

## Plant Biotechnology: Proven Benefits

### Farmers Choose Biotech Crops

Since 1996, farmers have chosen to plant crops enhanced with biotechnology traits due to the proven economic and environmental benefits they provide.

- The global adoption of biotech crops has sustained double-digit growth in planted hectares for nine consecutive years.
- The [2003 ISAAA report](#) on global plant biotech use and adoption noted, "Farmers have made up their mind... they continue to rapidly adopt biotech crops because of the significant agronomic, economic, environmental and societal benefits," (James, 2003).

In a USDA survey of United States farmers adopting biotech crops, farmers reported they chose to use biotech crops for the following reasons:

- To increase yields through improved pest control methods (54 percent to 76 percent of adopters).
- To decrease pesticide costs (19 percent to 42 percent of adopters).
- All other reasons to plant biotech crops combined, such as increasing planting flexibility, accounted for just 3 percent to 15 percent of adopters (Fernandez-Cornejo, 2003).

Monsanto surveys of farmers who use biotech crops demonstrate product satisfaction ratings of over 90 percent in almost every product category. In many cases, product satisfaction ratings by farmers are nearly 100 percent.

### Significant Economic and Environmental Benefits

In 2003-04, biotech crops grown in 18 countries were valued at approximately \$44 billion gross revenue, according to [Dr. Ford Runge](#) of the University of Minnesota.

- In the United States, biotech crops (soy, cotton, corn and canola) generated \$27.5 billion of gross revenues for farmers.
- In Argentina, biotech crops (corn, soy and cotton) generated \$8.9 billion of gross revenue for farmers.
- In China, biotech cotton generated \$3.9 billion of gross revenue for farmers.
- In Canada, biotech crops (canola, soy and corn) generated \$2 billion in gross revenue for farmers.
- In Brazil, biotech soybeans generated \$1.6 billion of gross revenue for farmers (Runge, 2004).

Farmers have benefited from biotech crops through increased yields. Several examples of improved yields from biotech crops are published, including:

- The National Center for Food and Agricultural Policy ([NCFAP](#)) reported recently that US farmers increased yields by 5.3 billion pounds in 2003 due to their use of biotech crops such as soybeans, corn, cotton and canola. Increased yields provide higher economic returns for farmers (Sujatha and Blumenthal, 2004).
- In China, biotech cotton yields averaged 24 percent higher than non-biotech cotton from 1999-2001 (Huang et al., 2003).
- In India, farmers who planted Bt cotton realized 45 percent to 63 percent higher yields in 2002-2003 (Bennet et al., 2004).
- The first generation of Bt maize holds the potential to create yield gains of up to 35 million tons on a global basis, with additional gains possible through second generation Bt traits (James, 2003).
- Field studies of Bt corn in Germany indicate average yield gains of 12 percent to 15 percent. Similar trials in South Africa with Bt corn showed 10 percent average yield gains (James, 2004).

Farmers have benefited from reduced production costs primarily due to fewer pesticide applications and more efficient use of farm labor. Several examples of reduced production costs are published, including:

- [NCFAP](#) recently reported that US farmers eliminated more than 46 million pounds of pesticide use\* due to the use of biotech crops.
  - Biotech soybean production accounts for the largest amount, with an estimated 20 million pounds eliminated in 2003.
- The reduction of pesticide applications\* on all other biotech crops in the US, excluding soybeans, grew by 55 percent between 2001 and 2003 (Sujatha and Blumenthal, 2004).
- Farmers in India who use Bt cotton have reduced pesticide applications\* by two-thirds according to a recent published report (Bennet et al., 2004).
- YieldGard® Corn Rootworm corn is expected to eliminate the use of 1 million plastic containers, 68,845 gallons of aviation fuel, 5 million gallons of water used in insecticide formulations, 5 million pounds of insecticide active ingredient, and 5 million gallons of diesel fuel per year (Rice, 2004).
- In Australia, the use of INGARD® Bt cotton in 1998-99 resulted in an average of 50 percent fewer pesticide applications (Fitt, 2003).
- In China, published studies have documented a 67 percent reduction in pesticide applications among Bt cotton farmers in China (Huang, 2003).

Farmers have benefited from increased yields, reduced production costs, or both in some instances, to create significantly improved net economic returns.

- NCFAP recently reported that US farmers benefited by \$1.9 billion in 2003 due to the use of biotech crops - a 27 percent increase in the level of economic benefits achieved in 2001 (Sujatha and Blumenthal, 2004).
- A published survey from the Canola Council of Canada reported that the use of biotech canola increased net economic gains for Canadian farmers by C\$15 per hectare. The report estimated the total economic impact of biotech canola to be C\$464 million between 1997 and 2000 (Canola Council of Canada).
- [ISAAA](#) reports that average net incomes among farmers have increased by US\$50 per hectare of biotech crops in the US and by more than US\$300 per hectare of biotech crops in China.
  - Farmers growing cotton on less than one hectare benefit the most from Bt cotton - an estimated US\$400 per hectare versus US\$185 per hectare for larger-scale farmers (James, 2002).
- Spanish farmers growing Bt corn gained 10.2 million euros over the six-year period 1998-2003 according to a recently published report (Demont and Tollens, 2004).
- Small-scale farmers in the northeastern part of Spain are receiving up to €150 per hectare in net economic benefits due to Bt corn (Brookes, 2002).
- South African smallholder farmers in the Makhatini are increasing yields and net economic returns by US\$25 to \$51 per hectare due to Bt cotton according a study conducted in 2002 (Morse et al., 2004).
- Bt cotton in India has provided significantly higher yields and a 49 percent to 73 percent increase in profits (Bennett et al., 2004).
- In Argentina, the average reported benefit for Bt cotton was \$58 per hectare for the two years 1999-00 to 2000-01 according to a 2003 report (M.G.E. de Bianconi, 2003).
- Also in Argentina, a study on the impacts of Roundup Ready® soybeans found production costs were reduced by US\$20 per hectare and accumulated benefits through the crop year 2001-2002 are US\$5.2 billion (Trigo and Cap, 2003).
- The estimated accumulated value of Bt maize in Argentina through 2001-2002 is US\$400 million (Trigo and Cap, 2003).

Biotech crops have helped facilitate reduced tillage methods for crop production. Reduced tillage methods reduce soil erosion, increase moisture availability for growing crops, and improve wildlife habitat. Several published reports document the impact of biotech crops in this area, including:

- The Conservation Technology Information Center ([CTIC](#)) reported in 2002 that, "Nearly all growth in no-till acreage occurred where herbicide-tolerant crop varieties can help farmers control weeds without needing to repeatedly disrupt precious topsoil... as a result, society is reaping another wave of environmental benefits associated with further reducing tillage on our farmland."
- The CTIC report cited the following key facts:
  - 63 percent of all US soybean farmers who reduced their tillage practices since 1996 list herbicide tolerant technology as the key factor.
  - Reduced tillage and the Conservation Reserve Program (CRP) are listed as the key factors behind a reduction of soil erosion by 1 billion tons per year.
  - Reduced soil erosion results in less sediment polluting water, saving US consumers an estimated \$3.5 billion in 2002 in water treatment and storage, as well as waterway maintenance, navigation, flooding and recreation costs. The result is cleaner, more affordable drinking water for consumers.
  - Farmers are saving more than 309 million gallons of fuel per year through reduced tillage methods, which decrease greenhouse gases released from burning fuel by more than 1 billion pounds of carbon dioxide per year.
  - Reduced tillage dramatically improves agricultural land as habitat for wildlife. Earthworm populations are three to six times higher in a no-till field than in a field that's plowed, while quail can find their daily food in about one-fifth the time in a no-till field compared to a field farmed with conventional tillage (Fawcett and Towery, 2002).
- A US Cotton Council report in 2002 documented that since 1997, 80 percent of cotton growers are making fewer tillage passes and 75 percent are leaving more crop residue due to herbicide tolerant cotton (Doane Marketing Research, 2002).
- In Argentina, reduced tillage methods have increased from 300,000 hectares in 1990-91 to more than 11 million hectares in 2002-03, due to a number of factors which include the availability and use of Roundup Ready® soybeans (Penna and Lemma, 2003).
- A study by the [Canola Council of Canada](#) found 28 percent of farmers surveyed had increased their use of reduced tillage methods by 69 percent due to the availability and use of herbicide tolerance technology, such as the Roundup Ready® system (Canola Council of Canada).

Other benefits from biotech crops have been documented, such as cleaner grain and earlier seeding resulting in higher yields.

- A published report demonstrates biotech canola has produced cleaner canola with 50 percent less dockage, creating an estimated benefit for growers of C\$21 million in 2000.
  - In the same report, it was also noted that farmers gained an extra C\$70 million from biotech canola due to earlier seeding opportunities, resulting in higher yields (Phillips, 2003).
- A study published in Weed Technology reported average foreign matter from weed seeds in biotech soybeans to be just 1.9 percent. That's 24 percent less than conventional soybeans (Shaw and Bray, 2003).

Consumers also benefit economically from biotech crops and consistently rank the reduction of pesticide applications as their top perceived benefit.

- In Argentina, Qaim et al., reported that Roundup Ready® soybeans created increased economic value with the largest share,

53 percent, going to consumers (Qaim et al., 2002).

- Reducing pesticide use in agriculture helps conserve water and fuel since less energy and water are used in the manufacture, distribution and application of these products. Fewer pesticide applications also result in less packaging entering the environment.
- In addition to reducing the overall number of pesticide applications, biotech crops have allowed farmers to substitute herbicides with more favorable environmental characteristics that help reduce overall environmental impact.

### **Benefits Extend to Developing Countries**

Farmers in developing countries have generated increased economic returns by using biotech crops, primarily due to reduced production costs, increased yields and, in some cases, both benefits combined.

- Insect-protected Bt cotton has been adopted by several million small farmers in developing countries such as China, South Africa and Mexico. Published reports by leading agricultural economists have summarized the economic benefits in these countries.
- In China, a 1999-2001 survey of farmers demonstrated three-year average increased yields from Bt cotton of 523 kilograms per hectare (24 percent) over non-Bt cotton. Three-year net economic returns per hectare averaged US\$332 for Bt cotton versus a loss of US\$138 for non-Bt cotton - a difference of US\$470 (Huang et al., 2002).
- In South Africa, a three-year analysis of 2,200 small farmers from the Makhathini area demonstrating consistently higher yields and increased revenues for Bt versus non-Bt cotton farmers. Bt cotton farmers experienced increased gross margins of 531 to 742 South African rand per hectare (equivalent to US\$86 to \$93) versus non-Bt cotton farmers over the study period (Morse et al., 2004).
- In Mexico, a study documented the economic benefits of Bt cotton during 1998. The study demonstrated increased yield of 0.29 tons per hectare and reduced expenditures on seed and pesticides of US\$83 per hectare, creating a net economic advantage of US\$626 per hectare for Bt cotton farmers versus non-Bt cotton farmers (Traxler et al., 2003).

Environmental benefits from the reduction in pesticide applications have been documented in several developing countries:

- In Argentina, Qaim and Traxler reported an 83 percent reduction in herbicides with toxicity class II and a 100 percent reduction in herbicides with a toxicity class III due to the availability and adoption of Roundup Ready® soybeans (Qaim et al., 2002).
- In South Africa, farmers who use Bt cotton can eliminate three pesticide applications, saving 14 hours of labor per hectare and 200 South African rand (US\$18), according to a recent published report (Morse et al., 2004).
- A recent study reported a 57 percent decrease in pesticide applications by Chinese farmers growing Bt cotton in 2000, and corresponding reductions in reported pesticide poisonings, resulting in improved human health (Hossain, 2004).
- In India, the average number of pesticide applications for non-Bt cotton is 3.68 compared to just 0.62 applications for Bt cotton (Qaim, 2003).

\* Pesticides registered by the U.S. EPA will not cause unreasonable adverse effects on man or the environment, when used in accordance with label directions.

YieldGard®, INGARD® and Roundup Ready® are registered trademarks of Monsanto Technology LLC.