WFL Publisher
Science and Technology Food, Agriculture & Environment Vol.1(2) : 258-261. 2003 www.world-food.net

Can GM and non-GM crops coexist? Setting a precedent in Boulder County, Colorado, USA

P.F. Byrne[1*] and S. Fromherz[2]

[1] Department of Soil and Crop Sciences, Campus Delivery 1170, Colorado State University, Fort Collins, CO 80523, USA.[2] Department of Molecular, Cellular and Developmental Biology, UCB 347, University of Colorado, Boulder, CO 80309, USA. email: pbyrne@lamar.colostate.edu*

Received 11 january 2003, accepted 18 April 2003.

Abstract

The coexistence of genetically modified (GM) and non-GM crops has emerged as one of the key issues in the ongoing debate over genetically engineered food. Some growers of organic and conventional crops fear economic losses if GM components are present in their fields or harvested products. We describe a public process in Boulder County, Colorado, USA, in which protocols were developed to encourage coexistence of GM and non-GM maize (*Zea mays* L.) on publicly owned Open Space farmland. The protocols (1) approve GM maize hybrids on a case-by-case basis; (2) promote communication among neighboring farmers; (3) provide for a 46 m buffer zone to keep cross-pollination between adjacent fields below 1%; (4) support measures to minimize the probability of insect resistance development; and (5) call for monitoring and dispute resolution mechanisms. These protocols, which will go into effect in the 2003 growing season, were developed with the intention of supporting organic, conventional, and GM crop farmers and encouraging shared responsibility for identity preservation of non-GM crops.

Key words: GM crops, organic farming, coexistence, pollen drift, *Zea mays*, transgenic.

Introduction

The growth in U.S. cropland planted to genetically modified* (GM) crops has occurred simultaneously with growth in the demand for organically produced foods. The U.S. GM crop area grew from 1.5 million ha in 1996 to 39.0 million ha in 2002[1], while retail sales of organic products increased by approximately 20% annually from 1996 to 2000[2]. It can be argued that both GM and organic agriculture are approaches to improving conventional† farming methods, e.g. by reducing the use of synthetic chemical pesticides, improving soil management, and increasing economic returns to farmers. However, not all observers share that view. Lyson[3] argued that the differences between biotechnology-based and organic agriculture are so fundamental that we will see the development of two distinct food production systems. As currently implemented, the two forms of agriculture are in conflict because (1) U.S. organic standards prohibit the use of genetically engineered inputs, and (2) pollen drift from GM crops to nearby organic fields can reduce the marketability of some organic crops. A 2002 survey of U.S. organic growers found that 48% had taken some measures to avoid the presence of GMOs (genetically modified organisms) in their farming operations, and 8% had borne direct costs or damages associated with the presence of GMOs[4].

Given the increasing importance of both the biotechnology and organic food production sectors, coexistence between the two becomes a critical issue. Several national ministries of agriculture, international organizations, and trade groups have undertaken studies or proposed guidelines addressing the coexistence issue[5-8]. Discussion of coexistence has been less prominent in the U.S., although the potential field planting of bio-pharmaceutical crops has increased interest in the topic[9].

In this article, we describe a public process in Boulder County, Colorado, USA that resulted in protocols for encouraging coexistence between GM crop farmers and their neighbors who wish to preserve the identity of their non-GM crops. To our knowledge, this is the first time a public entity in the U.S. has approved guidelines addressing the coexistence issue.

The setting: Boulder County is situated in the eastern foothills of the Rocky Mountains and adjacent plains, a region that has experienced rapid population growth in recent decades. As early as the 1970s, both the City of Boulder and Boulder County implemented Open Space programs to preserve farmland and natural areas in their undeveloped states, thus limiting the extent of residential and commercial development. Both city and county programs include outright purchase of land as well as conservation easements. In 2002, the amount of land managed by the county Open Space program was approximately 8,000 ha, with about 1,600 ha leased to farmers for crop production. In recent years, from 160 to 200 ha of insect resistant and herbicide tolerant GM maize have been planted annually on Boulder County Open Space (R. Alexander, Boulder County Parks and open Space, personal communication).

Boulder County residents are divided on their feelings toward genetic engineering. In 2001, a survey of 600 voting-age residents indicated reluctance by a plurality (46%) to accept GM organisms without further study, while 36% said they believe GMOs are a scientific advance that will allow us to better feed the hungry and reduce chemical use[10]. Boulder County residents provide relatively strong support for local agriculture, especially organic agriculture, as evidenced by the number of growers who produce for the local market.

Formation of advisory committee: Prompted by requests from a local activist organization, the county commissioners (highest ranking elected officials in the county) held public hearings in

* We use the terms "genetically modified" and "GM" to describe plants containing DNA transferred using recombinant DNA technology; synonymous with "genetically engineered" and "transgenic."

† We use the term "conventional" to describe practices that are neither organic nor based on biotechnology.

June, 2000 and January, 2001 to discuss the question: "Should the county prohibit the use of genetically modified crops on Boulder County Open Space land leased to farmers?" After 15 hours of testimony, the commissioners decided against a ban on GM crops. Instead they supported a thoughtful decision-making process to consider the appropriateness of specific GM crop varieties on county Open Space. This decision led to the formation of the Genetically Modified Organism Technical Advisory Committee (GMO-TAC). The purpose of the committee was "... to provide direction to the Boulder County Parks and Open Space Department (BCPOS) on the use of GMOs on county owned agricultural land," to recommend appropriate protocols for planting Bt*, Roundup Ready®†, and Liberty Link®¶ maize on county-owned land, and to consider potential impacts on organic maize growers in the vicinity of GM crops on Open Space lands.

The GMO-TAC was a 10-member advisory board appointed by the county commissioners in mid-2001. The commissioners solicited applications through public notices for volunteers to serve on the committee. In selecting the members, the commissioners attempted to assemble a balance of technical expertise, organic, conventional, and GM crop farming experience, and general citizens' views. The committee consisted of:

- Three university scientists (including the authors of this article) with specialties in plant molecular biology or plant breeding and genetics;
- Three local farmers: a retiree who acted as a representative of the Colorado Farm Bureau; a BCPOS-lessee who has grown both conventional and GM crops; and a commercial grower of both conventional and organic crops;
- An economist and policy analyst with specialties in natural resources and the environment;
- A former plant biotechnology researcher;
- A citizen with a background in microbiology and dispute resolution;
- A businessman and activist in the organic food industry.

In addition to the appointed members, the GMO-TAC benefited from the services and advice of several county staff, including a policy analyst from the commissioners' office, who acted as chair of the committee's meetings, recorded minutes, and provided other administrative services; an agricultural resource specialist who manages the BCPOS agricultural programs; and the county attorney.

Operating procedures and principles: The members met approximately monthly in meetings that were announced through public notices in newspapers, at the county courthouse, on the BCPOS website, and through a specific email list of interested persons compiled by county staff. In accordance with state and local open meeting requirements, public notice was given for any meeting of two or more committee members. A public comment period was scheduled at the end of every meeting, and minutes were posted on the county's website. The group adopted its own operating procedures. It determined that decisions would be made by a two-thirds majority vote of members present at any meeting where a quorum was present. It stipulated that any member could present a minority report.

The committee also adopted a set of principles to guide the development of protocols. These principles state that:

1) Farmers have the right to grow crops by any allowable method to achieve maximum yield and productivity, minimum negative effects on the environment, and alleviation of pests such as weeds and insects;
2) Farmers should observe planting and growing protocols that preserve the identity of hybrid, organic, transgenic, and other types of crop varieties;
3) Farmers should adhere to protocols that prevent development of Bt insect resistance, and that will therefore continue to permit the use of pest control options by other Boulder County farmers and gardeners;
4) Crops and production methods used on Open Space land should be implemented with the goal of minimizing any detrimental environmental impact; and

All transgenic crops must have approved protocols that reflect the above beliefs before being grown on Open Space cropland.

Results

The committee's accomplishments can be divided into three major categories: (1) fact-finding, which lasted nearly a year; (2) a research study on pollen drift in maize during the 2002 growing season; and (3) development of protocols, which extended over a three-month period.

Fact-finding: Rather than attempting to investigate a comprehensive set of issues involving transgenic crops, the committee focused on topics likely to have a direct impact on the local environment or farming operations. Topics studied and discussed by the committee included the following:

- BCPOS agricultural leasing program, including current GM crop policy.
- Definition of a GM crop.
- Reproductive biology of maize.
- Molecular biology and mode of action of Bt, Roundup Ready®, and Liberty Link® maize.
- Regulation of GM crops.
- Organic certification and the new U.S. federal organic standards.
- Insect resistance management.

In addition, several speakers from outside the committee were invited to make presentations on specific topics (Table 1). The committee also received input from time to time from knowledgeable persons in the audience, for example, on legal issues, state pesticide regulations, or procedures for monitoring insect resistance.

Pollen drift study: A major concern raised by the growing of GM maize on county-owned land is that pollen drift from GM hybrids will cross-pollinate with organic or non-GM conventional maize, potentially reducing the marketability of the latter crops. Therefore, the GMO-TAC research subcommittee undertook a study to estimate the amount and distance of pollen drift in maize. Although similar studies have been conducted in other parts of the U.S., to our knowledge none had been carried out under conditions similar to Colorado's maize growing areas.

Trials were grown in two locations during the 2002 growing season, and a different marker trait was used to track pollen drift at

* Insect-resistant maize containing a gene from the soil bacterium *Bacillus thuringiensis*.

† Maize engineered for tolerance to the herbicide glyphosate.

¶ Maize engineered for tolerance to the herbicide glufosinate.

each site: blue kernel color on BCPOS land, and glyphosate tolerance (the Roundup Ready® trait) on a cooperating farmer's land in Morgan County, about 110 km to the east. Plots of maize with one of these traits were planted adjacent to maize varieties lacking the traits. At harvest, samples of 10 ears were collected at each of 8 to 10 predetermined distances (0.8 to 305 m) to the north, south, east, and west of the blue maize, and at each of eight distances (3 to 296 m) in two parallel strips to the north of the glyphosate-tolerant maize. Details of the experimental protocols and complete results of these trials will be reported elsewhere. Results relevant to protocol development are summarized here.

As expected, the amount of cross-pollination was high at the closest sampling sites, reaching 46% at the 0.8 m distance to the south of the blue maize plot. Cross-pollination dropped off rapidly with distance, so that by 46 m in the blue maize trial, an average of 0.23% (range of 0.02 to 0.53%) cross-pollinated kernels were observed. In the Roundup Ready® trial, an average of 0.75% (range of 0.51 to 1.01%) cross-pollination was detected at 37 m. The farthest distance at which any cross-pollination was detected was 183 m (0.05% blue kernels) in the blue maize trial and 82 m (0.26% resistant kernels) in the herbicide tolerance trial. Our cross-pollination results were consistent with previous reports on pollen drift in maize[11-13]. Collectively, the studies indicated that 46 m is a reasonable isolation distance to ensure <1% cross-pollination. This figure was adopted in the protocols as the standard buffer distance to prevent unwanted GM maize pollination in adjacent maize fields. Realizing that because of year-to-year variability in weather conditions, one year's data is insufficient for this type of study, the BCPOS has sponsored the research again in the 2003 growing season.

Protocol development: After nearly a year of fact-finding meetings, two members of the committee collaborated to generate a relatively complete draft set of protocols that were meant to provide balanced representation of GMO-TAC members' diverse opinions. After considerable debate and modification, the committee adopted the protocols in November, 2002, with 7 of the 10 members supporting them, one opposing, one abstaining, and one absent. The county's Parks and Open Space Advisory Committee then discussed and adopted the protocols in December, 2002 on a 9-4 vote. Finally, the protocols were discussed at a public meeting of the Boulder County Commissioners, who adopted them unanimously in February, 2003. The protocols reflect the intent of the county government to remain a good neighbor to nearby growers by working together to avoid negative effects of GM crops on adjacent fields, particularly organic fields.

A copy of the protocols can be accessed at http:www.co.boulder.co.us/openspace/advisory/adv_pdfs/gmotac_protocol02-11-03.pdf.

Minority reports addressing Bt maize and IP grower and buffer zone responsibilities were also submitted, and these can be accessed at http://www.co.boulder.co.us/openspace/advisory/adv_pdfs/gmotac_minrpt11_26.pdf.

A central concept embedded in the protocols is shared responsibility for prevention of unwanted cross-pollination from GM to non-GM crops. Farmers on county Open Space planning to grow GM crops, as well as those desiring to preserve the non-GM identity of their crops, are asked to communicate their intentions to county officials. Where the possibility of unwanted cross-pollination occurs, the farmers involved are encouraged to communicate with each other to seek a satisfactory resolution. If none can be agreed upon, BCPOS and its lessee farmer will provide a buffer distance of 46 m (150 ft) to keep cross-pollination below the 1% level. If a lower percentage of cross-pollination is desired or required, the grower seeking identity preservation for his or her crop must provide the additional isolation distance.

Another key concept in the protocols is the need to evaluate GM crops on a case-by-case basis, rather than giving blanket approval or rejection of the technology and its products. For example, three Bt maize "events"* (Bt11, MON810, and TC 1507) were approved for control of European corn borer, but Bt maize for corn rootworm control (event MON863, recently approved by U.S. federal agencies) was not included in the protocols, and will require a separate decision before being allowed on county-owned land. Criteria to be used in allowing new GM crops or events will include usefulness of the GM trait for Open Space farmers, potential consequences on neighboring farm operations, and possible environmental effects. The protocols require strict adherence to insect resistance management plans for Bt maize to minimize the probability that insect resistance will develop, in accordance with existing U.S. Environmental Protection Agency and seed company requirements. The protocols also provide for a conflict resolution procedure, and a mechanism for monitoring compliance. The protocols do not address liability issues regarding unintended cross-pollination, as these were considered beyond the committee's mandate.

Discussion

The protocols developed by the GMO-TAC, and ultimately accepted by the county commissioners, came into existence because a majority of the committee members realized the complexities of the issues, displayed mutual respect despite opposing viewpoints, and recognized a need to compromise. Some members on both sides of the issue, however, were unwilling to modify their positions. One member stated that she voted in favor of the protocols only because it was her understanding that in the absence of protocols, GM crops on BCPOS would not be regulated beyond that of federal regulations. The willingness of most committee members to compromise arguably came from a genuine desire to consider and support both organic and GM crop farmers. In addition, the GM and organic farmers on the committee showed an understanding for their differing farming practices and emphasized repeatedly most farmers' desires to be good neighbors. The fact that the committee very clearly did not reach a unanimous decision suggests that other groups considering this volatile issue may be faced with a similar result. Throughout the time in which the GMO-TAC met, most members appeared committed to becoming more educated about GM crop topics and attempted to remain objective. The majority of members expressed satisfaction with the range of views presented by external speakers. However, three committee members felt that the range of viewpoints presented was unsatisfactory and requested that "scientifically credible" critics of GM technology and its applications be invited to speak. Although two of the scientists listed in Table 1 did make critical comments on several aspects of GM crops, local "scientifically

* A transgenic "event" indicates a successful DNA insertion. Events differ in the specific DNA segment transferred and the chromosome location of insertion. See the Ag Biosafety web site (http://www.agbiosafety.unl.edu/) for details on U.S. approved events.

Table 1. Invited speakers to the GMO-TAC and topics they addressed.

Speaker and affiliation	Topic
Two growers of GM crops on BCPOS	Farming practices and experiences with GM crops
An organic vegetable farmer in Boulder County	Farming practices and experiences with organic crops
The Director of Product Stewardship, Pioneer Hi-Bred Intl.	Development and regulation of GM crops
The Director of Regulatory Affairs, Syngenta Corp.	Development and regulation of GM crops
Professor of Bioagricultural Sciences & Pest Management and Extension Entomologist, Colorado State University	Effects of Bt maize on maize pests and the environment
Assistant Professor of Bioagricultural Sciences & Pest Management & Biological Control Specialist, Colorado State University	Unintended environmental effects of GM crops

credible" opponents of GM technology willing to speak to the committee could not be identified. A request from one member to fund the attendance of a specific out-of-state speaker was denied by the county, as funds were not available for that purpose. Local representatives of regional and national environmental activist groups declined invitations to speak.

The amount of public input to the committee, particularly anti-GM input, decreased markedly over time. At the first public hearing addressing GM crops on BCPOS, over 100 citizens attended, and the testimony, a substantial portion of which was anti-GM, lasted 15 hours. In contrast, at the public hearing held by the commissioners early in 2003 prior to their adoption of the protocols, fewer than 25 people attended and only a few raised objections. There was also a decrease in local newspaper articles devoted to the topic. Finally, a group of local citizens, who had expressed skepticism at the objectivity of the GMO-TAC and who had formed an alternative committee to consider GM issues, were not heard from after their initial objections. Anti-GM input most likely decreased either because those responsible for the original protests had moved on to other issues, or because they considered the GMO-TAC unreceptive to arguments favoring a ban on GM crops.

The level of controversy surrounding GM technology in Boulder County combined with public ownership of large tracts of cropland make this situation somewhat unusual, at least in the U.S. Nevertheless, we hope that the protocols described here will serve as a model for communities trying to strike a balance between GM and non-GM agriculture. Not all locations would need to conduct new pollen drift studies, if data from similar environments were already available. In our case, because of the low humidity and frequent high winds in Colorado, we felt it was important to have local results to help determine an appropriate isolation distance. In closing, we recommend that groups considering the coexistence of GM and non-GM crops seek a balance of perspectives on the issue, and that they emphasize compromise and mutual respect for differing points of view. We feel that shared responsibility for coexistence is a practical and desirable strategy, if based upon an acceptably low level of cross-pollination rather than a "zero-tolerance" level. Finally, we advise that each GM crop and "event" be evaluated for its specific risks and benefits based on the local environmental, economic, and social context.

Acknowledgment

We are grateful to Boulder County employees Jane Uitti and Rob Alexander and members of the GMO-TAC for the long hours devoted to the committee's work. The pollen drift study was funded by Colorado State University's Cooperative Extension Division and Boulder County Parks and Open Space Department.

References

[1] Crop Biotech Net. 2003. Global status of GM crops. Available on the World Wide Web: http://www.isaaa.org/kc/Bin/gstats/index.htm. Accessed May 23, 2003.

[2] Pew Initiative on Food and Biotechnology. 2002. Peaceful coexistence. AgBiotech Buzz vol. 2, issue 6, July 2, 2002. Available on the World Wide Web: http://pewagbiotech.org/buzz/archive.php3. Accessed May 23, 2003.

[3] Lyson, T.A. 2002. Advanced agricultural biotechnologies and sustainable agriculture. Trends in Biotechnology **20**: 193-196.

[4] Organic Farming Research Foundation. 2003. OFRF releases partial results of 4th National Organic Farmers Survey: First impacts of GMOs on organic farmers are now documented. Available on the World Wide Web: www.ofrf.org. Accessed May 25, 2003.

[5] Anonymous. 2003a. Government response to the Royal Commission on genetic modification: Report on managing the effects of GM organisms and coexistence in primary production - PAPER 1: overview. Available on the World Wide Web: http://www.maf.govt.nz/mafnet/rural-nz/research-and-development/biotechnology/gm-coexistence-decision/index.htm. Accessed May 23, 2003.

[6] Anonymous. 2003b. European Commission addresses co-existence of GM, conventional and organic crops. SeedQuest News Releases. Available on the World Wide Web: http://www.seedquest.com/News/releases/2003/march/5427.htm.Accessed May 23, 2003.

[7] Gene Technology Grains Committee. 2002. A strategic framework for maintaining coexistence of supply chains. Available on the World Wide Web: http://afaa.com.au, under Publications. Accessed May 22, 2003.

[8] Tolstrup, K., Anderson, S.B., Boelte, B., Buus, M., Gylling, M., Holm, P.B., Kjellson, G., Mikkelsen, S.A., Ostergard, H., and Pedersen, S. 2003. Report from the working group on the co-existence of genetically modified crops with conventional and organic crops. Danish Ministry of Food, Agriculture, and Fisheries. Available on the World Wide Web: http://www.fvm.dk/fvm_uk/news_extern.asp?artikelid=2074. Accessed May 23, 2003.

[9] Felsot, A. 2002. "Pharm farming." Agrichemical and Environmental News, no. 195, July 2002. Available on the World Wide Web: http://aenews.wsu.edu. Accessed March 10, 2003.

[10] National Research Center, Inc. 2002. A study of attitudes of Boulder County, Colorado residents regarding public policy issues. Report of results. National Research Center, Inc., Boulder, CO. Available on the World Wide Web: http://www.co.boulder.co.us/news/press_releases/2002/Biannual041502.htm.

[11] Jemison, J. M., and Vayda, M.E. 2001. Cross pollination from genetically engineered corn: Wind transport and seed source. AgBioForum 4(2): 87-92. Available on the World Wide Web: http://www.agbioforum.org. Accessed May 23, 2003.

[12] Luna V., S., Figueroa M., J., Baltazar M., B., Gomez L., R., Townsend, R., and Schoper, J.B. 2001. Maize pollen longevity and distance isolation requirements for effective pollen control. Crop Sci. 41: 1551-1557.

[13] Raynor, G.S., Eugene, C.O., and Janet, V.H. 1972. Dispersion and deposition of corn pollen from experimental sources. Agron. J. 64: 420-427.