



Genetically Engineered Crops

A Risky Investment for Southern Economies

by Travis Coan

During the past decade, genetically engineered (GE) crops have been widely planted by farmers in many countries around the world. But has the technology lived up to the industry hype by delivering the promised economic and environmental benefits? This paper reviews important research findings from India, Argentina and China that demonstrate the economic impact of GE crops on rural farmers and communities.

The agricultural biotechnology industry claims that GE crops will benefit developing countries by reducing pesticide use and increasing yields, promising to make farming more profitable and less environmentally harmful. However, according to a growing body of research, the majority of farmers that chose to adopt GE crops have experienced exactly the opposite: increased seed and input costs, higher pesticide use and lower yields. Additionally, many have lost important markets for their products due to consumer rejection of GE crops in Europe and elsewhere. Farmers also complain about loss of crop diversity, local and indigenous seed varieties and the age-old practice of saving and exchanging seeds—additional risks with very real economic consequences posed by the introduction of GE crops.



Farmers in developing countries are protesting the introduction of transgenic crops, which they claim threatens their livelihoods, their ability to exchange seeds and biodiversity.

India The Bt Cotton Fiasco

Pesticide companies have genetically engineered a number of crops to contain the naturally-occurring bacterial insecticide, *Bacillus thuringiensis*, or Bt. One such transgenic crop, Bt cotton, has been widely planted in India. Two research teams studied the first commercial growing season of Bt cotton in India (2002–2003).¹ Both studies indicate that Bt cotton led to higher pesticide use and lower yields, posed unnecessary financial risks to Indian farmers and threatened the stability of India's fragile rural economy.

Yield reductions

The agricultural biotechnology industry claimed that Bt cotton would yield approximately 15 quintals per acre.² But farmers in the states of Maharashtra and Andhra Pradesh reported an average yield of only three to four quintals per acre, and the majority of Bt farmers in Madhya Pradesh reported an average yield of 4.01 quintals per acre.³ Moreover, a study conducted by the Andhra Pradesh government found the majority of Bt farmers reporting average yields of six

quintals per acre, compared to 14 quintals for conventional varieties. Similar findings were reached in studies conducted by the governments of Madhya Pradesh, Gujarat and Maharashtra.⁴

The Gene Campaign study showed that in all landholding categories, Bt cotton averaged lower overall yields when compared to non-Bt varieties.⁵ Additionally, several Indian researchers have shown that diseases caused by *Fusarium*,⁶ such as wilt and root-rot, are likely to lower yields even further and lead to higher pesticides use.⁷ Studies conducted in the United States found an increased incidence of *Fusarium*-related diseases in fields previously planted with GE crops.⁸

Increased pesticide use

Studies show that Bt cotton failed to protect Indian farmers against the Cotton Bollworm (*Helicoverpa armigera*), which is India's primary cotton pest. Farmers had to spray roughly the same amount of pesticides to control the Cotton

Bollworm for both Bt and non-Bt varieties (two to three sprays). The studies also show that Bt farmers experienced increased attacks by secondary pests. For example, during the 2002–2003 growing season, Bt farmers reported that attacks from non-target cotton pests increased approximately 250–300% and farmers had to spray up to seven times to control sucking pests.⁹ Furthermore, Bt cotton offered little resistance against the Pink Bollworm (*Pectinophora gossypiella*)—thereby increasing the need for pesticide sprays.¹⁰

In addition to increased pest attacks, entomologists at the Indian Agricultural Research Institute in New Delhi determined that the Bollworm is developing resistance to the Bt toxin. The study found that protection afforded by the Bt gene at best lasts only six years.¹¹

The near systemic economic failure of Bt cotton in India has left many farmers with increased debt and virtually no means of support for their families.

Proponents of agricultural biotechnology have suggested that farmers set aside land for non-Bt “refuges.” Planted with conventional or traditional varieties of the same crop, these refuges provide Bt-free food for cotton pests, thus slowing the speed with which pests develop

resistance to Bt. Indian farmers, however, consist of predominantly small to marginal landholders operating on less than two hectares of land and are thus unable to set aside land for pest refuges.¹² U.S. studies confirm that eliminating or decreasing the size of Bt-free refuges increases the probability that pests such as the Cotton and Pink Bollworm will develop resistance to Bt, thereby rendering transgenic Bt crops obsolete.¹³

The development of Bt resistance has another potentially devastating effect: organic farmers rely on Bt to control pests without the use of synthetic chemical pesticides. Loss of Bt as an effective pest management tool threatens the economic success and livelihood of organic farmers.

Increased costs and decreased net profits

Bt cotton crops garnered a lower overall market value in India due to inferior quality and smaller staple sizes. Farmers received an average rate of around Rs. 1,500¹⁴ per quintal for Bt cotton, com-

pared to the normal rate of Rs. 2,000–2,200 per quintal for high quality conventional cotton crops.¹⁵

Sixty percent of Bt cotton farmers in the states of Maharashtra and Andhra Pradesh failed to recover their production costs, with most showing losses of up to Rs. 80 per acre. Input costs for Bt crops were approximately Rs. 1000 per acre higher than for conventional non-Bt varieties, and Bt seed costs alone were roughly four times higher than costs for conventional seeds.¹⁶

Substantial economic losses were associated with sowing Bt cotton seeds in four Indian states (see table below).¹⁷

The social impacts of the failure of Bt cotton

Farmers from the states of Karnataka and Andhra Pradesh have burned Bt cotton fields to protest the biotechnology company Monsanto–Mahyco’s attempt to push GE crops on Indian farmers. Monsanto owns the patent rights to the popular Bt cottonseed variety “Bollgard,” and has profited from charging “technology fees” on top of seed prices. The ability of biotechnology companies to control patent rights not only leads to higher seed costs, but also ends farmers’ ability to practice the age-old tradition of saving seeds from previous growing seasons.¹⁸

The near systemic economic failure of Bt cotton in India has left many farmers with increased debt and virtually no means of support for their families. Reports from states such as Punjab, Andhra Pradesh and Karnataka indicate that farmers have resorted to selling their kidneys to repay loans and protect family honor; suicide rates have increased significantly.¹⁹

Economic Viability of Bt Cotton in India

(in rupees/acre)

| States | Profit or Loss | | Economic Loss with Bt Cotton* |
|----------------|----------------|----------------|-------------------------------|
| | Bt Cotton | Non-Bt Hybrids | |
| Maharashtra | -1,500 | +10,750 | -12,250 |
| Andhra Pradesh | -1,500 | +10,750 | -12,250 |
| Madhya Pradesh | +543 | +6,315 | -5,772 |
| Karnataka | -1,285 | +3,750 | -5,035 |

*Economic loss includes the actual loss incurred by farmers as well as the opportunity cost, i.e., the loss incurred by choosing not to grow a more profitable non-Bt variety.

Source: Jafri, H. and V. Shiva. Failure of Bt Cotton in India. *Research Foundation for Science, Technology and Ecology*. September 26, 2002. www.vshiva.net/articles/gmo_failure.htm.

Argentina A Desert of Soy²⁰

Over the past ten years, the quantity of soy grown in Argentina, mostly for export, has almost tripled. Two major technological innovations have fuelled the precipitous growth of soybeans in Argentina: the farming technique known as direct seeding²¹ and the introduction of herbicide-resistant soybeans. In 2003, close to 100% of Argentina's soy production relied on direct seeding and herbicide resistant seeds. Both technologies are part of an input-intensive, industrialized system of agriculture that, studies show, has increased pesticide dependence and harmed rural environments.

Increased pesticide use

Contrary to the claims of the biotech industry, Roundup Ready (RR) soybeans (soybeans genetically modified to resist the herbicide Roundup) use an average of more than double the amount of Roundup when compared to conventional varieties.²² The Institute of Science and Society reported that in 2001 more than 9.1 million kilograms of extra herbicide use resulted from the adoption of herbicide resistant soy in Argentina. The use of glyphosate (the active ingredient in Roundup) for all crops doubled between the 1997/98 and 1998/99 growing seasons, from 28 million liters to 56 million liters, and reached 100 million liters in 2002.²³ Herbicide resistant varieties of soy were also treated more often, at a rate of 2.5 applications per year, compared to 1.9 per year for conventional varieties.²⁴ Similarly, a recent paper published by Bio Tech Info Net documents that in the U.S., the average amount of herbicide applied per acre planted has increased compared to the first few years of adoption. The paper attributes the increase to predictable ecological adaptations, including changes in weed communities and herbicide resistance.²⁵

Argentina's reliance on a single herbicide (Roundup) increases the likelihood that farmers will experience problems with herbicide resistant "superweeds." Already, the list of weeds resistant to glyphosate in Argentina include: *Commelia erecta*, *Convolvulus arvensis* (bindweed), *Ipomoea purpurea* (morning glory), *Iresine difusa* (iresine), *Hybanthus parviflorus* (violetilla), *Parietaria debilis* (pellitory), *Viola arvensis* (violet wild), *Petunia axillaris* (petunia), *Verbena sp* (verbena), *Tragopogon sp* (goats beard), *Senecio pampeanus* (ragwort) and *Taraxacum officinale* (dandelion). Highly toxic herbicides, some of which are banned in other countries,

are being used in Argentina in addition to glyphosate to control these superweeds. These herbicides include 2,4D, 2,4DB, paraquat, atrazine, metsulphuron methyl and imazethapyr.²⁶

Argentina's RR soy monocultures are also under attack by an increasing number of stinkbugs (a major soy pest) including, *Nezara viridula* (Southern Green Stink Bug), *Piezodorus guildinii* (Westwood), *Edessa mediot-abunda* and *Dichelops furcatus*. To control stinkbugs, farmers are using a mixture of the pesticides endosulphan and cypermethrine (both chemicals are suspected endocrine disruptors) that is extremely toxic to bees, fish and birds.²⁷

Yield reductions

Argentinean research shows that RR soy yields 5% to 10% less per hectare than conventional soy seed varieties under similar environmental conditions.²⁸ Studies in the U.S. indicate that not only are yields for RR soy varieties lower, but they are also likely to decrease even more over time. Scientists have found that herbicide resistant soybean root development, nodulation and nitrogen fixation are increasingly impaired, and the effects are exacerbated by drought and soil infertility. As a result, fields containing RR crops and treated with glyphosate may yield up to 25% less than conventional crop varieties.²⁹ Researchers are also identifying increased levels of the fungus *Fusarium* in cornfields previously planted with RR soy. Twenty percent of Argentina's agricultural sector operates on a soy-corn-wheat rotation; research in these fields show that *Fusarium* related diseases could have substantial impacts on corn production. Scientists agree that *Fusarium*-driven diseases are the number one cause of yield losses in corn crops.³⁰

Argentina's increasing dependence on industrial monocultures has devastating social implications as well, creating an "agricultural nation without farmers."

The social costs of failed GE crops

Researchers have found that RR soy crops are a prime driver of Argentina's shift towards industrialized monocultures for export. The intensification of agriculture

in Argentina has caused numerous social and environmental problems, including excessive spraying of glyphosate, 2,4D and paraquat, which have polluted rural water supplies and caused health problems. In addition, flooding has occurred, as forests are cleared to plant more GE soy crops.³¹ In the city of Santa Fe, floods led to the evacuation of 140,000 people and several deaths. Large portions of the city were completely submerged and thousands lost their homes and all their possessions.³²

China GE Crop Failure Looming

Studies from China indicate that unlike other developing countries, many Bt cotton farmers have experienced higher yields and lower pesticide use. Nonetheless, scientists are beginning to identify problems with pest resistance and loss of beneficial insects that are common in other developing countries. The research indicates that although initially GE crops provided some environmental and economic benefits, Chinese farmers will be unable to escape the long-run risks associated with growing GE crops.

Pest resistance

A study conducted by the Nanjing Institute of Environmental Sciences found that the Cotton Bollworm is developing resistance to Bt cotton crops in China. Furthermore, the study showed that although it appears that Bt cotton is not directly harming the bollworm's

predatory natural enemies, there is conclusive evidence indicating a negative effect on parasitic natural enemies of this major cotton pest. The study also showed that Bt cotton is not effective against many secondary pests. The long-term effects of increased pest resistance and the loss of beneficial insects could have substantial economic impacts on Chinese farmers.³⁵

In January 2003, a comprehensive survey of consumer attitudes toward GE foods in China found the majority of respondents surveyed would choose non-GE food over GE food, and many were willing to pay more for it.

Moreover, laboratory tests in China indicate that Bt cotton will probably lose its resistance to the Cotton Bollworm wherever fields have been planted with it for eight to ten consecutive years.³⁶ Similarly, laboratory tests conducted in the U.S. show that 15 different pest species have already developed resistance to Bt proteins,

Argentina's increasing dependence on industrial monocultures has devastating social implications as well, creating an "agricultural nation without farmers."³³ Over 300,000 farmers have migrated to the cities and more than 500 villages have been abandoned or nearly abandoned. Much of Argentina's population is on the brink of economic ruin, with close to 43% or 13 million people struggling with debilitating financial debt.³⁴

including the beet armyworm, one of China's major cotton pests.³⁷

Chinese domestic markets and trading partners reject GE

The Chinese government spent nearly US\$112 million on biotech research in 1999 and plans to quadruple its spending by 2005. While this research has led to the commercial release of several GE varieties of tomato, sweet pepper, chili pepper and petunia, the area planted with these four crops remains small. Chinese farmers remain reluctant to fully embrace GE crops due to the possible loss of markets.

Significantly, members of the Chinese Agricultural Biosafety Committee have admitted that the economic benefits of adopting these crops are minimal or non-existent. As a result, no private companies have been attracted to invest in their commercialization.³⁸

In January 2003, a comprehensive survey of consumer attitudes toward GE foods in China found the majority of respondents surveyed would choose non-GE food over GE food, and many were willing to pay more for it.³⁹ In addition, roughly 87% of consumers surveyed wanted GE foods to be labeled. Because most of China's agricultural production is consumed domestically, these findings are of substantial economic importance to the Chinese agriculture industry.⁴⁰ As of 2003, 32 Chinese food producers, with 53 different brands, had agreed not to sell genetically altered food. The companies include well-known brands such as Lipton, Wrigley, Wyeth and Mead Johnson.⁴¹

Moreover, China enacted GE labeling regulations in 2001 to safeguard citizens, animals and the environment against the untested effects of GE food. The regulations provide cost incentives to non-GE producers

and have caused many farmers to express concerns over the loss of competitiveness associated with adopting GM crops.⁴² Actually applying the legislation, however, has been more problematic as Chinese officials struggle to find cost-effective methods of identifying GE products with sufficient sensitivity.

While only 5% of China's agricultural production is devoted to export markets, the total value of exported crops remains significant. Five out of China's top ten

trading partners have enacted labeling regulations that will limit international markets for GE products, including Japan, the European Union (EU), South Korea, Russia and Australia.⁴³ Chinese farmers and food processing companies have already experienced troubles accessing export markets due to regulations; in 2000, Britain banned the import of Chinese soy sauce containing GE soybeans—soybeans grown in the U.S., but processed in China.⁴⁴

Lessons for the Developing South

The North American experience

The negative experiences of GE farmers in developing countries is supported by a growing body of research from North America on the long-term impacts of GE crops, showing that many North American GE farmers are faced with increased costs, decreased productivity and loss of export markets. In light of this information, the rapid increase of land under GE cultivation presents a major risk to millions of farmers worldwide.

GE crops: added costs and decreased productivity

A recent paper published by Bio Tech Info Net analyzing data collected by the United States Department of Agriculture (USDA) found that in the first eight years (1996–2003) of GE crop production, total pesticide use increased 50.6 million pounds.⁴⁵ The increased pesticide use is attributed to naturally occurring physiological changes, shifts in weed or insect populations and growing pest resistance.⁴⁶ The paper found that the increase, in large part due to growing pest resistance in herbicide tolerant crops, substantially increased input costs for U.S. farmers.

In addition to herbicide resistant weeds, herbicide resistant volunteers⁴⁷—crops from previous seasons that fail to germinate initially but emerge later and are resistant to herbicides—pose significant, yet hard to calculate costs for GE farmers. Canola (rape seed) farmers throughout western Canada have reported instances in which volunteer populations have increased beyond a controllable level.⁴⁸ Furthermore, a recent study by the Canadian Wheat Board showed that the problems associated with RR wheat volunteers exceeded those of canola. The study concluded that, in the future, her-

bicide resistant volunteers will pose the largest threat toward maintaining a profitable RR wheat industry.⁴⁹

Multiple studies confirm that GE crops have produced lower yields when compared to non-GE varieties.

For instance, U.S. studies show that Roundup Ready soybeans yield between 5%–19% less than

conventional varieties.⁵⁰

Research also shows that in years with low pest pressure, U.S. farmers lose more money on Bt corn seed than they save during high pressure years—resulting in a net loss.⁵¹ Canadian research, such as a 1999 University of Saskatchewan study, has shown that yields for Roundup Ready canola were 7.5% less than conventional varieties.⁵²

Researchers have also identified an increased susceptibility to *Fusarium*-driven diseases in GE crops. In the U.S., studies show that *Fusarium*-driven seedling, root and stalk rot were the primary diseases impacting corn farmers in terms of aggregate yield losses. In addition, *Fusarium* Head Blight continues to be the number one problem plaguing U.S. wheat farmers. Scientists have identified increased *Fusarium* levels in wheat fields previously planted with RR soy. Problems associated with *Fusarium*-driven diseases could have substantial negative long-term impacts on yield and pesticide use.⁵³

The negative experiences of GE farmers in developing countries is supported by a growing body of research from North America on the long-term impacts of GE crops, showing that many North American GE farmers are faced with increased costs, decreased productivity and loss of export markets.

Finally, the prices paid for GE seed varieties are significantly higher than non-GE varieties because biotechnology companies are able to charge a “technology fee” on top of seed price.⁵⁴

Loss of export markets

Although the position of the European Union (a major importer of Indian, Argentine and Chinese agricultural products) on GE regulation and labeling legislation has weakened in the past several months—in large part due to U.S. pressure—the European public remains overwhelmingly opposed to GE crops. In a recent public opinion poll, 70% of European Union (EU) consumers reported that they would refuse GE products and 94% are in favor of labeling.⁵⁵ In reaction to consumer resistance, EU regulatory officials have rejected agricultural exports likely to contain transgenic material. For example, the EU threatened to reject Namibia’s beef exports since Namibian cattle are fed South African maize, which may include genetically modified crops. EU officials are expected to maintain their precautionary approach towards allowing GE exports following the recent release of five independent studies confirming the negative environmental, health and economic impacts of GE foods.⁵⁶

In addition to the EU, mandatory labeling requirements are present in Japan, China, Korea, Australia, New Zealand, Indonesia and Russia.⁵⁷ Studies confirm that not only does consumers’ willingness to pay for GE food products decrease with the presence of labels,⁵⁸ but the estimated additional cost of implementing a labeling system ranges from US\$5 to \$25 per ton

depending on the type of grains and the traceability system.⁵⁹ Furthermore, U.S. surveys show that “the more North American consumers hear about genetically modified foods, the less they like them.”⁶⁰ International public opinion polls also show a decline in the global acceptance of GE crops (i.e., global demand) and an increased willingness to pay a premium for non-GE crops.⁶¹

Decreasing global demand for GE crops is pushing down their price in international markets. Reports from the Institute for Agriculture and Trade Policy indicate that 25–30% of U.S. corn grown and 30% of U.S.-grown soybeans sold for less-than-production costs on international markets in 2002.⁶² As a result of declining transgenic crop prices, many U.S. farmers are beginning to question the economic viability of adopting GE technology and thus putting pressure on agricultural biotechnology companies to deliver the promised economic benefits. In May 2004, Monsanto announced that it would abandon its efforts to commercially release GE wheat, citing consumer rejection⁶³ and concerns from North American farmers as the primary reasons for the abandonment.⁶⁴ Monsanto’s failure to release GE wheat led to a US\$1.01 decline in Monsanto’s share price. Similarly, during Bayer AG’s 2004 annual general meeting, concerned investors appealed to Bayer’s executive board and an estimated 7,000 shareholders, on economic grounds, noting Bayer’s failure to commercialize GE maize in the UK, which led to a 1.9% drop in the company’s share value. The investors pointed out that a similar rejection of Bayer’s GE oilseed rape by Belgian authorities limited the market for Bayer products.

World Bank GE Funding Pushing a Losing Technology on the Developing South

Despite the well documented economic risks associated with GE crops, the World Bank continues to finance the research, development, field-testing and planting of transgenic varieties in the developing South. Recent internal World Bank documents, such as the briefing note entitled “Biotechnology for Poverty Alleviation and Economic Growth: challenges and options for the World Bank,” indicate that the Bank has already approved US\$50 million in project loans for “agricultural biotechnologies,” including funds to develop transgenic crops such as Bt cotton and Bt rice.⁶⁵ A dozen or more World Bank-funded projects, in Brazil, Indo-

nesia, India, Peru, Romania, Ethiopia, Mozambique and Kenya refer specifically to agricultural biotechnology in publicly available project documents.⁶⁶ For example, the India National Agricultural Technology Project (NATP) is a five-year, US\$200 million project that allocates \$20 million to support the research and development of transgenic cotton, rice, sorghum and groundnut, as well as “large-scale production of transgenic chickpea and pigeon pea plants.”⁶⁷ Other projects, such as the Mozambique Agricultural Sector Public Expenditure Project (MASPEP), plan to use

Bank funds to introduce or revise laws regarding intellectual property rights on genetic resources. The MAS-PEP plans to devote resources to “addressing issues surrounding intellectual property rights and patents for the import and sale of trademark genetic material and other technology.”⁶⁸

The research reviewed in this paper indicates that the World Bank’s continued support for GE crops is a clear violation of the Bank’s stated goal to alleviate rural poverty and promote sustainability by supporting agricultural systems that are “environmentally sound, financially and economically feasible and socially acceptable.”⁶⁹ Pesticide Action Network North America recommends that rather than relying on risky GE technology, the World Bank should:

- Support rural development strategies that empower rural communities to control their own resources and build on local agricultural knowledge and technology systems;
- Emphasize farming strategies that rely on local agricultural biodiversity and locally available inputs that have been shown to increase farmers’ profits, protect the environment and biodiversity, and lower rural poverty levels;⁷⁰ and
- Institute a moratorium on financing the research and introduction of GE crops until lasting economic benefits for farming communities can be proven, and independent safety testing proves no harmful effects on human health, ecosystems and the environment.

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Notes

- 1 The first was carried out in the states of Maharashtra, Madhya Pradesh, Andhra Pradesh and Karnataka by the New Delhi-based non-governmental organization (NGO) Research Foundation for Science, Technology and Ecology (RF-STE): Jafri, H. and V. Shiva. *Failure of Bt Cotton in India*. Research Foundation for Science, Technology and Ecology. September 26, 2002. www.vshiva.net/articles/gmo_failure.htm. The second study was conducted in Maharashtra and Andhra Pradesh by the New Delhi-based agricultural policy think tank, *Gene Campaign: Performance of Bt Cotton in India: Data from the first Commercial Crop*. Gene Campaign. April 2003. Available at: www.genecampaign.org/bt-cotton.html.
- 2 1 quintal = 100 kilograms = 220.46 pounds. 1 acre = 0.4047 hectares.
- 3 Jafri, H. and V. Shiva, 2003, op cit.
- 4 Krishnakumar, A. A Lesson From the Field. *Frontline*. Vol. 20: Issue 11. May 24–June 6, 2003.
- 5 The 2003 Gene Campaign study divided landholdings into low yielding, medium yielding and high yielding based on the quality of soil, topography, availability of water for irrigation and the resource capacity of farmers.
- 6 *Fusarium* is a type of fungus that is associated with a number of crop and livestock diseases. The most common *Fusarium*-driven diseases include root rot (caused by the fungus *Rhizoctonia bataticola*) and wilt (caused by the fungus *Fusarium oxysporum*).
- 7 Jafri, H. and V. Shiva, 2003, op cit. Researchers that have confirmed these findings include: Dr. S.W. Khodke of the Zonal Agriculture Research Center (ZARC) in Yawatmal; Dr. Jalapathi Rao of the Agriculture Research Center in Warangal; and Mr. A.M. Ingle, Agricultural Development Officer (ADO) of Yawatmal.
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- 9 Jafri, H. and V. Shiva, 2003, op cit.
- 10 Gene Campaign, 2003. op cit. and Jafri, H. and V. Shiva, 2003, op cit.
- 11 Bt Cotton Benefits Short Lived: Study. *The Financial Express*. February 11, 2004. www.financialexpress.com/full_story.php?content_id=52355.
- 12 Krishnakumar, A, May 24– June 6, 2003, op cit.
- 13 Jafri, H. and V. Shiva, 2003, op cit.
- 14 The exchange rate for the Indian Rupee (Rs.) in terms of U.S. dollars is approximately Rs. 45.26 (i.e., \$1 = Rs. 45.26). Exchange rate accurate as of February 5, 2004.
- 15 Jafri, H. and V. Shiva, 2003, op cit.
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- 17 Jafri, H. and V. Shiva, 2003, op cit.
- 18 Monsanto says it wants to help the poor. But millions of them want it gone. *The Ecologist*. 1999. www.paulkingsnorth.net/monsanto.html.
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- 20 Valente, M. The Green Desert of Soya. Inter Press Service News Agency. August 30, 2003. <http://ipsnews.net/interna.asp?idnews=19906>.
- 21 Seeds are planted directly into the soil, without the need for plowing, and herbicides are used to remove weeds.
- 22 Benbrook C., 2002, op cit.
- 23 Ho, M. and L. Joensen. Argentina’s GM Woes. Institute of Science in Society: 2002. www.i-sis.org.uk.
- 24 Benbrook C., 2002, op cit.
- 25 Benbrook, C. *Impacts of Genetically Engineered Crops on Pesticide Use in the United State: The First Eight Years*. Bio-tech Info Net, Technical Paper Number 6. November 2003.
- 26 Bleakley, C. GE Soybeans Have Been a Disaster in Argentina. Press Release, September 8, 2003. Available at: www.organicconsumers.org?ge?argentina.cfm. The press release summarizes the findings of “Biotechnology and the origins of the Argentine Catastrophe,” Eduardo Rulli de Jorge, *Ecopartal* 11-09-02. Movimiento Campesino de Formosa (Peasant Movement of Formosa) September 8, 2003.
- 27 Ibid.
- 28 Ho, M. and L. Joensen, 2002, op cit.
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- 32 Ibid.
- 33 Ibid.
- 34 Beakley, C., 2003, op cit.
- 35 Xue Dayuan. *A Summary of Research on the Environmental Impacts of Bt Cotton in China*. Nanjing Institute of Environmental Sciences and the State Environmental Protection Administration of China. Greenpeace: June 2002. www.greenpeace.org.
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- 37 Latham, D. *The Ecological Effects of Genetic Engineering Technologies in Agriculture*. University of California, Berkeley. May 13, 2003.
- 38 Huang, J. and Q. Wang. Agricultural Biotechnology Development and Policy in China. *AgBioForum*, 5(4): 122–135. 2002.
- 39 Food companies go GE-Free in China. Greenpeace press release. July 18, 2003. www.thecampaign.org/News/july03t.php#food.
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- 41 Ibid.
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- 43 Carter, C. International Approaches to the Labeling of Genetically Modified Foods. *Agriculture and Resource Economics*, Vol. 6, No. 1. September–October 2002.
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- 45 Benbrook, C., 2003. op cit.
- 46 Ibid.
- 47 Volunteers are crops that were planted in previous growing seasons that failed to germinate then and instead germinate in later seasons; or plants that grow from split seeds of previously planted crops. Usually, extra glyphosate would be applied to get rid of volunteers, but RR crops are resistant, and thus glyphosate is ineffective.
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- 49 *An Environmental Safety Assessment of Roundup Ready Wheat: Risks for Direct Seeding Systems in Western Canada*. The Canadian Wheat Board. June 2003.
- 50 Benbrook, C. *Troubled Times Amid Commercial Success for Roundup Ready Soybeans*. Northwest Environmental Policy Center. AgBioTech InfoNet Technical Paper Number 4. May 3 2001.
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- 54 Soil Association, 2002, op cit.
- 55 European Parliament Lifts GM Food Ban. Press Association. July 2, 2003. Available at: www.thecampaign.org/news.
- 56 Growing Evidence of GM Risk. *Evening News (Scotland)*. October 24, 2003. The five studies cited were reviewed in the first report completed by the GM Science Review Panel, commissioned by the British government. For more information on this report see: *GM Science Review First Report: An open review of the science related to GM crops and food based on the interest and concerns of the public*. July 2003. <http://www.gmsciencedebate.org.uk/default.htm>.
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