Strategies to Minimize Genetic Contamination on Organic Farms

by Mary-Howell R. Martens

At a recent biotechnology conference at Cornell University, a consumer relations representative from Northeast grocery store chain Wegmans said that when customers come into their stores requesting "GMO-free food," they are directed to the organic food section. Consumers who are seeking reliably non-GM food are buying organic in record numbers. Partly because of that, demand for organic food is growing steadily each year, with international demand increasing even faster.

However, can organic farmers in the United States really produce non-GM crops? Can we produce the products that consumers think they are getting when they buy organic food? Many in the organic industry are beginning to doubt that this is possible. While no organic farmer would intentionally plant GM crops, the incidental contamination in some crops like corn and canola, known in the agricultural industry as "adventitious transgenic presence," is becoming increasingly common.

Billy Hunter, an organic and non-GMO inspector who works at Genetic ID, says, "All non-GMO corn grown in areas where corn is a major crop, such as the Midwest, is showing up contaminated, with an average of 0.25 percent of the kernels testing positive for GM marker genes. This is even higher where a lot of GM corn is grown. StarLink has been the big drifter in Iowa. The sum total is that all corn cross-pollinates, and if there is GM pollen in the air, it will inevitably contribute. Researchers at Genetic ID have not been able to find any corn from the U.S. 2000 crop that does not contain traces of GM content. We have tested hundreds of samples of non-GM corn from the upper Midwest, central Midwest and southern central states, and all of it shows some GM contamination." In Hunter's opinion, the situation has become "monstrous."

Francis Thicke, an organic farmer and soil scientist in Iowa, confirms this situation. His 2000 organic open-pollinated corn was tested after harvest and was found to be 0.25 percent contaminated. "We think it was from pollen drift, but the nearest Bt corn was over a mile away." His experience is being echoed by many other organic farmers throughout the Midwest, skilled experienced farmers who are careful to practice good organic management but, through no fault of their own, are harvesting contaminated crops.

What are organic farmers to do? Perhaps we are reaching the point when it is not possible to grow truly non-GM crops of some species in the United States. David Gould, an organic certification specialist from Oregon, says that "If indeed organic farmers must meet the zero tolerance standard, perhaps we won't be able to certify corn any longer in this country." Gould explains that there is no real international consensus of what "non-GM" means in food, and until this is set, organic farmers are at a disadvantage because they may be expected to grow a product that is virtually impossible to produce. However, he sees a real problem with setting such a level of acceptable contamination. "Once we set a definitive threshold, we then become obligated to test everything certified to be fair and accurate." And few in the organic community welcome that expense or burden.

Regardless of whether there are definitive acceptable thresholds established, the only way an organic farmer can ensure that their crops are essentially non-GMO is to take a very proactive approach, aggressively identifying key areas of risk on their farm and implementing strategies to minimize contamination at each point of exposure. Certifiers and consultants should play a key role in educating and sensitizing farmers on the main routes of contamination, providing education and information on risks and strategies. We can't just talk about how bad the problem is and about how unfair it is to organic farmers. We as organic farmers must actively take the responsibility to ensure that our organic crops are as protected as possible against potential GM contamination.

A management plan to limit the risk of GM contamination before it occurs would focus on four main points of contamination:

EXPOSURE RISK 1. SEED SUPPLY

Seed is arriving on organic farms already contaminated with traces of genetically modified DNA. In a 1999 study conducted by the American Corn Growers Association, 45 percent of the non-GM corn varieties tested positive for GM marker genes. Currently, there are GM versions of the following crops on the market: canola, corn (including sweet corn and popcorn), cotton, flax, papaya, radicchio, soybeans, squash, sugar beets and tomatoes. GM planting stock for bananas, potatoes and strawberries is also available. Within the next year or two, there will be commercially available GM varieties of alfalfa, wheat, rice, turf grasses and many other vegetables.

Seed purity can be defined by the percent physical purity (weed seeds, dirt, seed fragments) and percent genetic purity (variety identity). Apparently, no commercial seed sold in the United States is 100 percent pure, either physically or genetically, and a low level of either type of contamination is allowed under U.S. and international law. Genetic contamination from pollen drift, mixing in equipment, and genetic contamination of parent lines are all likely in seed production. Dean Urmston, Executive Vice President of the American Seed Trade Asso-

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March 2001 - Vol. 31, No. 3 - Page 16

ciation, recently noted, "With the increased commercialization of modern biotechnology and production of transgenic crops, traditional (non-transgenic) seed production has been subject to minute levels of adventitious presence of transgenic events. It is impossible at the current time to guarantee that traditional seed moving in international commerce will not have minute levels of adventitious presence of transgenic events." In other words, the non-GM bags of corn seed you buy in 2001 are likely to be a "Trojan horse" on your farm, carrying in GM contamination which can later be magnified as pollen carrying the contaminating DNA drifts within your field.

What can organic farmers do to ensure they are planting uncontaminated seed? The IOIA inspector manual instructs inspectors that "whenever crops which are known to be available as genetically engineered are being grown, all information, including statements from suppliers, must be assessed for accuracy." This sounds very responsible, but exactly what type of documentation should organic farmers obtain from seed dealers, and how will it be assessed to determine whether it is sufficient and accurate?

Requesting company statements of non-GM status of seed for the 2001 crop has been remarkably frustrating. Most companies are reluctant to state that their seed is uncontaminated, and those seed companies that will volunteer some type of documentation usually include broad disclaimers and evasions about absolute purity. *(See sidebar.)* In most cases, the seed companies honestly do not know whether their seed is pure or not. Many small seed companies produce little of their own seed, purchasing it instead from large seed production operations. Even larger seed companies may obtain parental inbreds from foundation seed companies such as Holden Seeds, which is owned by Monsanto. Without very stringent purity controls at every stage of seed production, seed contamination will be very difficult to control.

Obviously, simply getting a non-GM statement from the seed company does not prevent an organic farmer from obtaining contaminated seed. What requiring such a statement does do is to put the seed company on notice that there might be liability involved if they don't deliver what is promised. It may also show what lawyers might call "due diligence," that the organic farmer has done everything that is reasonably possible to ensure a non-GM seed supply. For many farmers, that may be the best they can do.

Some seed companies are proudly displaying the "Safe Seed Pledge" in their 2001 catalogs, stating that they do not knowingly sell any GM products. This is a worthy statement, showing an admirable philosophy on the part of the seed company. The pledge, however, makes no guarantees about the possible GM contamination of seed lot, though many customers may not realize that fact. Terry Allen of Johnny's Selected Seeds says, "It is a statement drafted and adopted by genuinely concerned seed companies to do our best to protect the integrity of our genetic resources and support healthy, sustainable agro- ecosystems. But — what if our best isn't good enough?"

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March 2001 - Vol. 31, No. 3 - Page 16

Very few seed companies test for GM contamination in their seed lots. NC+ Organics, in Lincoln, Nebraska, is one of the few companies that is attempting to supply the demand for organic, GM-tested seed. Maury Johnson, manager of

What is Genetic Testing?

It is important to understand the difference between DNA and its protein product. DNA, which is more or less identical in all cells of an organism, serves as a template or code upon which a protein is built. For example, chromosomes in all cells of a Bt corn plant contain a certain DNA sequence that was inserted during the genetic engineering process. This DNA acts as the instructions to tell the cell how to make the protein product, the Bt toxin, which then kills the insects. While the specific engineered protein product is of concern for human health, we do not know what health and environmental effects the altered DNA or other unintentionally altered proteins might eventually have.

The total DNA content in a given quantity of raw grain is fairly consistent, but protein expression can be affected by a range of factors, including the environmental conditions under which the grain was grown and the plant part sampled. Not all plant tissues on a single plant produce the same proteins at the same levels. When grain is processed, protein can be easily broken down by heat or acid and may not be detectable using the usual tests. That doesn't necessarily mean that the protein isn't present, it could just mean that the protein has lost its characteristic shape which allows positive test detection. The DNA molecule is much more resistant to degradation.

There are two main types of GMO tests available. The first type, the PCR test, extracts DNA from a sample of grain or food and detects certain characteristic marker sequences in the DNA molecule. DNA tests can accurately detect contamination down to the 0.01 percent level; that is, one contaminated kernel in 10,000, or approximately eight to 10 kernels of corn per bushel. Genetic ID terms genetically modified DNA presence from 0.01 to 0.08 percent as "faint trace contamination," 0.08 to 0.1 percent as "trace contamination," and above 0.1 percent as "contamination."

The strip test, used widely this year to detect StarLink contamination, tests for the protein product, not the DNA. Strip tests are similar to pregnancy tests; a color change indicates whether the protein product is present in the sample. Strip tests are much less sensitive than PCR tests. Strip tests can quickly distinguish between high and low contamination, but are not able to detect contamination below 0.25 percent. False negative readings are fairly common with strip tests, and they generally are not accurate with processed food products.

Billy Hunter, an organic inspector, says that using good representative sampling technique is essential to getting an accurate reading. If testing with a probe into a bin or wagon, be sure to take multiple probes into various spots and blend. It is better to sample while grain is being unloaded from a combine or wagon. Hold a coffee can under the stream of flowing grain, collecting a slight deflection of the grain flow continuously during unloading. Mix the sample together thoroughly in a pail. Collecting a 1- to 2-quart of sample this way from a 200-bushel gravity wagon would be sufficient. This composite sample then can be tested with a strip test or submitted to a lab for a PCR test.

NC+ Organics, says, "Our orders are up about 30 percent for the 2001 season. We estimate the number of organic corn acres in the United States to be about 150,000 acres, which would mean that this is a 30,000- to 45,000-bag market. Unfortunately, we don't have enough seed to meet this demand for the 2001 planting season. Could we meet this demand for 2002 if more certifiers require organic and GM tested seed? It would be a stretch, but I think we could meet most of the demand. We would not be able to supply the seed corn products that have limited uses, such as short season hybrids or blue corn, and we probably could not offer as wide a variety of products on a national basis as organic farmers are now used to getting."

Producing as much seed as possible on-farm or purchasing seed from other organic farmers is a good option. However, farmers must realize that there is still a possibility that some cross-pollinated crops, such as OP corn, could become contaminated by drifting GM pollen. This contamination would likely go undetected but would produce crops that test positive for GM DNA in subsequent years. Francis Thicke, growing OP corn in Iowa, says that, "as our open-pollinated corn becomes polluted by GM pollen drift, we may have little choice but to plant GM-contaminated seed the following year." Saving and sharing organically produced seed from self-pollinated crops probably would carry little risk and, with some deliberate in-field selection, could provide a good source of regionally and organically adapted varieties.

EXPOSURE RISK 2.
POLLEN DRIFT

In a self-pollinated plant, both pollen and egg usually come from the same flower, and typically fertilization occurs just before or shortly after bloom. Examples include most small grains, legumes, and solanaceous plants. As pollination usually occurs within the enclosed flower structure, these crops are not particularly vulnerable to pollen drift contamination. However, even this is not consistent throughout all plants. Certain species of self-pollinated crops, especially cotton, sorghums, and annual sweet clover, show at least 5 percent of natural outcrossing under most environmental conditions, and as much as 50 percent under some conditions. In other species such as barley, oats, rice, lettuce and tomatoes, the amount of natural outcrossing is rarely above 1 percent. In lima beans, 25 percent or more outcrossing is usual, though this can range from 100 percent under humid conditions to under 1 percent in dry conditions.

In a cross-pollinated plant, the pollen is designed to travel. In some cases, the flowers display bright petals or produce a strong aroma, thus attracting insect pollinators. Canola, cucurbits, many tree and small fruits, and alfalfa are examples of this pollination strategy. In other cases, the pollen is lightweight and plentiful and can travel long distances on wind currents. Corn, rye, conifers, poplars, and many grasses exhibit this approach. In either case, the cross-pollinated seed will often result from an egg and a pollen grain from different plants. In most fruits and vegetables, the fleshy edible portion will not carry the pollen's genes, only the seed will. However, in corn, the kernels express both parents' genes, so a kernel on a non-GM corn plant that has been fertilized by Bt pollen will produce the Bt toxin and will test positive for GM DNA. In oilseed crops such as canola, if GM pollen contamination occurs, the seed will test positive for GM DNA, though the oil may not, since little DNA is released during the extraction process.

The factors involved in determining the degree of potential pollen drift include biological considerations such as whether the crop is cross- or self-pollinating, whether it is bee- or wind-pollinated, and certain other environmental and geographical considerations, such as the wind direction and speed, the lay of the land, the weather conditions during pollination, and the proximity of sexually compatible plants.

Dr. Allison Snow at Ohio State University states that in general, bees can spread a greater quantity of pollen away from the parent plant, possibly up to several miles in some cases, while wind can spread a smaller amount of pollen remarkably far from the parent plant. In either case, it is inevitable that some pollen will travel out of the field. Studies using Vaseline-coated microscope slides have detected over 2,500 corn pollen grains per square meter at a distance of 60 meters from the parent plant. We simply don't have enough information to accurately estimate either distance or amount of pollen movement, but regardless, the 660-foot buffer standard used by the seed industry is probably not sufficient to completely contain gene flow to unintentional plants. Certainly the standard organic 25-foot buffer is inadequate to prevent pollen drift from an adjacent field. In areas where a crop such as like canola has sexually compatible wild relatives, GM contamination into the wild population will result in continued gene flow in subsequent years through additional pollen drift and through seed carried by wind, animals, equipment and people.

Genetic ID's Hunter says, "We feel that there is a virtual umbrella of corn pollen over the Midwest at pollination time. This is not enough to effectively pollinate a crop for even kernel production, but it is enough to skew the genetics. Buffers are beginning to appear meaningless in areas where corn is a major crop. We are recommending a three-mile isolation distance, regardless of planting times." Hunter cites the experience of one certified organic farmer in 2000. "The farmer planted open-pollinated corn seed that had been tested and showed no trace of GM contamination. The closest Bt corn crop was approximately 0.75 miles to the north, and the farmer delayed planting his corn crop by three weeks in order to offset pollination. At harvest, his non-GMO, certified organic, open-pollinated corn showed a 0.25 percent GMO contamination." Many experts agree that if more American organic farmers run genetic tests on their 2000 corn crop, much of it will probably show low levels of contamination.

What can an organic farmer do to minimize contamination from pollen drift? The organic farmer should begin by asking themselves the same questions that IOIA inspector manual instructs inspectors ask: Are any GM crops being grown on adjoining land? If so, what crops are they? Are they of the same species or in the same family as the crops requested for certification? What is the distance between GM crops and organic fields? Is the pollen carried by wind or transferred by insects? What is the direction of the prevailing wind? Are there any physical barriers to prevent the airborne transfer

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March 2001 - Vol. 31, No. 3 - Page 16

of pollen and/or seed? Has the farmer talked with the neighbor about pollen drift concerns? Has the organic producer taken proactive steps such as adjusting crop rotation to avoid planting similar species near GM crops?

A good place to start is to mark all your field maps to identify any borders where adjacent non-organic fields might pose a pollen drift hazard. This will help you identify key risk areas in need of special management. Talk to your neighbors about their planting plans in adjoining fields, and if your neighbor intends to plant a crop that poses a pollen drift hazard, you should probably plan not to plant the same crop on your field. If you do inadvertently end up with organic corn adjacent to conventional corn, harvesting the outside 19 rows as a non-organic buffer will probably take care of most potential contamination, as the standing corn will provide a vertical barrier. While Mark Bradley of the USDA says that the National Organic Standards will not decertify a field if the crop tests positive for adventitious GM contamination, some of the current certifiers' standards will.

Some in the organic industry are more aggressive about pollen drift hazards. Neil Sorensen of the Institute for Agriculture and Trade Policy feels that organic farmers must take a hard line against GM contamination, even to the point of alienating neighbors. He feels that organic farmers should send certified and notarized letters to all their conventional farming neighbors, copied to the state attorney general, stating that they are planting certified organic GM-free seed and that they will pursue legal action if their crops are adventitiously GM contaminated. While not all farmers are willing to go quite this far, it is increasingly clear that legal action is necessary to shift the burden off the organic farmer and onto the parties actually responsible for the contamination.

Though it is difficult to determine in which field the contaminating pollen originated, it is possible to determine a genetic signature for the pollen. This makes it theoretically feasible to identify which company's genetics did the deed. Perhaps this could form the basis of a class-action lawsuit against specific biotech companies, rather than legally pitting neighbor against neighbor in an emotionally charged battle that both are bound to lose.

EXPOSURE RISK 3. EQUIPMENT

One often-overlooked point of major contamination is that of accidental mixing in equipment, especially for organic farmers who hire or rent equipment or use custom operators. When equipment is used on both organic and non-organic crops, the chance of contamination is very great, especially with combines, planting equipment, augers, trucks and storage facilities. What "clean" means to one farmer may be very different to another. It is extremely important for organic farmers to take responsibility to thoroughly clean out equipment, even when the custom operator is standing there, impatiently waiting to get moving.

Anne Mendenhall, executive director of the Demeter Association of Biodynamic Farmers, says that "For combines that have been used on non-organic crops, a major clean-down is needed. This will certainly add to the cost for the organic grower. Custom operators may balk at this, even if their time is paid, just because of the aggravation." Recent studies at Iowa State University show how difficult it is to really clean out a combine. After harvesting red corn and emptying the hopper, researchers spent hours removing remnants from every corner of the machine, gleaning an additional 3 bushels of corn. Then they headed into a yellow corn field. After 10 acres, they found the equivalent of another 3 bushels of red corn in the harvested yellow corn.

Case IH engineers say that time and high-velocity air are the keys to cleaning harvesting equipment. An air compressor with lots of hose and a long-reach nozzle are the best tools for cleaning. In the field, a portable leaf blower is better than nothing. Using pressurized water just makes mud, allowing seeds to hide in unseen nooks and crannies. Purging with straw or organic grain should be done only after the machine is manually cleaned, as purging alone is not an effective method of cleaning. The Case engineers state that a thorough cleaning of a combine can take up to four hours. They have developed a checkpoint system, identifying key areas of a combine where stubborn contamination is likely. These areas include specific sites on the cutting platforms, corn head, feeder houses, separators, grain tanks and unloading augers.

Guaranteeing grain purity doesn't stop with a clean combine. Any equipment that touches the grain during harvest, storage or transport must be completely clean of GM crops. This includes grain carts, trucks, wagons, unloading augers, dump pits, dryers, bins, bin stirring systems, and bin unloading augers. Whenever possible, equipment should be designated organic-only for all field operations.

EXPOSURE RISK 4. AGRICULTURAL PRODUCTS

Increasingly, any agricultural product derived from soybeans, corn, cotton, or canola, or produced through fermentation, is likely to be manufactured from GM ingredients. These include microbial seed and soil inoculants, animal supplements, medicines and vitamins, soil fertility amendments, natural herbicides containing corn gluten, natural insecticides containing vegetable oils, and silage inoculants. The IOIA inspector manual says that "the operator must be able to prove that all inputs are not genetically engineered or derived from GEOs. Letters from suppliers must be on file. These must be assessed for accuracy." For the organic farmer, there are several practical problems with this requirement. When it comes to agricultural products, organic farmers must keep their eyes wide open!

For one thing, there seems to be no real consensus on what exactly is meant by a GM-derived product. OMRI currently defines GM products based on a number of factors, including whether they are alive and self-replicating, whether they pose a risk of contaminating an organic crop with modified DNA, whether the GM protein trait (not just the GM DNA) is expressed in the final product, and whether they cause a detrimental impact to the organic system. Under OMRI determinations, a GM microbial inoculant would be considered a GMO because it is alive and self-replicating. However, soybean meal used as a fertility amendment would not (even though it is most probably derived from Roundup Ready soybeans) because soybean meal is not self-replicating (the enzyme that deactivates

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March 2001 - Vol. 31, No. 3 - Page 16

Roundup is not expressed in the beans) and it cannot transfer the genetically modified DNA to the organic crop. On the other hand, conventional corn gluten is considered GM derived, since the product may produce the Bt toxin in the soil.

Not everyone in the organic community agrees with the OMRI approach to determining GM status. Both Neil Sorensen and Anne Mendenhall concur that agricultural products such as soybean meal and corn gluten should come only from certified organic sources to ensure non-GM status. Sorensen categorically states that unless agricultural products are derived from certified organic sources, "the entire legitimacy of the system breaks down, not to mention the impetus for organic practices in the first place." Other certifiers are more general, including the OCIA 2000 standards which require simply that "The use of products made from organisms that have been modified by genetic engineering techniques is prohibited." It is not clear, however, how organic farmers are supposed to know whether their certifier is using the OMRI determination of GM status or a more purist approach.

There are currently genetically engineered Rhizobium inoculants on the market, but it can be pretty confusing. For example, Urbana sells two alfalfa/clover inoculants: "Dormal,"' which is not genetically engineered, and "Dormal Plus PC2" which is. Some organic farmers who ordered untreated alfalfa seed last year received seed that came pre-inoculated with Dormal Plus, even though they did not ask for it. In a few cases, organic farmers received some bags of alfalfa seed treated with Dormal and some with Dormal Plus in one order, necessitating a very careful checking of the label of each seed bag before planting. In 2000, there were instances of organic farmers losing certification on fields where they planted alfalfa seed pre-inoculated with Dormal Plus. These fields were de-certified for three years — back to the start of transition — because this was considered a prohibited material by their certifier.

Few agricultural products are currently labeled for GM content, and it appears that OMRI approval may not be sufficient proof of non-GM status for some certifiers. Farmers may have a hard time obtaining information from their suppliers documenting non-GM status of agricultural products. In some cases, the supplier may not even know, with their own suppliers unable or unwilling to provide this information. Sometimes suppliers will be uncooperative or evasive, fearing liability if they state something in writing that they are not sure about. But in other cases, it may just be difficult to tell.

The GM status of any products derived from manure or composted manure from conventional farms can be particularly difficult to determine. When an animal digests GM corn or soybeans, the DNA in the feed materials is broken apart into little snippets. Sections of DNA sequences can be found in manure, but rarely enough to extract and amplify using standard DNA testing procedures. This doesn't necessarily mean that the genetically modified DNA is gone, it just means that with current techniques, we can't easily find it. It is always best for an organic farmer to try to obtain all manure or composted manure from another organic farm.

Dave Mattocks, president of the Fertrell Company in Pennsylvania, which supplies animal supplements and fertility amendments to many organic farmers, is very aware of the potential problem of GM ingredients. He carefully selects suppliers who are conscientious about the need to provide non-GM ingredients. Mattocks feels comfortable about using peanut meal because at this time, there are no GM peanuts on the market, and he has substituted peanut meal for soybean meal in many of his formulations to avoid potential GM contamination. However, he is very conscious that the situation is constantly changing. With the current StarLink crisis, a large amount of GM corn is being shunted into the animal feed market and, increasingly, any agricultural product derived from corn may be now manufactured from StarLink-contaminated corn. Mattocks succinctly summarizes the GM situation, saying, "It's like scattering a pillow full of feathers to the wind and then trying to pick each one up again, only now the feathers can reproduce!"

SUMMARY

There are many people in the organic community who are radically opposed to anything that even remotely looks like biotechnology and who honestly believe that we can craft the certification requirements to specifically exclude such things. But is that reality? Perhaps it is not. Instead we must carefully develop the organic farming system in such a way as to encourage farmers to steward their land in the very best possible manner. Organic certification standards should lead farmers to greater sustainability, relying on a minimum of external resources while still maintaining high quality and productivity. At this time, GM crops and GM derived products do not belong on an organic farm. But if we begin to focus primarily on producing a non-GM organic crop, we stand to lose something very important. As organic farmers, our focus instead should be on the total organic management process, not solely on the chemical composition of the product.

At the same time, it is important that we actively incorporate strategies into that organic process to minimize potential GM contamination. Until there is a concerted proactive approach by the entire organic community to ensure awareness of risk of GM contamination on organic farms; until all groups involved with the production of organic crops — farmer, certifier, inspector, buyer, consumer — work together to implement strategies that effectively minimize potential exposure; and until we emphatically refuse to tolerate seed contamination, pollen drift or unlabeled agricultural products; then it is just a matter of time before a sample of organic food tests positive for GM genes and then we'll have our own "StarLink" tango with our consumers.

And these days, that is a tough act to balance.