Global View of Biotech/GM Crops and Their International Commercialization in Agriculture

Clive James [1]

Summary

In the early 1990s, some were skeptical that genetically modified (GM) or transgenic crops, now more often referred to as biotech crops, could deliver improved crop products and make an impact at the farm level. There was even more skepticism that developing countries could access, adopt and benefit from biotech crops. The adoption of biotech crops, in 2006 and the period 1996 to 2006 is reviewed, within a broad framework, that addresses their adoption and impact, and their contribution to food, feed, fiber production on a global basis.

The initiative of the Arab Authority for Agricultural Investment and Development to convene a workshop in Jordan in 2007 could identify the necessary critical mass in biotechnology in the Arab states to ensure a more sustainable agriculture in the future.

Keywords: Genetically modified crops; Transgenic crops; Biotech crops.

Introduction

2006 marked the first year of the second decade of commercialization, 2006-2015, of biotech crops. The experience of the first eleven years of commercialization, 1996 to 2006, during which a cumulative total of 577 million ha of biotech crops were planted globally in over 20 countries, has confirmed that the early promise of crop biotechnology has been fulfilled.

Results

Global Area of Biotech Crops:

Biotech crops were first commercialized in 1996. In 2006, the global area of biotech crops continued to grow for the tenth consecutive year at a sustained double-digit growth rate of 13% reaching 102 million ha, a historical landmark in that this is the first time for more than 100 million ha of biotech crops to be planted in any one year (James, 2006). It is also the first time that the accumulated ha from 1996 to 2006, 577 million ha, has exceeded 500 million ha. Biotech crops have also set a precedent in that the biotech area has grown by double-digit rates every single year for the last 11 years, since commercialization first began in 1996. Also, the number of farmers growing biotech crops in 2006, reached 10 million for the first time at 10.3 million of which 90% or 9.3 million, (up from 7.7 million in 2005), were small resource-poor farmers from developing countries. To put the 2006 global area of biotech crops into context, 102 million ha of biotech crops is equivalent to more then 10% of the total land area of China (956 million ha) or the total land area of Egypt (100 million ha).

During the first 11 years of commercialization 1996 to 2006, the global area of biotech crops increased sixty-fold, from 1.7 million ha in 1996 to 102 million ha in 2006. This rate of adoption is the highest rate of crop technology adoption for any crop technology and reflects the growing acceptance of biotech crops by both large and small farmers in industrial and developing countries. During the period 1996 to 2006, an accumulated total of 577 million hectares of biotech crops have been successfully grown, accumulatively since 1996, as a result of approximately 45 million repeat decisions by farmers to plant biotech crops. Farmers have signaled their strong vote of confidence in crop biotechnology by consistently increasing their plantings of biotech crops by double-digit growth rates every single year since biotech crops were first commercialized in 1996, with the number of biotech countries increasing from 6 to 22 in the same 11-year period.

Distribution of Biotech Crops in Industrial and Developing Countries:

Figure 1 shows the relative hectarage of biotech crops in industrial and developing countries during the period 1996 to 2006. It clearly illustrates that whereas the substantial but consistently declining share (60% in 2006 compared with 62% in 2005) of biotech crops continued to be grown in industrial countries in 2006, the proportion of biotech crops grown in developing countries has increased consistently every single year from 1996 to 2006.

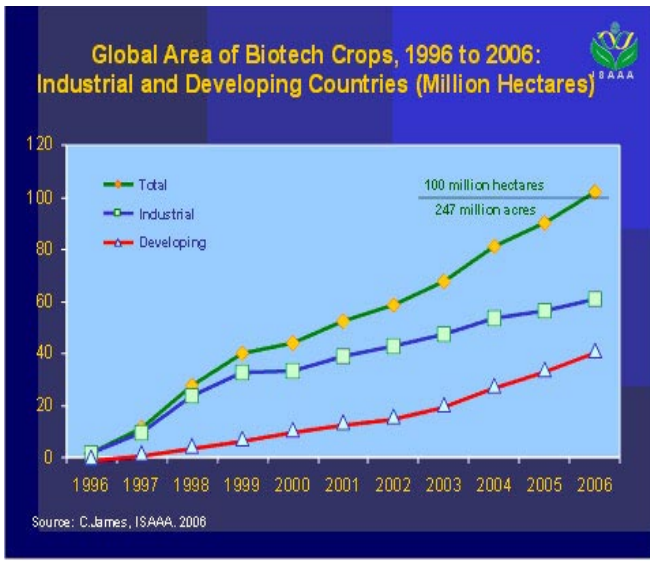

Fig. 1. Global Area of Biotech Crops, 1996 to 2006: Industrial and Developing Countries (Million ha).

1. International Service for the Acquisition of Agri-biotech Applications (ISAAA), Cornell University, 417 Bradfield Hall, Ithaca N.Y. 14853, USA. E-mail: cjames@candw.ky

Distribution of Biotech Crops, by Country:

The eight principal countries that grew biotech crops on 1 million hectares or more in 2006, listed by ha (Table 1), were the USA which grew 54.6 million ha, (53% of global total), Argentina with 18.0 million ha (18%), Brazil 11.5 million ha (11%), Canada 6.1 million ha (6%), India 3.8 million ha (4%), China 3.5 million ha (3%), Paraguay with 2.0 million ha (2%), and South Africa with 1.4 million ha (1%). An additional 14 countries grew a total of 1 million ha in 2006. It should be noted that of the top eight countries, each growing 1.0 million ha or more of biotech crops, the majority (6 out of 8) are developing countries, Argentina, Brazil, India, China, Paraguay, and South Africa, compared with only two industrial countries, USA and Canada. The number of biotech mega-countries (countries which grow 50'000 ha, or more, of biotech crops) numbered 14 in 2006, the same as in 2005. Notably, 10 of the 14 mega-countries are developing countries from Latin America, Asia and Africa. The high proportion of biotech mega-countries in 2006, 14 out of 22, equivalent to two thirds, reflects the significant broadening, deepening and stabilizing in biotech crop adoption that has occurred within the group of more progressive countries adopting more than 50'000 ha of biotech crops, on all six continents in the last 11 years.

Table 1. Global Area of Biotech Crops in 2005 and 2006: by Country (Million Hectares)

Country	2005	%	2006	%	+/-	%
1. USA*	49.8	55	54.6	53	+4.8	+10
2. Argentina*	17.1	19	18.0	18	+0.9	+5
3. Brazil*	9.4	10	11.5	11	+2.1	+22
4. Canada*	5.8	6	6.1	6	+0.3	+5
5. India*	1.3	1	3.8	4	+2.5	+192
6. China*	3.3	4	3.5	3	+0.2	+6
7. Paraguay*	1.8	2	2.0	2	+0.2	+0.2
8. South Africa*	0.5	1	1.4	1	+0.9	+180
9. Uruguay*	0.3	<1	0.4	<1	+0.1	+33
10. Philippines*	0.1	<1	0.2	<1	+0.1	+100
11. Australia*	0.3	<1	0.2	<1	-0.1	-33
12. Romania*	0.1	<1	0.1	<1	<0.1	--
13. Mexico*	0.1	<1	0.1	<1	<0.1	--
14. Spain*	0.1	<1	0.1	<1	<0.1	--
15. Colombia	<1	<1	<1	<1	<0.1	--
16. France	<1	<1	<1	<1	<0.1	--
17. Iran	<1	<1	<1	<1	--	--
18. Honduras	<1	<1	<1	<1	<0.1	--
19. Czech Rep	<1	<1	<1	<1	<0.1	--
20. Portugal	<1	<1	<1	<1	<0.1	--
21. Germany	<1	<1	<1	<1	<0.1	--
22. Slovakia	--	--	<1	<1	<0.1	--
Total	**90.0**	**100**	**102.0**	**100**	**+12.0**	**+13**

* Mega-biotech countries growing 50,000 ha, or more, of biotech crops.
Source: Clive James, 2006.

The six principal countries that have gained the most economically from biotech crops, during the first decade of commercialization of biotech crops, 1996 to 2005 are, in descending order of magnitude, the US ($12.9 billion), Argentina ($5.4 billion), China ($5.2 billion), Brazil ($1.4 billion), Canada ($1.0 billion), India ($0.5 billion), Paraguay ($0.1 billion) and others ($0.5 billion) for a total of $27 billion, $13 billion for developing countries and $14 billion for industrial countries.(Brookes and Barfoot, 2006)

Distribution of Biotech Crops, by Crop:

The distribution of the global biotech crop area for the four major crops is illustrated in Fig. (2) for the period 1996 to 2006. It clearly shows the continuing dominance of biotech soybean occupying 57% of the global area of global biotech crops in 2006; the entire biotech soybean hectarage is herbicide tolerant RRr soybean. Biotech soybean retained its position in 2006 as the biotech crop occupying the largest area globally occupying 58.6 million ha followed by biotech maize, cotton and canola.

Distribution of economic benefits for the four major biotech crops for the decade1996 to 2005 were as follows: soybean $.14.4 billion, Bt cotton $ 7.5 billion, Bt maize $ 2.4 billion, herbicide tolerant cotton $ $0.9 billion, herbicide tolerant canola $ 0.9 billion, herbicide tolerant maize $0.8 billion for a total of $27 billion.

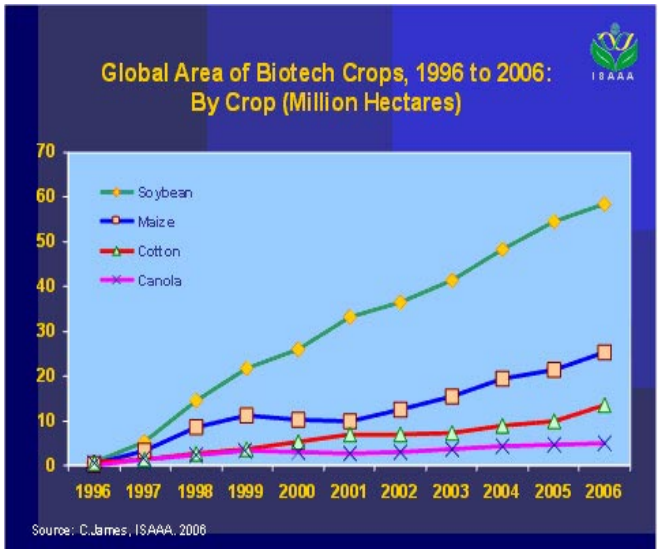

Fig. 2. Global Area of Biotech Crops, 1996 to 2006: by Crop (Million ha)

Distribution of Biotech Crops, by Trait:

During the eleven year period 1996 to 2006, herbicide tolerance has consistently been the dominant trait with insect resistance second (Fig. 3). The significant increase in stacked traits in maize and cotton reflects the needs of farmers who have to simultaneously address the multiple yield constraints associated with various biotic and abiotic stresses. This stacking trend will continue and intensify as more traits become available to farmers and is a very important feature of the technology.

The Global Value of the Biotech Crop Market :

In 2006, the global market value of biotech crops, esti-

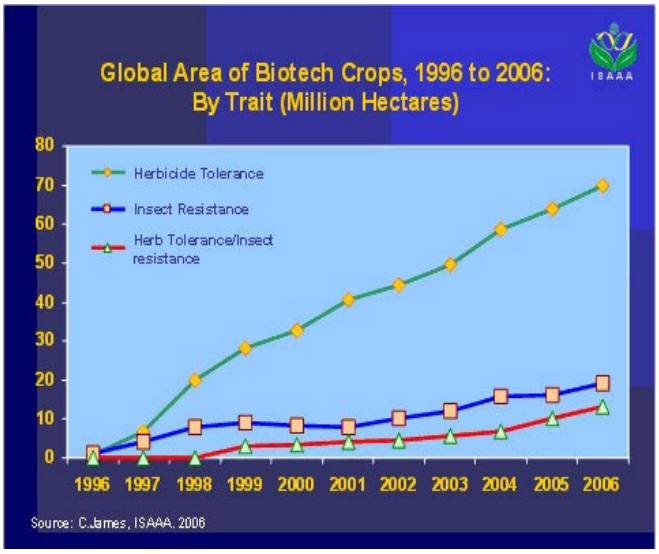

Fig. 3. Global Area of Biotech Crops, 1996 to 2006: by Trait (Million ha)

mated by Cropnosis, was $6.151 billion representing 16% of the $38.5 billion global crop protection market in 2006 and 21% of the ~$30 billion 2006 global commercial seed market. The $6.15 billion biotech crop market comprised of $2.68 billion for biotech soybean (equivalent to 44% of global biotech crop market), $2.39 billion for biotech maize (39%), $0.87 billion for biotech cotton (14%), and $0.21 billion for biotech canola (3%). The market value of the global biotech crop market is based on the sale price of biotech seed plus any technology fees that apply. The accumulated global value for the eleven-year period, since biotech crops were first commercialized in 1996, is estimated at $35.5 billion. The global value of the biotech crop market is projected at approximately $6.8 billion for 2007.

Discussion

In 2006, the first year of the second decade of commercialization of biotech crops, 2006-2015, the global area of biotech crops continued to climb at double-digit rates to 102 million ha (equivalent to 117.7 million trait ha), with a 13% gain, equivalent to 12 million ha, the second highest increase in the last five years. In 2006, the following global milestones were achieved for biotech crops for the first time:

- Exceeded 100 million has of biotech crops planted in one year;
- More than 10 million farmers grew biotech crops in 22 countries;
- Bt cotton hectarage in India at 3.8 million ha exceeded Bt cotton ha in China at 3.5 million ha placing India at number 5 in the world biotech crop rankings in 2006 compared with number 7 in 2005;
- An accumulated biotech crop ha, for the period 1996 to 2006, exceeding 500 million ha, resulting from an unprecedented 60-fold increase in adoption since 1996, the first year of commercialization of biotech crops.

It is noteworthy that in 2006 more than half (55% or 3.6 billion people) of the global population of 6.5 billion live in the 22 countries where biotech crops were grown in 2006 and generated significant and multiple benefits. Also notable is that more than half (52% or 776 million ha of the 1.5 billion ha of arable land) of the cropland in the world are in the 22 countries where approved biotech crops were grown in 2006.

It is estimated that the global value of total crop production from biotech crops in 2003/04 was $44 billion (Runge and Ryan, 2004), and by extrapolation the value will probably have reached $50 to $55 billion in 2006.

Biotech crops are also delivering benefits that are less evident to consumers and society at large, through more affordable food, feed and fiber that require less pesticides and hence a more sustainable agriculture. In developing countries, biotech crops have also delivered invaluable humanitarian social benefits to poor subsistence farmers and the rural landless dependent on agriculture for their livelihood, in terms of a contribution to the alleviation of poverty, hunger and malnutrition.

The most recent survey of the global impact of biotech crops for the first decade of commercialization of biotech crops, 1996 to 2005, (Brookes and Barfoot, 2006), estimates that the global net economic benefits to crop biotech farmers in 2005 was $5.6 billion, and $27 billion for the accumulated benefits during the decade 1996 to 2005; these estimates include the benefits associated with the double cropping of biotech soybean in Argentina. The accumulative reduction in pesticides for the decade 1996 to 2005 was estimated (Brookes and Barfoot, 2006) at 224'300 MT of active ingredient, which is equivalent to a 15% reduction in the associated environmental impact of pesticide use on these crops, as measured by the Environmental Impact Quotient (EIQ) - a composite measure based on the various factors contributing to the net environmental impact of an individual active ingredient. In addition to the direct savings from insect resistant and herbicide tolerant traits associated with yield improvements, reduced pesticides, fuel and labor, there were also indirect benefits associated with herbicide tolerance related to an increased usage of no/low till systems and lower fuel consumption. These benefits (direct and indirect) have contributed to a permanent reduction in carbon dioxide emissions and resulted in higher carbon sequestration in soil, estimated to have produced carbon dioxide savings of approximately 9 billion kg in 2005 alone.

Biotech crops can potentially contribute to reduction of greenhouse gases and climate change in three principal ways. First, permanent savings in carbon dioxide emissions through reduced use of fossil-based fuels, associated with fewer insecticide and herbicide sprays; in 2005 this was an estimated saving of 962 million kg of carbon dioxide (CO_2), equivalent to reducing the number of cars on the roads by 0.43 million. Secondly, conservation tillage (need for less or no ploughing with herbicide tolerant biotech crops) for biotech food, feed and fiber crops, led to an additional soil carbon sequestration equivalent in 2005 to 8,053 million kg

of CO_2, or removing 3.6 million cars off the road. Thus, in 2005 the combined permanent and additional savings through sequestration was equivalent to a saving of 9'000 million kg of CO_2 or removing 4 million cars from the road. Thirdly, in the future cultivation of a significant additional area of biotech-based energy crops to produce ethanol and biodiesel will on the one-hand substitute for fossil fuels and on the other will recycle and sequester carbon. Recent research indicates that biofuels could result in net savings of 65% in energy resource depletion (Anonymous, 2006a). Given that energy crops will likely occupy a significant additional crop hectarage in the future the contribution of biotech-based energy crops to climate change could be significant (Anonymous, 2006b). Based on the unprecedented adoption and substantial impact of biotech crops in the first 11 years of commercialization, 1996-2006, it is projected that the strong growth will continue in the second decade of commercialization 2006-2015; some of the principal trends and developments are highlighted in the closing paragraphs below:

- Continuing strong growth in established and mature industrial country markets such as US and Canada, increasingly manifested through stacking of traits expressed as trait ha rather than adopted ha which are already close to saturation in soybean and cotton in the US. An expanded range of crops will become available featuring more agronomic traits, particularly the all important drought trait, and for the first time an increasing range of quality traits ranging from improved and healthier oils to more nutritious products, and other non-conventional products such as vaccines and specialized products.
- Whereas the first decade, 1996-2005, was the decade of the Americas, (where 94% of global biotech crops were planted in 2005) the second decade, 2006-2015, will likely feature strong growth in the key developing countries of Asia led by China, India and countries like Pakistan, Vietnam and the tiger economies of SEAsia where the Philippines has led with biotech maize and is assigning high priority to biotech rice, including Vitamin A rice, expected to be available by 2011.
- Recognizing the urgent need in the Arab States to ensure food security, the Arab Authority for Agricultural Investment and Development convened a workshop in Jordan in May 2006 to assess the priority scientific and investment needs of the Arab States in crop and animal biotechnology. This important initiative is both a timely and strategic development that could provide the necessary critical mass in biotechnology in the Arab states to ensure a more sustainable agriculture in the future when biotechnology is expected to play an increasingly important role.

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الوضع العالمي للمحاصيل المنتجة بالتقانة الحيوية/المحوَّرة وراثياً وتداوُلها التجاري في مجال الزراعة

كلايف جيمس [2]

الخلاصة

مع بداية التسعينات كان البعضُ يشكك في أن المحاصيل المحورة وراثياً (GM Crops) أو المحاصيل المنتجة بالتقانة الحيوية يمكن أن تحسن إنتاجية المحاصيل أو لها تأثير على مستوى المزرعة، وكذلك في مقدرة الدول النامية على الاستفادة من تلك المحاصيل.

يتناول المقال مراجعة الوضع العالمي للمحاصيل المنتجة بالتقانة الحيوية للفترة من 1996–2006 من حيث درجة تبنيها وتأثيرها ومساهمتها بتوفير الغذاء والعلف والألياف على مستوى العالم.

إنَّ مُبادرة الهيئة العربية للاستثمار والإنماء الزراعي في عقد ندوة التقانة الحيوية في الأردن عام 2007 ستساعد في التعرف على المتطلبات الضرورية في مجال التقانة الحيوية في البلدان العربية لضمان زراعة مستدامة في المستقبل.

1. الخدمة الدولية لتطبيقات التقنية الحيوية الزراعية، جامعة كورنيل، الولايات المتحدة الأمريكية. بريد إلكتروني: cjames@candw.ky