Maize and Biodiversity: The Effects of Transgenic Maize in Mexico

Issues Summary

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By Chantal Line Carpentier and Hans Herrmann—CEC Secretariat[1]

Since humans first began domesticating crops, they have altered the genetic makeup of those plants through selection. This selection has been continuous for most of the 10,000-year history of domestication of crops, but it has accelerated over the past two centuries. In most cases, the plant species being selected have hybridized with wild and weedy races and related species, and this hybridization has enhanced the variability of the crops and, hence, the genetic material available for selection. Historically, this genetic material has come from the crop species themselves and from those related races and species capable of crossing directly with them. More recently, however, special methods of hybridization have been developed that widen the circle of species that can be included, as appropriate methods (e.g., embryo culture) have become available. Since the first experiments were successfully performed in 1973, it has also become possible to transfer genes to a recipient organism (like a crop) from any species, regardless of the degree of phylogenetic relationship. Such introduced genes are known as 'transgenes,' and the organisms to which they have been transferred as 'genetically modified organisms' (GMOs). GMOs and ingredients derived from them are becoming part of an increasing number of products, including foods and food additives, beverages, drugs, and fuels. Genetic modification is being promoted as a way to improve crops and produce medicines, but it has raised concerns about potential side effects on human health and the environment, including risks to biological diversity.

Public scrutiny and media attention have been building around the issue of GMOs for the past several years. In response to these concerns, governments have negotiated a subsidiary agreement to the Convention on Biodiversity to address the potential risks posed by cross-border trade and accidental or intentional releases of living modified organisms (LMOs as they are called in the Protocol). Adopted in January 2000, the Biosafety Protocol requires that the exporter provide a detailed, written description of the LMO exported for intentional introduction into the environment of the Party of import in advance of the first shipment to ensure that recipient countries have both the opportunity and the capacity to assess risks that may be associated with the LMO before agreeing or not to its import. As well, LMOs intended for direct use as food or feed, or for processing, must be clearly identified with "may contain" LMOs and as not intended for intentional introduction into the environment (Mexico has ratified the Protocol and Canada is a signatory to it).

Over the past year, the public debate over GMOs and transgenes has focused in part on the possibility that transgenic material has been introduced into some of Mexico's maize land

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races (traditional varieties). The debate has moved from the scientific community and more specialized journals into newspapers, and other mass media. One reason for the relevance of this issue and contentiousness of the debate is that Mexico is the region where cultivated maize was developed from the wild grasses known as teosintes. Cultivated for at least 5,000 to 8,000 years, maize has proliferated in Mexico into dozens of local races, changing dynamically from place to place and through the years. The wild teosintes, some populations of which are now classified as part of the same species as the cultivated races, have persisted—often as part of the agrosystem where maize is grown. Although new hybrids of maize have been introduced into Mexico for decades and, in some cases, have contributed their genes to the genetic make-up of certain local races, the idea of introducing transgenes from unrelated phylogenetic groups into the land races and wild relatives of maize has become a matter of concern, both in Mexico and internationally. The concern about the three broad trends of the changing nature of agriculture and the loss of biological and cultural diversity has added to the focus on the impact of these GMOs. It is precisely the assignment of the Secretariat of the Commission for Environmental Cooperation (CEC) of North America, an organization established to implement the environmental side agreement to NAFTA, to determine whether and how GMOs influence existing trends, and to analyze the implications of moving transgenes from one organism to another in the rich cultural and biological heritage of Mexico.

Maize is the grain with the second-highest production levels in the world after rice, and the United States is the largest maize (corn) producer and exporter. \The majority of the world's maize production is used for animal consumption or as an industrial input, with only approximately 20 percent consumed by humans. However, the pattern of consumption in Mexico is distinct from those of the United States and other industrial countries, since 68 percent of all maize there is used directly as human food. In 1998, when genetically modified corn was first commercially planted in the United States, the total planted area was 8 million ha, and is expected to increase to 10.3 million ha in 2002, representing 32 percent of the total planted area in the US. Worldwide, transgenic maize represents 7 percent of the total maize area in 2001 (Bio 2002).

In Mexico, maize is the most important cultivar in terms of land area devoted to it (7.9 million hectares in 2001) and the second in terms of gross production volume (18.6 million tons in 2001). About 1.5 million hectares of this maize consist of hybrid varieties (developed mainly by transnational companies) and 0.9 million hectares are of open-pollinated improved varieties (developed by national public research institutions and small companies) that have replaced land races, particularly in areas where industrialized agriculture is practiced. This has affected local populations and economies.

Approximately 94 percent of current total maize exports from the United States are bound for Latin America in general, and Mexico in particular, accounting for 5.6 million tones (24 percent of total corn consumption in Mexico now comes from the US). In 2000, Mexico was second only to Japan as a market for US corn, absorbing 11 percent of US exports. Since 1996, US corn exported to Mexico has increased at the same time that exports to Europe have decreased. As recently as 1996, the United States exported over US$305 million worth of corn to the EU. But in 2000, that figure had fallen to US$8 million of US-grown corn. This decline in European markets coincided with the nascent production of

GM corn in the United States. Maize has been engineered to be herbicide- and virus-resistant through transgenetic modifications. It has also been made insect-resistant by integrating genes derived from a soil bacterium *Bacillus thuringiensis* (*Bt*), which causes the maize plants to express the protein *Cry1Ab,* which is toxic to insects. More recently, maize has been engineered to produce pharmaceutical proteins; although these plants are currently grown on only a very small scale in the United States, their distribution is expected to increase with time.

Maize is open-pollinated, and we know that gene flow occurs easily among such plants that grow closely together. For centuries, peasants have taken advantage of this characteristic, hybridizing cultivated maize and weedy or wild relatives, and thus have directed the evolution of new races of maize that fit their needs, preferences and local environments. Ethnic groups practicing traditional agriculture have maintained these selection processes with domesticated maize, and this represents an important form of *in situ* conservation of the country's germplasm (seed or other materials used in crop breeding).

We know that wild-domestic hybridization happened widely in Mexico in the past.. This hybridization has the potential to happen now or in the future with GMOs if fertile GM races are grown near teosintes or cultivated maize. The outcrossing of crops with wild relatives is expected, but concerns associated with transgenes make this a special case. For this reason, it is important to assess the agronomic and ecological role that the new transgenes, which are few in number but expected to increase, are likely to have on rural economies, cultures, and the environment.

If peasants have access to transgenic varieties that are perceived as valuable, they will crossbreed these varieties with traditional varieties, in the same way they have crossbred different varieties of maize for centuries. This will spread the transgene and its trait among their land race fields. Should this happen, not only the land races but also the wild relatives of maize could be affected. While awaiting a full evaluation of these questions, Mexico has imposed a ban on the planting of transgenic maize. The publication of an article in *Nature* by Quist and Chapela, offering evidence that transgenic maize was already to be found growing in Mexico and had crossbred with Mexican land races, thus caused concern. Later *Nature* "…concluded that the evidence available is not sufficient to justify the publication of the original paper." However, even if some results and methods have been questioned, their finding of transgenic flow to land races in Mexico has been confirmed by subsequent research.

Recently, the Mexican government has requested two research groups at recognized scientific centers to test for transgenic flow to wild species and land races. Both studies reached the same results: constructs of transgenes were found in land race samples obtained from the field. One of the studies has been submitted to *Nature* but has not been accepted in its first review, pending a complete set of tests to verify the results before re-submission of the paper. Regardless of the extent to which transgenes derived from GM crops have spread in Mexico already, they are certain to do so in the future. Thus, the impact of transgene flow upon economic, social, and environmental values must be assessed as soon as possible to provide a sound foundation for future policy, regulatory and other actions.

The CEC has been petitioned by local communities from some of the poorest and most culturally diverse Mexican states and by Mexican environmental NGOs to shed light on issues surrounding gene flow to Mexican maize land races and their wild species, and the actual and potential effects of this upon the livelihoods and daily life of these communities. The CEC has agreed to study this issue under Article 13, a section of the NAFTA environmental side agreement that gives authority to prepare a report that will include findings from background papers on key issues as well as recommendations from the Advisory Group. The final report will be presented to the Council of the CEC, representing the governments of Mexico, Canada, and the United States. The CEC has now conducted four Article 13 reports, which are recognized as an important means to aid environmental NGOs, governments, industry and civil society in exploring complex environmental issues together. It is in this context that the CEC is undertaking this Article 13 on transgenic maize.

This is a difficult task. There are many questions science has not yet resolved, and there are wide-ranging beliefs regarding possible environmental and animal and human health risks associated with GMOs. The questions of social, cultural, and economic impacts of technological and other changes in agriculture are also subjects of dynamic debate. The CEC Secretariat recognizes that this topic has special significance for Mexico, being an evolutionary center of origin of maize.

With this Article 13 study on transgenic maize in Mexico, the Secretariat will involve widely diverse experts and stakeholders to ensure that the study is grounded in rigorous scientific analysis and that the process allows for public participation, yielding valuable recommendations to the Parties. It is the role of the Advisory Group, a multi-stakeholder group of experts, to offer their recommendations to the Council, based on the background papers and the results of a public symposium on this issue. The Advisory Group had its first meeting on 25 November 2002. As background material for the meeting, three dicussion papers were commissioned by the Secretariat to present a few experts' perspectives of the state of knowledge in four broad dimensions of this issue: biodiversity; and socio-cultural, economic, and trade issues. The authors also highlight unresolved issues where controversy persists, and the areas where we just do not know—either because there has not been enough research, or because transgenic crops have not been planted long enough for us to know. These papers reflect the views of the authors alone; and not those of the Commission, the Secretariat, the Parties, or the Advisory Group.

The first paper, "Ecological and Biological Aspects of the Impacts of Transgenic Maize, Including Agro-Biodiversity," by Dr. Elena Alvarez-Buylla, discusses the risks of releasing transgenic materials into wild and cultivated populations, and the biological consequences of such introgression. The second paper, "Socio-Cultural Aspects of Native Maize Diversity," by Dr. Miguel Altieri, looks at traditional farming systems and their ecological and social significance in marginal environments, as well as the potential socio-cultural impacts of transgenic crops on those traditional agro-ecosystems (including the cosmovision and the ritual value of maize production). The third paper, "Economic Valuation," by Dr. Scott Vaughan, examines the role of economic valuation and the indirect and intangible non-market values associated with maize and its land races, as a means to

understanding the consequences of different policy choices. The paper also introduces some international trade and trade-related obligations relevant to maize and transgenic corn.

The terms of reference are now being prepared and will be posted shortly for public comments. The Secretariat will compile and share these comments with the Advisory Group, before finalizing the terms of reference. The latter will guide the independent experts selected to write the various background papers that will contribute to the final report.

In conclusion, the goal of the Secretariat in this process is to contribute positively to this debate by enabling and fostering joint fact finding on the above-mentioned themes. Further details and timeline for the study can be found at <http://www.cec.org/maize>.