved heavy investment in research and development to create proprietary products with significant intrinsic and extrinsic advantages over conventional offerings. These strategies resulted in the commercialization of transgenic crop and plant seeds with a number of desirable properties, such as herbicide tolerance, insect protection, and increased yield. The potential of biotechnology to improve the quality and cost-effectiveness of agricultural commodities has been well established. However, regulatory obstacles and widespread marketplace resistance have limited global transgenic seed demand to only a few products, with major end users existing in only a few countries.

The inability to commercialize large-selling product lines and penetrate lucrative new markets is prompting agricultural biotechnology companies to adopt more conservative, narrowly focused competitive strategies. The most common strategies are built around partnerships which pursue the development of less controversial products and technologies. Dow AgroSciences, for example, participates in several ventures and alliances which seek to apply genetically modified traits to plant-based medicines and non-edible crops (such as cotton).

The development and licensing of proprietary technologies remain a leading revenue-generating strategy followed by most agricultural biotechnology companies. Monsanto, for instance, continues to derive considerable funds from licensing the use of proprietary traits to crop and plant seed producers. In addition, many small companies, such as Exelixis, continue to generate financing by marketing unique patented technologies to larger industry participants.

Another increasingly popular strategy in the agricultural biotechnology industry revolves around the production and sale of conventional crop and plant seeds to...
Company Profiles

The Profiles Section analyzes 21 companies active in the world transgenic crops industry. These profiles represent a sampling or cross-section of the types of companies involved in the industry.

Divisions, subsidiaries, joint ventures, etc., are discussed under appropriate parent companies.

Sources for profiles included:

- Information provided by key staff members in the respective companies
- Annual reports
- 10-K reports
- Security analysts reports
- Corporate product literature

COMPANY PROFILES

Dow Chemical Company
2030 Dow Center
Midland, MI 48674
517-636-1000
http://www.dow.com

Dow AgroSciences LLC
9330 Zionsville Road
Indianapolis, IN 46268
317-337-3000
http://www.dowagro.com

Sales: $27.8 billion (2001)
Geographic Sales: (2001, as percent of total) US 42%, Europe 32%, Other Countries 26%
Key Products: seed traits, crop seed products and biopesticides

Dow Chemical is a diversified worldwide producer and supplier of chemicals, plastics and agricultural products which operates in seven segments: Performance Plastics; Performance Chemicals; Agricultural Products; Plastics; Chemicals; Hydrocarbons and Energy; and Unallocated and Other. In February 2001, Dow acquired Union Carbide Corporation (Danbury, Connecticut), a chemicals and polymers company.

Dow is active in the world agricultural biotechnology industry through the Agricultural Products segment, which consists of the Dow AgroSciences LLC and Mycogen Corporation subsidiaries. Dow AgroSciences develops and produces seed traits and crop seed products using transgenic methods as part of its Plant Genetics

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Companies Profiled

AstraZeneca plc
Advanta BV
Aventis SA
Agrinomics LLC
RhoBio
Solavista GmbH
BASF AG
American Cyanamid Co.
Cyanamid Agricultural Products Group
ExSeed Genetics LLC
Cargill Inc.
Renessen LLC
Cosun BV
Advanta BV
AgriPro Seeds Inc.
Garst Seed Co.
Pacific Seeds
CropTech Corp.
Delta and Pine Land Co.
Anhui An Dai Cotton Seed Technology
CDM Mandiyu Srl
D&M International LLC
Hebei Ji Dai Cottonseed Technology Co.
Dow Chemical Co.
Advanced AgriTraits LLC
Cargill Hybrid Seeds
Mycogen Corp.
PhytoGen Seed Co.
DuPont (EI) de Nemours
Pioneer Hi-Bred International
Qualicon Inc.
Emergent Genetics Inc.
Acala Cotton Seeds
Daehnfeldt A/S
Helena Cotton Research
Produsem SA
Stoneville Pedigreed Seed
Exelixis Inc.
Agrinomics LLC
Agritope Inc.
GenOptera LLC
Groupe Limagrain
AgReliant Genetics LLC
Bio Seeds BV
Biogemma
GEMSTAR
RhoBio
Soygenetics
Vilmorin Clause & Cie

Land O'Lakes Inc.
Agriliance LLC
CROPLAN GENETICS
FFR Cooperative
Soygenetics
Wilson Genetics LLC
Millennium Pharmaceuticals Inc.
Cereon Genomics LLC
NovaFlora Inc.
Novartis International AG
Nufarm Ltd.
Florigene Ltd.
Pharmacia Corp.
Anhui An Dai Cotton Seed Technology
Asgrow Seed Co. LLC
CDM Mandiyu Srl
Cereon Genomics LLC
D&M International LLC
DEKALB Genetics
Hebei Ji Dai Cottonseed Technology Co.
Limagrain Canada Seeds Inc.
Monsanto Co.
Renessen LLC
Research Seeds Inc.
Forage Genetics International
Nitril Urbana Laboratories
Seed Research of Oregon
Urbana Laboratories
Savia SA de CV
Bionova Holding Corp.
DNA Plant Technology Corp.
Semini Inc.
VPP Corp.
Syngenta AG
Societe Etablissement CC Benoist
Wilson Genetics LLC

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Freedonia does not just collect and reprint data; Freedonia develops data. Our analysts thoroughly investigate an industry by extensively interviewing key industry participants and analyzing information from sources such as associations, government and trade literature. Once this research is complete, Freedonia establishes one set of forecasts. All writing, editing and forecasting is done in-house to assure quality and consistency. In cases where data does not exist, Freedonia develops the data based on input/output ratios, bills of materials and flow charts. The following chart summarizes Freedonia’s methodology.
About The Freedonia Group

Advantages of Freedonia Reports

The Freedonia Group, Inc. is a leading international industry study/database company.

Since 1985, Freedonia has published 1,800 titles covering areas such as plastics, chemicals, coatings and adhesives, building materials, industrial components and equipment, health care, packaging, household goods, security, and many other industries.

Freedonia has produced a wide variety of titles, including:

- *Biotechnology in Agriculture*
- *Plant-Derived Chemicals*
- *Pesticides*
- *Industrial Starch & Other Corn Chemicals*

Because Freedonia is a reliable information source, our forecasts are cited in numerous publications such as *The Wall Street Journal, Chemical Week, Chemical Market Reporter* and *European Chemical News*.

**In-house operations**
Because all of our staff work at the same location, interaction between analysts and departments provides a strong system of checks and balances.

**Consistency**
Our Economics Group develops indicators that are used by all analysts. Therefore, every Freedonia study is based on a consistent set of economic assumptions (GDP, total crop acres planted, world population, etc.).

**Reliable forecasts**
Because all of our forecasts consider the environment in which a product or industry is operating, as well as threats and opportunities to the market, Freedonia forecasts are reliable indicators of future performance.

**One-on-one interviews**
All studies are produced by conducting interviews with key industry participants and end-users.

**Proprietary electronic database**
Freedonia’s analysts can tap into an extensive in-house electronic database containing corporate literature (including private company information), trade publications, government reports and many other sources of information.
Freedonia’s clients include major US and international companies in the manufacturing, services, consulting and financial sectors.

Typical purchasers of Freedonia studies:

- Key Executives
- Corporate Planners
- Market Researchers
- Financial Analysts
- Information Centers
- New Product Developers
- Merger & Acquisition Specialists

Since 1985 we have provided research to customers ranging in size from global conglomerates to one person consulting firms. More than 90% of the industrial companies in the Fortune 500 use Freedonia research to help with their strategic planning.

Some of Freedonia’s customers in the transgenic crop industry include: Aventis, BASF, Bayer, Cargill, Dow Chemical, DuPont and Monsanto.
**Pesticides**

US demand for pesticide active ingredients will reach $10.5 billion in 2006, driven mainly by a continuing shift toward more sophisticated products. Herbicides and pesticides will remain dominant while biopesticides and fungicides grow the fastest. Reduced risk pesticides and chiral versions of extant pesticide actives hold the best prospects among conventional products. This study analyzes the US pesticides industry to 2006 and 2011 by product and market. It also evaluates market share and profiles key companies.

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**Biocides**

Regulatory compliance, safety and environmental issues will continue to favor biocides that offer broad-spectrum effectiveness with relatively low toxicity and minimal environmental impact. Growth opportunities await those products that emerge as successors to less benign biocides used in water treatment, wood preservation and other key biocides. This study examines the US specialty biocides industry to 2006 and 2011 by type, function and market. It also evaluates market share and profiles key companies.

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**Biomass Energy**

Demand for biomass energy and raw materials will grow 8.5% annually to 2005. The fastest gains will occur in the market for biomass transportation fuels, which will be spurred by cellulosic ethanol capacity coming online, production cost reductions and legislative incentives for biodiesel consumption. This study analyzes the US biomass energy industry to 2005 and 2010 by type (e.g., ethanol, biodiesel, methanol, direct power production); material and region. It also presents market share data and profiles key firms.

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**Plant-Derived Chemicals**

Demand for plant-derived chemicals in the US will grow over 7% annually. Growth will be driven by new plant-based pharmaceuticals and gains in the beverage market, where consumers are preferring higher natural flavor loadings. Botanical extracts will be the fastest growing segment, surpassing essential oils as the top product by 2010. This study analyzes the $2 billion US plant-derived chemical industry to 2005 and 2010 by product and market. It also presents market share data and profiles key companies.

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**Biotechnology in Agriculture**

US sales of agricultural biotechnology products will grow over 12% annually. Transgenic seeds and crops will continue to dominate, led by insect-protected and/or herbicide-tolerant corn and soybeans, as well as crops carrying beneficial output traits (e.g., vitamin-fortified rice, cholesterol-lowering corn). This study analyzes the $1.6 billion US market for genetically enhanced agricultural products to 2004 and 2009 by product, function and market. It also presents market share data and profiles key producers.

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**Biotechnology Pharmaceuticals**

US demand for biotech drugs will grow almost 13% annually. Gains will be driven by new products as continuing advances in biotechnology enable drug researchers to develop safe and effective medicines for conditions not adequately treated with conventional pharmaceuticals. Faster regulatory review will also benefit demand. This study analyzes the $15.7 billion US biotech drug industry to 2004 and 2009 by type, technology and application. It also presents market share data and profiles leading companies.

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**Industrial Starch & Other Corn Chemicals**

Corn-derived chemicals demand in the US will exceed $3 billion in 2004, boosted by polyactic acid as it becomes more competitive with products derived from petrochemical feedstocks. Industrial corn starch will remain the largest product, while better growth opportunities lie with organic and amino acids and polyols. This study analyzes the $2.5 billion US starch and corn chemical industry to 2004 and 2009 by product, function and market. It also presents market share data and profiles key industry players.

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