

Transgenes in Mexican maize: Desirability or inevitability?

Peter H. Raven*

Missouri Botanical Garden, P.O. Box 299, St. Louis, MO 63166

Contributed by Peter H. Raven, August 15, 2005

For several years, there has been uncertainty about the presence of transgenes in maize landraces in the state of Oaxaca, Mexico. The first report of their presence in this region was that of Quist and Chapela (1, 2), who based their results on samples obtained in 2000; these findings were later called into doubt because of the methodology used. However, further studies by the Mexican government confirmed the presence of transgenes in Oaxaca in 2000 and 2001 (3, 4, †). Most recently, Ortiz-Garcia *et al.* (5), in an outstanding analysis, failed to find evidence for the presence of transgenes in the same area in 2003 and 2004. Presumably, their frequency had diminished greatly over the course of 2–3 years, and the genes may even have disappeared. It will be of scientific interest to monitor the presence and frequency of such genes in the future.

What, however, is the social significance of these results in the region concerned and in the broader context of the growing use of transgenic crops in agriculture throughout the world? Approximately one-eighth of the world's cropland is planted in transgenic crops, with nearly 10 million farmers involved in their cultivation, and the proportion of such crops is growing rapidly. Does this growth represent a threat to maize in its center of origin, to Mexico, or to the world? I offer the following comments as a member of the Commission for Environmental Cooperation on the Effects of Transgenic Maize in Mexico (6).

It has generally been accepted for about three decades that the process of producing transgenic organisms does not pose any threat in itself. Furthermore, no credible argument has been offered as to why such organisms would, as a class, pose a threat to human health. Hundreds of millions of people have been consuming foods derived from transgenic plants for ≈10 years, and no health problems have been reported, nor has any credible reason been advanced as to why such a problem should be expected. As for environmental problems, such as the origin of novel weeds, none has been observed with the transgenic crops currently grown, although such problems certainly remain a theoretical possibility for novel genes not yet approved and introduced. Modern agri-

culture of any kind, with its cleaner, more productive fields, certainly harbors less biodiversity than more traditional, less productive forms of agriculture, but that is not a criticism of transgenic crops.

For preserving the genetic variability of maize, a very important crop, near its center of origin, it is important to note that maize does not exist as a wild plant outside of cultivation. It was derived as a crop plant from grasses of the same genus (*Zea*), which occur in Mexico and northern Central America, probably starting ≈5,500 years ago. Hybridization between maize and these wild relatives has been demonstrated, but genetic barriers exist, and the extent of gene flow has not been documented properly.

Maize exists in Mexico, as in other parts of the world where it has long been cultivated, as a series of more or less distinctive landraces that interbreed with one another. These races are continually being modified by farmers through selection to produce the kinds of plants they want. The agronomic selection of desirable characteristics in maize throughout the world, but notably in the U.S., has resulted in the production of additional distinctive races with unique gene combinations. Particularly after the widespread adoption of hybrid maize in the U.S., many races developed or improved externally were introduced into Mexico, and very numerous genes were introduced into Mexican landraces that were not present there initially. Both the introduction of these new genes and the continuation of traditional practices have led to the progressive modification of Mexican landraces over time, and the process is a continuous one.

Some of the genetic variability of landraces can be maintained by encouraging indigenous cultivators to keep growing their distinctive strains. To do so effectively would probably require economic incentives for the cultivators, because they are often poor and apt to seek alternative lifestyles outside of the areas to which they are indigenous. Maize germplasm also can be conserved in seed banks or by selective cultivation outside of its regions of origin, but at much greater expense than when the strains are simply cultivated by indigenous farmers. In any event, the preservation of the genetic variability of maize

is clearly a desirable objective in a world that increasingly depends on large-scale uniform agriculture.

Whether or not transgenes are present in landraces in Oaxaca at present, they will inevitably be found in them as time passes, because of the nature of the indigenous agriculture I have just described. There they will persist if they confer a selective advantage on the plants in which they occur, or they may disappear if they do not confer such an advantage in the prevailing conditions. Such genes are no more “invaders” into the populations concerned than any other genes, and the avoidance of such value-laden terms would presumably assist in the objective conduct of scientific discourse about the situation. Similarly, the principles of population genetics certainly do not indicate that they would “disrupt” the germplasm of the maize populations they might enter, whatever that term might be taken to mean. As Ortiz-Garcia *et al.* (5) have pointed out, it is unlikely that the presence of transgenes could reduce the genetic diversity of the landraces in which they might occur. In general, for the landraces of maize in Mexico or for any other populations, their genetic characteristics should remain essentially unchanged unless there is strong selection for whole constellations of characteristics from radically different strains of maize, conditions that have not been observed in southern Mexico.

My overall conclusion, therefore, is that the introduction of the transgenes currently in use for maize poses no danger to maize near its center of origin, to the Mexicans, or generally. It is presumably for these reasons that President Vicente Fox of Mexico, following the example of essentially all developing countries with an indigenous cadre of scientists and engineers capable of providing internal advice on the situation, recently signed a decree authorizing the cultivation of transgenic plants, properly tested and understood, in Mexico.

*E-mail: peter.raven@mobot.org.

†Alvarez-Morales, A., in *Proceedings of the 7th International Symposium on the Biosafety of Genetically Modified Organisms*, Oct. 10–16, 2002, Beijing, pp. 65–66.

© 2005 by The National Academy of Sciences of the USA

In my opinion, the dissemination of agronomic information among the indigenous farmers of Mexico and elsewhere has been unbalanced to a very unfortunate extent. Far too much emphasis appears to have been placed on “warning” them about the supposed dangers of transgenes and not nearly enough on explaining to them not only the agro-

nomic advantages of some of these plants but also the benefits of appropriating other advanced agronomic methods and thus achieving higher levels of food production. As a result of this unbalanced situation, indigenous farmers are greatly worried about these particular genes but appear to gain no benefit whatever from their concern. Neither

the government of Mexico nor commercial firms have devoted much effort to explaining the benefits of adopting such methods and strains, whereas much has been made of the hypothetical dangers, to the detriment of those being warned but not counseled properly or in a humane way about the gains they could achieve.

1. Quist, D. & Chapela, I. H. (2001) *Nature* **414**, 541–543.
2. Quist, D. & Chapela, I. H. (2002) *Nature* **416**, 602.
3. Kaplinski, N., Braun, D., Lisch, E., Hay, A., Hake, S. & Freeling, M. (2002) *Nature* **416**, 601.
4. Ezcurra, E., Ortiz, S. & Soberón Mainero J. (2001) in *LMOs and the Environment, Proceedings of an International Conference*, ed. Roseland, C. R. (Organization for Economic Cooperation and Development, Paris), pp. 286–295.
5. Ortiz-Garcia, S., Ezcurra, E., Schoel, B., Acevedo, F., Soberon, J. & Snow, A. A. (2005) *Proc. Natl. Acad. Sci. USA* **102**, 12338–12343.
6. Commission for Environmental Cooperation of North America (2004) *Maize and Biodiversity: The Effects of Transgenic Maize in Mexico, Key Findings and Recommendations*, Secretariat Article 13 Report, Nov. 8, 2004 [North American Agreement on Environmental Cooperation, North American Free Trade Agreement (NAFTA) (Commission for Environmental Cooperation, Quebec)].