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Genetic Engineering and Organic Production Systems

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What is organic agriculture?

Organic farming is an agricultural production system that eliminates the use of synthetically produced fertilizers, pesticides, growth regulators, and livestock feed additives. To maintain soil productivity and fertility and to control weeds and pests, organic farming relies primarily on crop rotations, crop residues, animal manure, legumes or other green manures (crops planted specifically to be returned to the soil as enhancements), and biological pest control. Several different terms are used for organic farming, such as biological farming, regenerative farming, and sustainable farming. However, these terms are not synonymous. In the United States, only products produced using specific methods and certified under the USDA's National Organic Program (NOP) can be marketed and labeled as "organic."

Organic agriculture strives to enhance the abundance of beneficial insects and organisms and places high value on reducing pesticide use in order to maintain a more diverse community of plants and associated organisms. Organic farming can be more energy efficient than conventional agriculture, due in part to the goal of recycling animal fertilizers and organic matter produced on the farm (Mader et al. 2003). Although yields on organic farms are sometimes less than those of conventional systems, price premiums make it an attractive option for growers looking for specialized markets and a higher-value product. Organic production practices can reduce pesticide use by as much as 97% relative to conventional farming practices (Mader et al. 2003), although biological pesticides and naturally occurring pesticides can be used. While many organic growers depend on improved genetic varieties, others specialize in heirloom vine-ripe commodities that produce reliable crops under their unique conditions. The demand for organically produced fruits, nuts, and vegetables is increasing. In 2004, California gross sales of organically produced crops generated about $752 million, or approximately 2% of California's $31.8 billion agricultural markets (California Organic Program 2005).

Do organic farmers have regulations about the way they grow crops?

In the United States, certified organic produce is grown in accordance with the USDA National Organic Program standards (see NOP 2006). Organic food differs from conventionally produced food in the way it is grown, handled, and processed. Organic certification is therefore a process-based certification, not a certification of the end product. That is, the certification process does not guarantee particular attributes of the end product; rather, it specifies and audits the methods and procedures by which the product is produced. The USDA makes no claims that organically produced foods are safer or more nutritious than conventionally produced foods. Growers must be registered by the California Department of Food and Agriculture (CDFA) in order to engage in the legal sale of organic produce in California. Before a product can be labeled "organic," growers must also be certified by an independent agent that is accredited by the USDA. Such agents carry out annual farm inspections and monitor records of crop management practices, handling, and inputs at individual farms. Some certifiers also require a long-term program for soil improvement and pest manage-

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ment. Before being certified as organic, no prohibited materials (e.g., synthetic pesticides or genetically engineered organisms) can be used in fields for 3 years. During this transitional period, the products from the field cannot be termed organic and therefore generally do not receive premium prices in the market.

Are there specific regulations about the use of genetically engineered organisms and organic agriculture?

The use of genetically engineered (GE) crops is specifically prohibited in certified organic production systems. Section 205.105 of the USDA National Organic Program standards states: "To be sold or labeled as '100 percent organic'… the product must be produced and handled without the use of excluded methods including a variety of methods used to genetically modify organisms or influence their growth and development by means that are not possible under natural conditions or processes and are not considered compatible with organic production. Such methods include cell fusion, microencapsulation and macroencapsulation, and recombinant DNA technology (including gene deletion, gene doubling, introducing a foreign gene, and changing the positions of genes when achieved by recombinant DNA technology). Such methods do not include the use of traditional breeding, conjugation, fermentation, hybridization, in vitro fertilization, or tissue culture."

While many conventional farmers find value in growing GE plants, many organic growers tend to see GE plants as "synthetic," something that does not belong in the foods that they produce. At the present time, there is no policy regarding the adventitious (unintended) presence of GE material in organic products or food, consistent with the fact that organic production is process-based and not product-based. "Adventitious presence" refers to low levels of unintended material in seed, grain, or feed and food products. Current regulations do not specify an acceptable threshold level for the adventitious presence of GE materials in an organic product. Many growers and consumers feel that organic products should be completely free of GE materials to be labeled as organic, and testing procedures are available that can detect extremely small amounts of GE material in food. Others feel that, like pesticide drift, some contamination is inevitable and regulations should allow for some threshold level of adventitious presence of GE material in organic products. Several countries have addressed this problem by setting GE material tolerance levels ranging from 0.9% (e.g., European Union) to 5% (e.g., Japan) in "non-GMO" or "GMO-free" products.

What are the potential benefits of using genetically engineered organisms in crop production?

Concerns regarding adventitious presence of GE crops in organic production systems need to be balanced against the potentially positive impacts of GE crops on conventional farming systems. Many conventional farmers in the United States also wish to reduce "synthetic" inputs, such as pesticides, but may not want to transition to certified organic production systems that require different farming methods as well as additional record keeping and a certification process. Studies performed by the USDA Economic Research Service in 2000 and 2002 have generally, but not invariably, documented a reduction in pesticide use in certain conventional cropping systems as a result of the adoption of GE varieties (Fernandez-Cornejo and McBride 2000, 2002). For example, synthetic and biologically derived pesticides are extensively used on many crops, and both can be toxic. The use of GE insect-resistant varieties can also lead to dramatic reductions in insecticide use (Huang et al. 2005; Qaim and Zilberman 2003; Toenniessen et al. 2003). For example, an 80% reduction in pesticide use was observed in small farms in China when they used GE insect-resistant rice as compared with conventional varieties. In the same study, exposure of Chinese farmworkers to broad-

spectrum pesticides was found to be correspondingly reduced. Importantly, none of the farmers who had planted their farms using only GE rice varieties reported adverse health effects from pesticide use, whereas among the farm households that used conventional rice varieties, adverse health effects related to pesticide use were reported (Huang et al. 2005). In the United States, conventional producers generate 98% of the nation's agricultural products, and many want to use GE crops as a component of their transition to more sustainable farming practices.

Can organic producers be decertified if genetically engineered pollen blows onto their farms?

No. The presence of detectable levels of GE material in a crop does not constitute a violation of NOP standards and regulations, as long as a grower has not intentionally planted GE seed and has taken reasonable steps to avoid contact with GE pollen or seed or both. The USDA indicated in a December 2004 letter to the National Association of State Departments of Agriculture that no grower has ever lost certification due to the presence of GE products in their organic product. However, if there is detectible GE material in their product, organic growers may have difficulty selling their crops if they have made contractual agreements with buyers to deliver "GMO-free" products. They could be forced to sell in a conventional market, forfeiting the organic premium price that they would otherwise have received for their product.

What level of genetically engineered material is allowed in organic products?

Current regulations do not specify an acceptable threshold level for the adventitious presence of GE materials in an organic product, and there is also no requirement to test for such adventitious presence. Nonetheless, it is clearly the expectation of many consumers purchasing organic foods that those foods do not contain materials developed using genetic engineering; that is, the consumers have an implied zero tolerance. Pragmatically, achieving 100% purity for any agricultural product is extremely difficult, and methods to detect DNA from GE plant material can be highly sensitive, raising the possibility of product rejection if thresholds are set too low. The organic industry has yet to establish any tolerance level, and it is therefore unclear what an acceptable level would be to meet consumer expectations and whether sampling and testing should be used to ascertain a level of adventitious presence. This can be contrasted to the approach that was taken regarding the presence of synthetic pesticide residues in organic products. Given that some level of pesticide drift from conventional agriculture is inevitable, the NOP allows for the marketing of certified organic products containing up to 5% of the U.S. EPA's specific tolerance level for each pesticide residue detected.

What is coexistence?

Coexistence of agricultural methods refers to the simultaneous production of agricultural products within a common geographic area in which distinctly different production methods are used. Unique farming systems have been coexisting within California agriculture for many years. California farmers grow 350 recognized crop and livestock commodities under a variety of farming conditions. Consequently, many different farming systems are currently employed in California, often on adjoining fields.

Farmers have always had the choice of what crops to grow and have always had to contend with commingling, admixtures, and other contaminants in their crops. Producers have a responsibility to work with their neighbors to minimize the impacts of their production methods on neighboring fields. Producers who plan on planting GE crops are encouraged to speak to their farm neighbors about their plans. Similarly, organic producers, or those who have concerns about transgenic crop plantings adjacent to their farm properties, are encouraged to talk to their farm neighbors about their need to meet their marketing standards. Best management practices (BMPs) can

be implemented to minimize pesticide and/or pollen drift onto fields that are being grown using certified organic production practices. For example, separating fields spatially, staggering planting dates, or growing varieties with different maturity dates can minimize or eliminate cross-pollination. Segregation of varieties during harvesting, shipping, and processing also helps prevent the inadvertent intermingling of organic and conventional products. Protocols to encourage coexistence of GE and non-GE corn on publicly owned farmland were recently developed in Boulder County, Colorado (Byrne and Fromherz 2003). Implementation of such protocols in California would support organic, conventional, and GE crop farmers and encourage shared responsibility.

PERSPECTIVE

Organic farmers practice a system of farming that relies on traditional inputs and deemphasizes synthetic inputs or prohibits their use altogether. Certified organic produce is grown in accordance with the USDA National Organic Program standards. These standards prohibit the use of GE crop varieties. Although current regulations do not specify an acceptable threshold level for the adventitious (unintended) presence of GE materials in an organic product (i.e., there is an implied zero tolerance), there is also no requirement to test for such adventitious presence, and a grower would not automatically lose organic certification if such contamination occurred. While 100% purity (zero tolerance for any undesired components) is very difficult to attain for any agricultural commodity, standard procedures involving spatial separation, border rows, planting dates, maturity dates, cleaning of equipment, and postharvest handling have traditionally been able to provide products that meet diverse market requirements.

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