Biotechnology Adoption, Industrial Structure, and Its Effect on Small Market Crops

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RECOMBINANT TECHNOLOGY

Recombinant technology (genetic engineering) allows transferring genes from one species to another and makes it possible for scientists to identify specific genes associated with desirable traits in one organism and transfer those genes across specie boundaries into another organism.

The technological procedure accelerated developments of new transgenic products in many fields, including the pharmaceutical (e.g., monoclonal antibodies and vaccines) and manufacturing (e.g., plastics and biofuels) sectors.

Application of this technology in the agricultural sector has provided a number of benefits such as:

- Developing plants that are resistant to disease and pests
- Increasing shelf life of fruits and vegetables
- Producing plants that possess increased nutritive values
- Increasing productivity.

Despite all these advantages and potential to solve many of the most striking problems in the world, the technology has become one of the most critically challenged technologies in the history of agriculture.

This study focuses on the current status of agricultural biotechnology in the world and the role biotechnology plays in the agricultural industry in the United States.

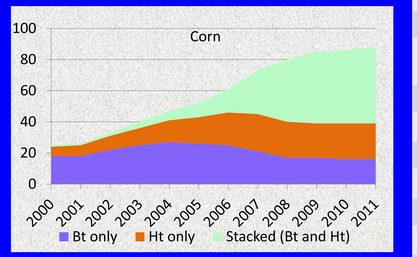
Adoption of Major Biotech Crops in the United States (Percentages of Acres).

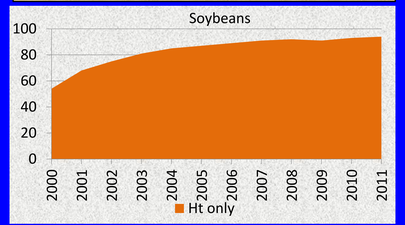
Corn, cotton and soybeans are the three most successfully adopted biotech crops in the United States.

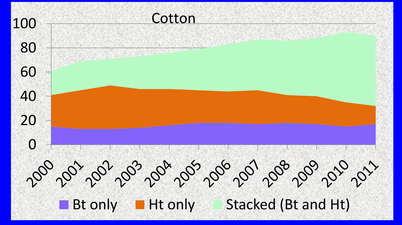
Figures show percentage of acres adopted by various traits such as insect resistant (Bt), herbicide tolerant (Ht) and stacked (Bt and Ht) for three crops, corn, cotton and soybeans.

Both corn and cotton have all three trait types available, but soybean seeds are available only as herbicide tolerant.

The fourth largest biotech crop grown in the US is Canola (only the Ht variety). About 1.5 million acres of canola is grown in the United States and 90 percent of this is biotech.







Global Area of Biotech Crops in 2010 (million hectares)

Rank	Country	Area (million hectares)	Biotech Crops
1	USA	66.8	Maize, soybean, cotton, canola, sugar beet, papaya, squash
2	Brazil	25.4	Soybean, cotton, maize
3	Argentina	22.9	Soybean, cotton, maize
4	India	9.4	Cotton
5	Canada	8.8	Canola, maize, soybean, sugarbeet
6	China	3.5	Cotton, papaya, poplar, tomato, sweet pepper
7	Paraguay	2.6	Soybean
8	Pakistan	2.4	Cotton
9	South Africa	2.2	Maize, soybean, cotton
10	Uruguay	1.1	Soybean, maize
11	Bolivia	0.9	Soybean
12	Australia	0.7	Cotton, canola
13	Philippines	0.5	Maize
14	Myanmar	0.3	Cotton
15	Burkina Faso	0.3	Cotton
16	Spain	0.1	Maize
17	Mexico	0.1	Cotton, soybean
18	Colombia	<0.1	Cotton
19	Chile	<0.1	Maize, soybean, canola
20	Honduras	<0.1	Maize
21	Portugal	<0.1	Maize
22	Czech Rep.	<0.1	Maize, potato
23	Poland	<0.1	Maize
24	Egypt	<0.1	Maize
25	Slovakia	<0.1	Maize
26	Costa Rica	<0.1	Cotton, soybean
27	Romania	<0.1	Maize
28	Sweden	<0.1	Potato
29	Germany	<0.1	Potato

BIOTECH INDUSTRY

Biotech firms have higher research and development costs and very little revenue during the development process.

Many small biotechnological firms must partner with larger firms in order to survive.

The larger firms have great power to influence the research decisions by small, independent biotech firms.

Consequently, only a few firms decide what to produce and who will be the beneficiaries of these new products.

As of now, the industry (large firms) has found that commodity and fiber crops are best suited for biotech innovations, and small market crops, such as vegetables, are the least suitable products.

MAJOR REASONS WHY COMMODITY CROPS ARE SUCCESSFUL

Commodity crop traits are specifically developed to target a large number of farmers.

Biotech firms develop varieties that are grown on large areas with low market barriers. Feed and fiber crops seem to be well suited for this venture.

GM field crops do not pose any significant food safety threat since the end use of these crops are for animal feed or industrial use.

MAJOR REASONS WHY SMALL MARKET CROPS ARE NOT SUCCESSFUL

Development and regulatory costs are the same whether the product is a commodity crop or a SMC. Thus the major deciding factor is which product can potentially produce larger revenue among alternative products.

Risks are higher on SMC because end users of the products can easily be influenced by a number of controversial issues.

Trade barriers related to GM products play an important role in their development for SMCs.

The biotech developer needs to be able to produce and sell its product (seeds) exclusively to recover development costs. Many SMC propagate by other methods such as cutting or grafting.

Geographic limitations

Deregulated Crops in the United States by APHIS Since 1992

Time Period	Company	Varieties that Deregulated	Successfully Deregulated Articles
2005-2010	Syngenta	Corn, Cotton	3
1998-2010	Pioneer	Corn, Soybean	5
2006-2009	Bayer	Cotton, rice	2
2009	University of Florida	Papaya	1
1994-2008	Monsanto	Soybean, Corn, Cotton, Potato, Rapeseed, Tomato, Alfalfa	24
2007	ARS	Plum	1
2004-2005	Dow	Corn	1
2004	Mycogen/DOW	Cotton	2
1998-2003	Aventis	Cotton, Rapeseed	3
2002	Vector	Tobacco	1
2001	Mycogen/DOW/Pioneer	Corn	1
1999	Univ. of Saskatchewan	Flax	1
1992-1997	Calgene	Cotton, Rapeseed, Tomato	9
1998	Novaritis/Monsanto	Beet	1
1995-1998	AgrEvo	Corn, Beet, Rapeseed, Rice, Soybean	10
1996-1997	Dekalb	Corn	1
1996-1997	Dupont	Cotton, Soybean	2
1996	Agritope	Tomato	1
1996	Cornell University	Papaya	1
1996	Northrup King	Corn	1
1996	Asgrow	Squash	1
1996	Plant Genetic System	Corn	1
1995	Cibaseeds	Cotton	1
1995	Zeneca & Petoseed	Tomato	1
1994	DNA Plant Tech	Tomato	1
1994	Upjohn	Squash	1

Only four biotech companies (Bayer, Monsanto, Pioneer and Syngenta) have successfully developed and deregulated products in the last five years (though a university and USDA also have crops deregulated). One of the major reasons is that the larger companies have already acquired or merged with other companies. For example, Monsanto acquired DeKalb (1998), Asgrow (1996), Calgene (1997) to name a few.

This slowdown might indicate that the regulatory agencies wanted to slow down the development of biotech products and allow market conditions to adjust to the new environment. Whatever the reason, these delays forced biotech firms to incur additional costs (increased opportunity costs) and change their strategies in order to survive.

The USA is the leading country in the transgenic crop research, development and adoption.

Since 1985, US regulatory agencies have received 33,926 applications for permits and notifications.

Interest in biotechnological research and development is still high in the US despite strong opposition to the technology in major food importing countries. International opposition, though, has had an impact on the US biotechnology, research and development.

The enthusiasm for biotechnology research began to wither in the late 1990s but it bounced back and applications reached an historic high (2,576) in 2007.

The current trend shows that agricultural biotechnology is one of the most expedient productivity-increasing technologies, and the high interest in R&D indicates that the technology can develop varieties that have the potential to mitigate a number of striking problems in the world (such as drought resistance and salt tolerance).

ADOPTION OF TRANSGENIC CROPS IN THE WORLD

Adoption of transgenic crops is continually increasing, every year more and more countries accept GM as a way for the future.

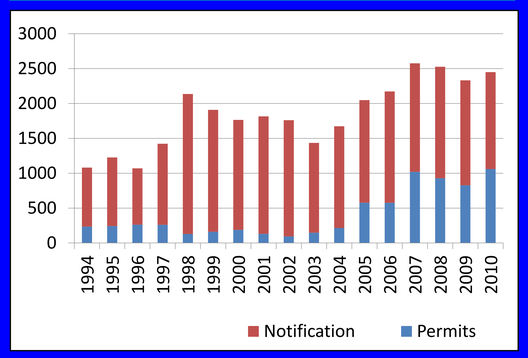
Currently 59 countries have granted approvals for biotech crops since the first biotech crop was commercially available in 1996.

Currently, 29 countries grow the crops and an additional 30 countries have regulatory approvals for importation for food and feed use.

The use of GM crops has spread rapidly and about 15.4 million farmers have adopted this technology worldwide.

The area grown for these crops is continually rising and it reached 148 million hectares in 2010, an increase of 10 percent compared to the previous year

The Number of Application Received by USDA for Seeking Permits and Notifications to Conduct Biotechnology Research During the Period of 1994 to 2010



Deregulated Crops in the U.S. as of June 2011

Crops	2000 and Before	After 2000
Alfalfa	0	1
Beet	2	0
Chicory	1	0
Corn	15	11
Cotton	6	6
Flax	1	0
Papaya	1	1
Plum	0	1
Potato	5	0
Rapeseed	4	3
Rice	1	1
Soybean	5	3
Squash	2	0
Tobacco	0	1
Tomato	11	0
Total	54	28

RECOMMENDATIONS TO ENCOURAGE SMALL MARKET CROPS

Creation of a public research crop trait program that get approvals for small market crops.

Working on freedom-to-operate (issues such as the public intellectual property)

Continue to advance science-based understanding to gain global acceptance.

Develop regulations that promote public confidence and good science.

Capacity building in developing countries.

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