PREVIEW

Global Review of Commercialized Transgenic Crops: 2000

by

Clive James
Chair, ISAAA Board of Directors

Global Area of Transgenic Crops, 1996 to 2000
(millions of hectares/acres)

	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**

Increase of 11%, 4.3 million hectares or 10.6 million acres, between 1999 and 2000

Source: Clive James, 2000

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Introduction

Global population exceeded 6 billion in 2000 and is expected to reach approximately 9 billion by 2050, when approximately 90% of the global population will reside in Asia, Africa, and Latin America. Today, 840 million people in the developing countries suffer from malnutrition and 1.3 billion are afflicted by poverty. Transgenic crops, often referred to as genetically modified crops (GM), represent promising technologies that can make a vital contribution to global food, feed, and fiber security. During the last five years, 1996 to 2000, global adoption rates for transgenic crops were unprecedented and reflect grower satisfaction with the products that offer significant benefits ranging from more convenient and flexible crop management, higher productivity or net returns/hectare, and a safer environment through decreased use of conventional pesticides, which collectively contribute to a more sustainable agriculture.

Global reviews of transgenic crops have been published by the author as ISAAA *Briefs* annually since 1996. This publication, a Preview of the 2000 Annual Review to be published later, provides the latest information on the global status of commercialized transgenic crops. A detailed global data set on the adoption of commercialized transgenic crops is presented for the year 2000 and the changes that have occurred between 1999 and 2000 are highlighted. The global adoption trends during the last five years from 1996 to 2000 are also illustrated. Given the intensity of the debate on transgenic crops in 1999, particularly the issues in relation to public acceptance, one of the key questions posed at the beginning of 2000 was whether the global area of transgenic crops would continue to increase in 2000; not surprisingly, there was much speculation.

Note that the words maize and corn, as well as rapeseed and canola are used as synonyms in the text, reflecting the usage of these words in different regions of the world. Global figures and hectares planted commercially with transgenic crops have

been rounded off to the nearest 100,000 hectares and in some cases this leads to insignificant approximations, and there maybe slight variances in some figures, totals, and percentage estimates. It is also important to note that countries in the Southern Hemisphere plant their crops in the last quarter of the calendar year; the transgenic crop areas reported in this publication are planted, not harvested, hectarage in the year stated. Thus, the 2000 information for Argentina, Australia, South Africa, and Uruguay is hectares planted in the last quarter of 2000 and which will be harvested in the first quarter of 2001.

Global Area of Transgenic Crops in 2000

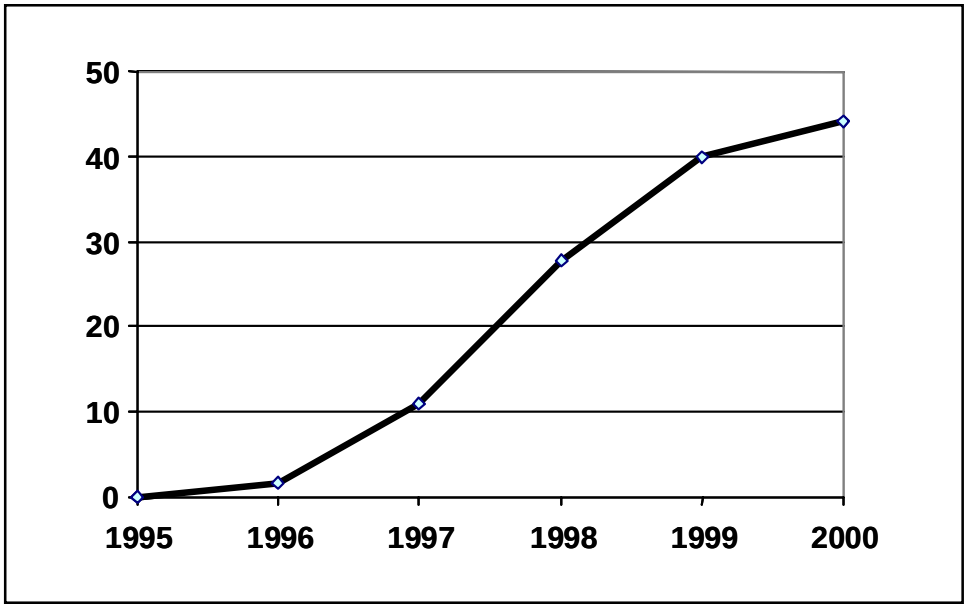
The estimated global area of transgenic crops for 2000 is 44.2 million hectares or 109.2 million acres (Table 1). It is noteworthy that 2000 is the first year when the global area of transgenic crops has exceeded 100 million acres and almost reached 45 million hectares. To put this global area of transgenic crops into context, 44.2 million hectares is equivalent to almost twice the area of the United Kingdom. The increase in area of transgenic crops between 1999 and 2000 is 11%, equivalent to 4.3 million hectares or 10.6 million acres. This increase of 4.3 million hectares between 1999 and 2000 is about one quarter of the corresponding increase of 12.1 million hectares between 1998 and 1999.

Table 1. Global Area of Transgenic Crops, 1996 to 2000

	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

Increase of 11%, 4.3 million hectares or 10.6 million acres between 1999 and 2000.
Source: Clive James, 2000.

Figure 1. Global Area of Transgenic Crops, 1996 to 2000 (million hectares).



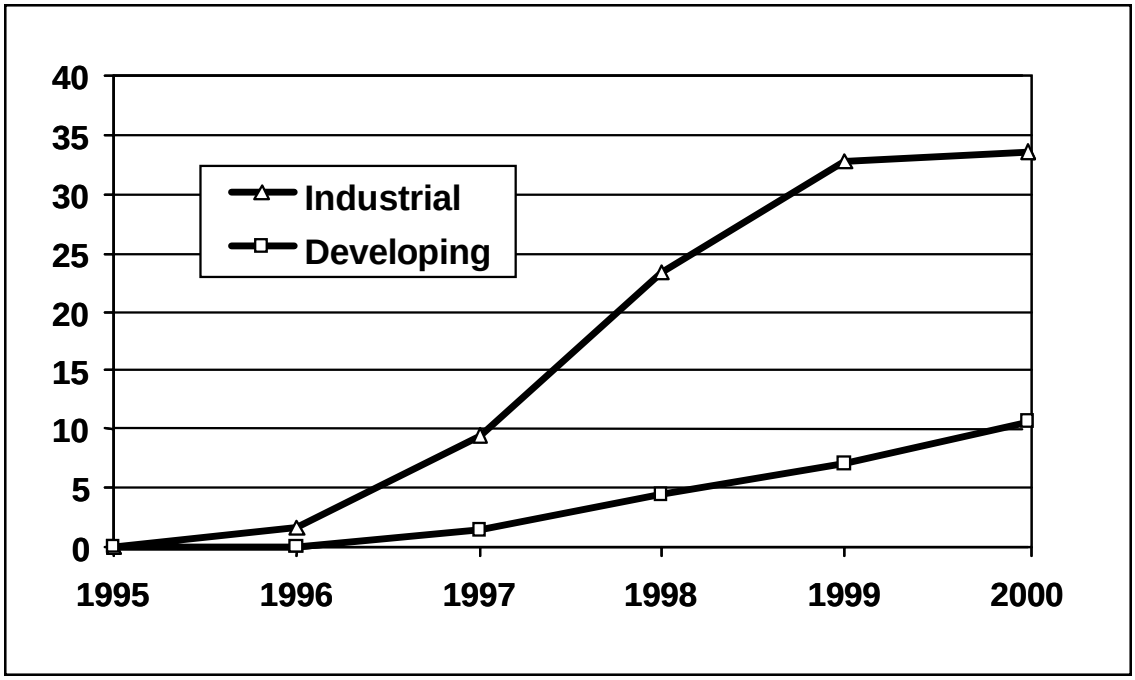
Source: Clive James, 2000.

During the five-year period 1996 to 2000, the global area of transgenic crops increased by more than 25-fold, from 1.7 million hectares in 1996 to 44.2 million hectares in 2000 (Figure 1). This high rate of adoption reflects the growing acceptance of transgenic crops by farmers using the technology in both industrial and developing countries. During the five-year period 1996 – 2000 the number of countries growing transgenic crops more than doubled, increasing from 6 in 1996 to 9 in 1998, to 12 countries in 1999 and 13 in 2000.

Distribution of Transgenic Crops in Industrial and Developing Countries

Figure 2 shows the relative hectarage of transgenic crops in industrial and developing countries during the period 1996 to 2000. It clearly illustrates that from 1996 to 2000 the substantial share, up to 85% of global transgenic crops, has been grown in industrial countries. However, the proportion of transgenic crops grown in developing countries has increased consistently from 14% in 1997, to 16% in 1998, to 18% in 1999 and 24% in 2000. Thus, in 2000 approximately one quarter (Table 2) of the global transgenic crop area of 44.2 million hectares, equivalent to 10.7 million hectares, was grown in developing countries where growth continued to be strong between 1999 and 2000, in contrast to the expected plateauing that is evident for the industrial countries.

Figure 2. Global Area of Transgenic Crops, 1996 to 2000: Industrial and Developing Countries (million hectares).



Source: Clive James, 2000.

Table 2. Global Area of Transgenic Crops in 1999 and 2000: Industrial and Developing Countries (million hectares).

	1999	%	2000	%	+/-	%
Industrial Countries	32.8	82	33.5	76	+ 0.7	+ 2
Developing Countries	7.1	18	10.7	24	+ 3.6	+ 51
Total	**39.9**	**100**	**44.2**	**100**	**+4.3**	**+ 11**

Source: Clive James, 2000.

Transgenic crop area is estimated to have increased from 39.9 million hectares in 1999 to 44.2 million hectares in 2000 (Table 2), resulting in a global increase of 4.3 million hectares in 2000, equivalent to 11% growth over 1999. Of this 4.3 million hectares, 3.6 million hectares, equivalent to 84% was in the developing countries - this compares with only 16%, equivalent to 0.7 million hectares in the industrial countries. Thus, the area of transgenic crops in developing countries grew by 51% from 7.1 million hectares in 1999 to 10.7 million in 2000, compared with a 2% growth in industrial countries where hectarage increased from 32.8 million hectares in 1999 to 33.5 million hectares in 2000.

Distribution of Transgenic Crops, by Country

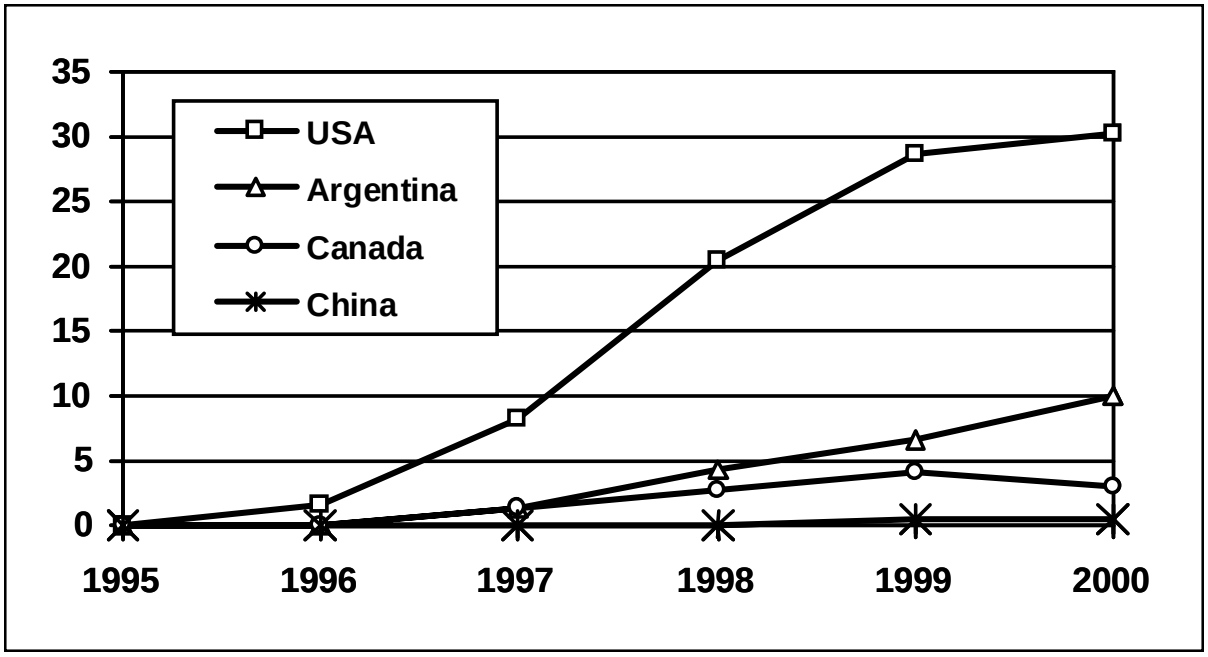
In 2000, four countries grew 99% of the global transgenic crop area (Table 3). It is noteworthy that they are two industrial countries, USA and Canada, and two developing

Table 3. Global Area of Transgenic Crops in 1999 and 2000: By Country (million hectares).

	1999	%	2000	%	+/-	%
USA	28.7	72	30.3	68	+1.6	+6
Argentina	6.7	17	10.0	23	+3.3	+49
Canada	4.0	10	3.0	7	-1.0	-25
China	0.3	1	0.5	1	+0.2	+66
South Africa	0.1	<1	0.2	<1	+0.1	- -
Australia	0.1	<1	0.2	<1	+<0.1	- -
Romania	<0.1	<1	<0.1	<1	+<0.1	- -
Mexico	<0.1	<1	<0.1	<1	+<0.1	- -
Bulgaria	- -	- -	<0.1	<1	+<0.1	- -
Spain	<0.1	<1	<0.1	<1	-<0.1	- -
Germany	- -	- -	<0.1	<1	-<0.1	- -
France	<0.1	<1	<0.1	<1	-<0.1	- -
Portugal	<0.1	<1	- -	- -	- -	- -
Ukraine	<0.1	<1	- -	- -	- -	- -
Uruguay	- -	- -	<0.1	<1	+<0.1	- -
Total	**39.9**	**100**	**44.2**	**100**	**+4.3**	**+11%**

Source: Clive James, 2000.

Figure 3. Global Area of Transgenic Crops, 1996 to 2000: By Country (million hectares).



Source: Clive James, 2000.

countries, Argentina and China. Consistent with the pattern since 1996, the USA grew the largest transgenic crop hectarage in 2000. The USA grew 30.3 million hectares, followed by Argentina with 10 million hectares, Canada with 3 million, and China 0.5 million hectares. In 2000, transgenic crop hectarage increased in 3 out of the top 4 countries growing commercialized transgenic crops. Increases were reported for the USA, Argentina, and China, with a decrease in area in Canada (Figure 3).

The 13 countries that grew transgenic crops in 2000 are listed in descending order of their transgenic crop areas (Table 3). There are 8 industrial countries and 5 developing countries. In 2000, transgenic crops were grown commercially in all six continents of the world—North America, Latin America, Asia, Oceania, Europe (Eastern and Western), and Africa. Of the top four countries that grew 99% of the global transgenic crop area, the USA grew 68%, Argentina 23%, Canada 7%, and China 1%. The other 1% was grown in the remaining 9 countries, with South Africa and Australia being the only countries in that group growing more than 100,000 hectares or a quarter million acres of transgenic crops.

In Argentina, a gain of 3.3 million hectares was reported for 2000 as a result of significant growth in transgenic soybean and corn and a modest increase in cotton. In the USA

there was an estimated net gain of 1.6 million hectares of transgenic crops in 2000; this came about as a result of an increase in the area of transgenic soybean, cotton and canola, and a decreased area of transgenic corn. For Canada, a net decrease of 1 million hectares was estimated with most of it associated with the decrease in area planted with transgenic canola. For China, the area planted to *Bt* cotton was estimated to have increased by approximately 0.2 million hectares in 2000 to 0.5 million hectares.

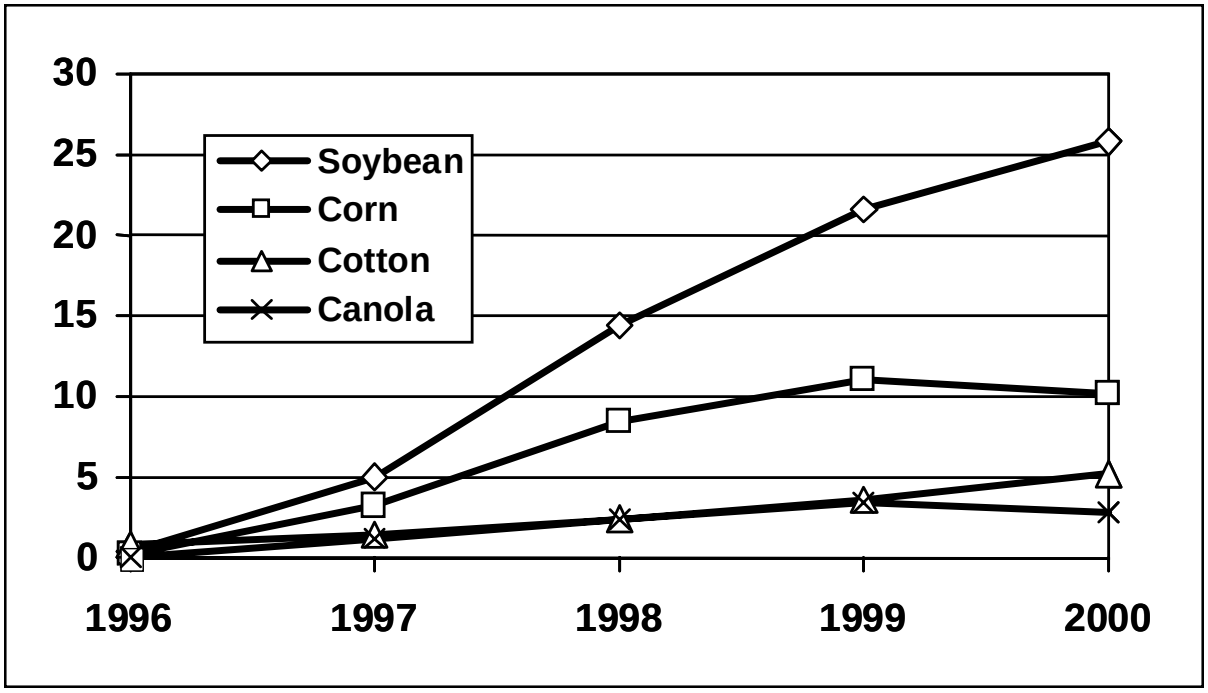
A significant increase of up to 100,000 hectares of transgenic crops is reported for South Africa, where the combined area of transgenic corn and cotton is expected to almost double. In Australia, 150,000 hectares of transgenic cotton was planted in 2000, with Mexico reporting a modest area of transgenic cotton. The countries growing transgenic crops in 2000 include two Eastern European countries, Romania growing soybean and potatoes, and Bulgaria growing herbicide tolerant corn. Ukraine, which grew transgenic potatoes in 1999, has not confirmed any transgenic hectarage for 2000. The three European Union countries—Spain, Germany, and France—which for the first time grew small areas of *Bt* corn in 1999, grew reduced areas in 2000; Portugal which grew *Bt* corn in 1999 withdrew registration in 2000 and no *Bt* corn was reported for Portugal in 2000. One additional country, Uruguay, reported the commercialization of transgenic crops for the first time in 2000, growing a small area, 3,000 hectares, of herbicide tolerant soybean.

Distribution of Transgenic Crops, by Crop

The distribution of the global transgenic crop area for the four major crops is illustrated in Figure 4 for the period 1996 to 2000. It clearly shows the dominance of transgenic soybean occupying 58% of the global area of transgenic crops in 2000; all of the transgenic soybean is herbicide tolerant. Transgenic soybean retained its position in 2000 as the transgenic crop occupying the largest area. Globally, transgenic soybean occupied 25.8 million hectares in 2000, with transgenic corn in second place at 10.3 million hectares, transgenic cotton in third place at 5.3 million hectares, and canola at 2.8 million hectares (Table 4).

In 2000, the global hectarage of herbicide tolerant soybean is estimated to have increased by 4.2 million hectares, equivalent to almost a 20% increase. Gains of approximately 2.7 million hectares of transgenic soybean are reported for Argentina and 1.5 million hectares for the USA, with adoption rates estimated at 95% of the 9.6 million hectares of soybeans grown in Argentina, and 54% of the national soybean area of 30.2 million hectares in the USA, in 2000.

Figure 4. Global Area of Transgenic Crops, 1996 to 2000: By Crop (million hectares).



Source: Clive James, 2000.

Table 4. Global Area of Transgenic Crops in 1999 and 2000: By Crop (million hectares).

Crop	1999	%	2000	%	+/-	%
Soybean	21.6	54	25.8	58	+4.2	+19
Maize	11.1	28	10.3	23	-0.8	-7
Cotton	3.7	9	5.3	12	+1.6	+43
Canola	3.4	9	2.8	7	-0.6	-18
Potato	<0.1	<1	<0.1	<1	<0.1	- -
Squash	<0.1	<1	<0.1	<1	(- -)	- -
Papaya	<0.1	<1	<0.1	<1	(- -)	- -
Total	**39.9**	**100**	**44.2**	**100**	**+ 4.3**	**+ 11**

Source: Clive James, 2000.

Transgenic corn area in 2000 is estimated to have decreased globally by about 800,000 hectares (Table 4) with the major decrease in the USA and some in Canada. Some observers have identified the principal cause of the decrease in transgenic corn in the USA in 2000 to lower plantings of *Bt* corn by farmers who concluded that the low infestation of European Corn Borer in 1999 may not merit the use of *Bt* corn in 2000 on the basis that infestation would continue to be low. Others have suggested that farmer uncertainty about markets for transgenic corn during the planting season may have led to decreased plantings of transgenic corn in 2000 by a small proportion of farmers. Decreases in transgenic corn in the USA and Canada have been offset by significant increases in transgenic corn in Argentina where adoption rates increased from 5 to 20% of the national corn crop, as well as an increase in transgenic maize in South Africa.

The net decrease in area planted globally with transgenic canola in 2000 is estimated at 600,000 hectares with all of the decrease in Canada, which is offset by a modest increase in transgenic canola in the USA. Canadian observers attribute the decrease in transgenic canola to three factors: firstly, the national canola hectarage decreased by 0.6 million hectares, from 5.5 million in 1999 to 4.9 million hectares in 2000; secondly, herbicide tolerant transgenic canola competed with mutation-derived herbicide tolerant canola varieties which increased in area and occupied 25% of the national acreage in 2000 – this compares with transgenic canola at 50% in 2000; thirdly, the low price of canola may have been a disincentive to farmers, who chose to decrease their cost outlays by planting conventional varieties.

In 2000, global area of transgenic cotton is estimated to have increased by 1.6 million hectares, from 3.7 million hectares in 1999 to an estimated 5.3 million hectares in 2000 – this is equivalent to a year-over-year increase of over 40% in the global area of transgenic cotton. The most significant increase was reported for the USA where the percentage of transgenic cotton increased from 55% in 1999 to 72% in 2000. China is reported to have significantly increased its transgenic cotton area to more than 10% of its national cotton area, and modest increases have been reported for Mexico, Australia, Argentina, and South Africa.

Distribution of Transgenic Crops, by Trait

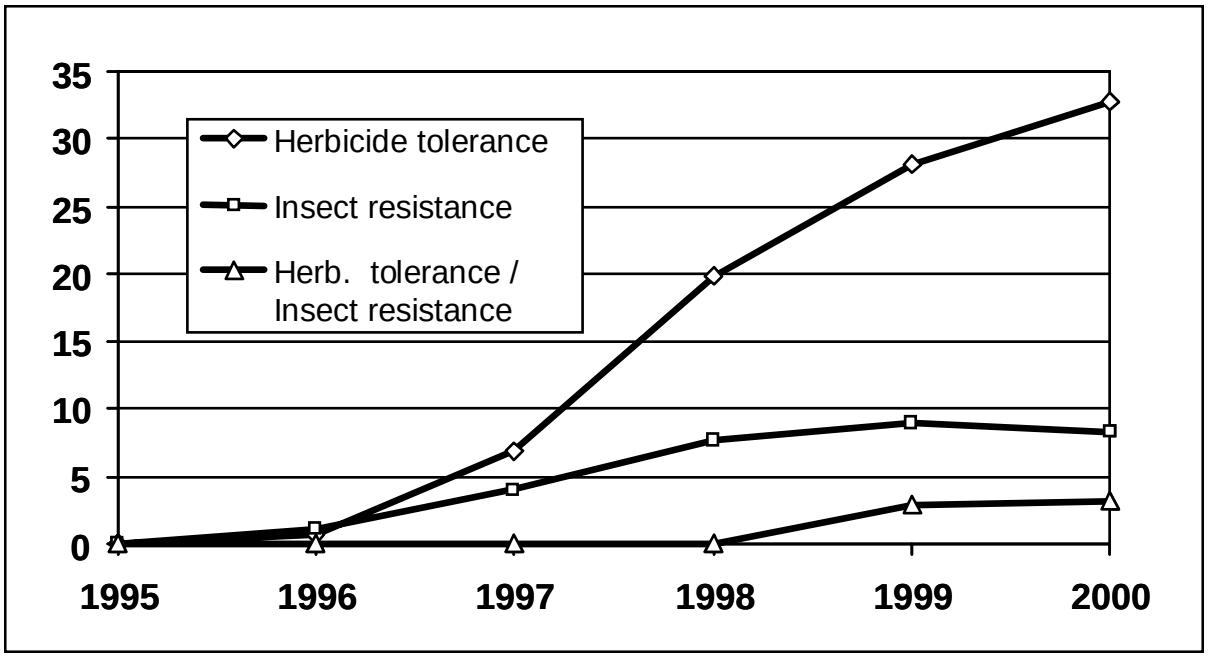
During the five-year period 1996 to 2000, herbicide tolerance has consistently been the dominant trait with insect resistance being second (Figure 5). In 2000, herbicide tolerance, deployed in soybean, corn and cotton, occupied 74% of the 44.2 million

Table 5. Global Area of Transgenic Crops in 1999 and 2000: By Trait (million hectares).

Trait	1999	%	2000	%	+/-	%
Herbicide tolerance	28.1	71	32.7	74	+4.6	+16
Insect resistance (*Bt*)	8.9	22	8.3	19	-0.6	-7
***Bt*/Herbicide tolerance**	2.9	7	3.2	7	+0.3	+10
Virus resistance/Other	<0.1	<1	<0.1	<1	<0.1	- -
Global Totals	**39.9**	**100**	**44.2**	**100**	**+4.3**	**11**

Source: Clive James, 2000.

Figure 5. Global Area of Transgenic Cops, 1996 to 2000: By Trait (million hectares).



Source: Clive James, 2000.

hectares (Table 5), with 8.3 million hectares planted to *Bt* crops, equivalent to 19%, and stacked genes for herbicide tolerance and insect resistance deployed in both cotton and corn occupying 7% of the global transgenic area in 2000. It is noteworthy that the area of herbicide tolerant crops has increased between 1999 and 2000 (28.1, to 32.7

million hectares) as well as crops with stacked genes for herbicide tolerance and *Bt* (2.9 million hectares in 1999 to 3.2 million hectares in 2000), whereas the global area of insect resistant crops has decreased from 8.9 million hectares in 1999 to 8.2 million hectares in 2000 (Table 5 and Figure 5). The trend for stacked genes to gain an increasing share of the global transgenic crop market is expected to continue.

Dominant Transgenic Crops in 2000

Herbicide tolerant soybean was the most dominant transgenic crop grown commercially in six countries in 2000 – USA, Argentina, Canada, Mexico, Romania, and Uruguay (Table 6). Globally herbicide tolerant soybean occupied 25.8 million hectares, representing 59% of the global transgenic crop area of 44.2 million hectares for all crops. The second most dominant crop was *Bt* maize, which occupied 6.8 million hectares, equivalent to 15% of global transgenic area and planted in six countries – USA, Canada, Argentina, South Africa, Spain, and France. The other six crops listed in Table 6 all occupy <10% of global transgenic crop area and include, in descending order of area: herbicide tolerant canola, occupying 2.8 million hectares (6%); herbicide tolerant maize on 2.1 million hectares (5%); herbicide tolerant cotton on 2.1 million hectares (5%); *Bt*/herbicide tolerant cotton on 1.7 million hectares (4%); *Bt* cotton on 1.5 million hectares (3%); *Bt*/herbicide tolerant maize on 1.4 million hectares (3%).

Table 6. Dominant Transgenic Crops 2000.

Crop	Million Hectares	% Transgenic
Herbicide tolerant Soybean	25.8	59
***Bt* Maize**	6.8	15
Herbicide tolerant Canola	2.8	6
Herbicide tolerant Maize	2.1	5
Herbicide tolerant Cotton	2.1	5
***Bt*/Herbicide tolerant Cotton**	1.7	4
***Bt* Cotton**	1.5	3
***Bt*/Herbicide tolerant Maize**	1.4	3
Total	**44.2**	**100**

Source: Clive James, 2000.

Global Adoption of Transgenic Soybean, Corn, Cotton, and Canola

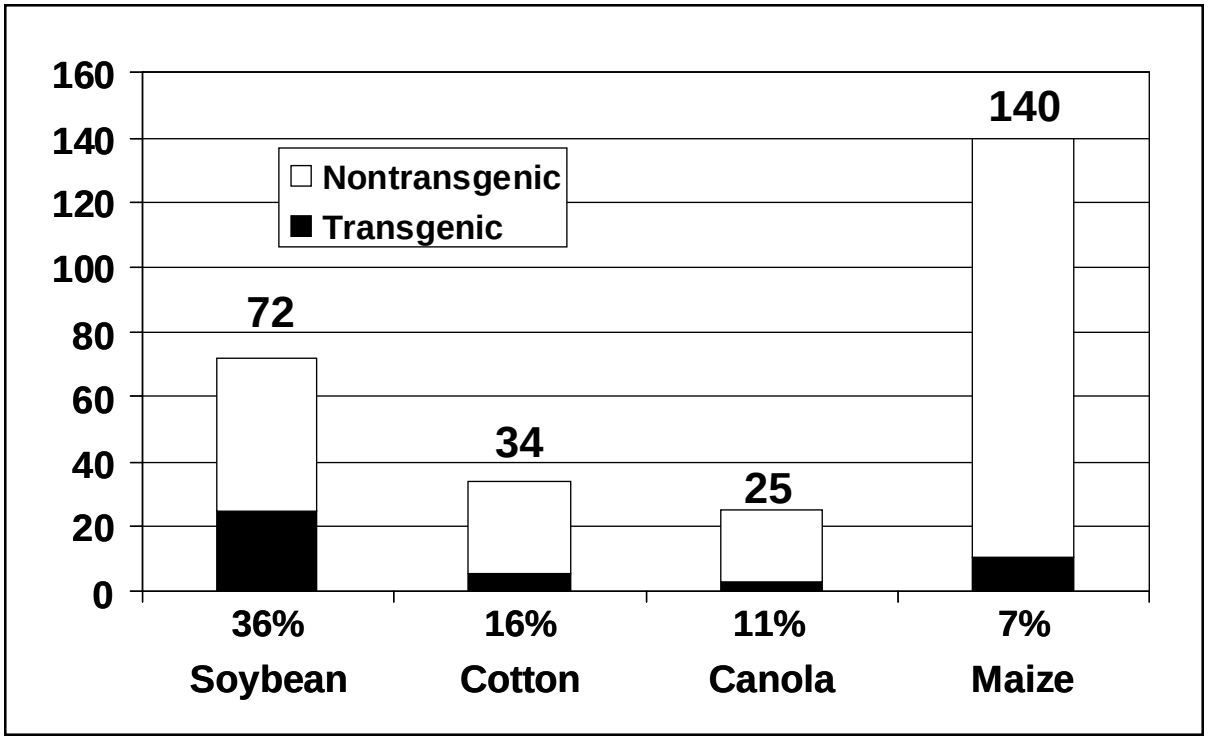
One useful way to portray a global perspective of the status of transgenic crops is to characterize the global adoption rates of the four principal crops — soybean, cotton, canola, and corn — in which transgenic technology is utilized (Table 7 and Figure 6). The data indicate that in 2000, 36% of the 72 million hectares of soybean planted globally were transgenic. Similarly, 16% of the 34 million hectares of cotton, 11% of the 25 million hectares of canola, and 7% of the 140 million hectares of corn, were transgenic. If the global areas of these four crops are aggregated, the total area is 271 million hectares, of which 16%, equivalent to 44.2 million hectares, is estimated to be transgenic. It is noteworthy that two-thirds of these 271 million hectares are in the developing countries where yields are lower, constraints are greater, and the need for improved production of food, feed, and fiber crops is the greatest.

Table 7. Transgenic Crop Area as % of Global Area of Principal Crops, 2000 (million hectares).

Crop	Global Area	Transgenic Crop Area	Transgenic Area as % of Global Area
Soybean	72	25.8	36
Cotton	34	5.3	16
Canola	25	2.8	11
Maize	140	10.3	7
Total	**271**	**44.2**	**16**

Source: Clive James, 2000.

Figure 6. Global Area Adoption Rates (%) for Principal Transgenic Crops (million hectares).



Source: Clive James, 2000.

Concluding Remarks

In the early 1990s, many were skeptical that transgenic crops could deliver improved products and make an impact in the near-term at the farm level. There was even more skepticism about the appropriateness of transgenic crops for countries of the developing world. The experience of the last five years, 1996 to 2000, when a cumulative total of 125 million hectares (over 300 million acres) of transgenic crops have been planted globally, has demonstrated that the early promises of transgenic crops are meeting expectations of large and small farmers planting transgenic crops in both industrial and developing countries. The fact that legions of farmers in both industrial and developing countries around the world have made independent decisions to increase their transgenic crop areas by more than 25-fold in five years (after evaluating the technology following their first plantings of transgenic crops in 1996), speaks volumes of the confidence and trust farmers have placed in transgenic crops that can make a vital contribution to global food, feed, and fiber security.

Governments, supported by the global scientific and international development community, must ensure continued safe and effective testing and introduction of transgenic crops and implement regulatory programs that inspire public confidence. Leadership at the international level must be exerted by the international scientific community and development institutions to stimulate discussion and to share knowledge on transgenic crops with society that must be well informed and engaged in a dialog about the impact of the technology on the environment, food safety, sustainability, and global food security. Societies in food surplus countries must ensure that access to biotechnology is not denied or delayed to developing countries seeking to access the new technologies in their quest for food security, because the most compelling case for biotechnology, more specifically transgenic crops, is their potential vital contribution to global food security and the alleviation of hunger in the Third World. In summary, we must ensure that society will continue to benefit from the vital contribution that plant breeding offers, using both conventional and biotechnology tools, because improved crop varieties are, and will continue to be, the most cost effective, environmentally safe, and sustainable way to ensure global food security in the future.

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The provision of data on global adoption of commercialized transgenic crops by a legion of colleagues from the public and private sectors in industrial and developing countries is much appreciated; without their collaboration, this publication would not be possible. It is a pleasure to thank Dr. Randy Hautea, Director of the ISAAA *SEAsia*Center, his staff, and my wife Glenys James, for formatting the text, graphs, and tables. Whereas the assistance of everyone is acknowledged and greatly appreciated, the author takes full responsibility for the views expressed in this publication and for any errors of omission or misinterpretation.