Chapter 5
Assessment of Biological Effects in Agriculture in Mexico

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Abstract

Mexico has the most diverse maize germplasm of any country, and is characterized by many small producers and high maize consumption. The country has an intricate agrarian history and a strongly polarized society. Maize is grown in contrasting environmental, social and technological conditions in plots that range from garden size to fields of hundreds of hectares. The typical *campesino* subsidizes maize with revenues from offspring working in cities or abroad and uses family labor to subsist. Until the 1960s, Mexico was more than self sufficient in maize, and could quickly be so again with minimal investment in local maize improvement and sustainable maize production strategies. NAFTA accelerated US maize imports, but Mexico produces 78 percent of the maize it uses; half of this is grown by smallholders who comprise two-thirds of all producers. Social forces impel *campesinos* to produce maize as insurance; economic forces invite them to quit. The situation is fragile; the breaking point uncertain. Finding alternative crops or jobs and housing for more millions in cities will not be easy.

Mexican *campesinos* depend on maize landraces, tuned to local conditions. Landraces are exchanged, mixed, re-selected and re-adapted. Varied ecology in Mexico has discouraged universal hybrid use. The proportion of maize production planted with landraces (80 percent) is high, compared to the rest of Latin America. Hybrids have existed since the 1950s, but often cannot compete with open-pollinated varieties; companies are unlikely to cater to specialized ecologies; public programs are too underfunded to develop such hybrids. Locally adapted, open-pollinated maize is often a "safer" crop under marginal farming conditions, and much maize is grown on marginal lands. Preservation of biodiversity in maize has been a service of Mexican *campesinos* for millennia. Germplasm banks preserve this material, but national funding has failed and continuous international funding is not available. Clearly, if widespread use of GMOs or wholesale maize imports were to become the future for Mexico, then first priority must be strengthening germplasm programs to preserve maize biodiversity. This chapter focuses on potential impacts on landrace diversity and on small-plot farmers because they are the key to Mexico's current maize biodiversity and what makes transgenic maize in Mexico unique. Impacts on agroecosystems as a whole (e.g., pest resistance and non-target populations) are not discussed in detail here, nor are they conclusive, as the topics remain controversial, but they are addressed in Chapters 2 and 4.

While GMOs are the headlines, the immediate threats to Mexican maize landrace biodiversity are economic, headed by subsidies paid to US farmers. Landraces provide variability to cope with vagaries of weather patterns, pests and diseases, but they cannot overcome the 20 to 30 percent subsidies that bolster US exports. In this fragile situation of maize landraces it is necessary to analyze possible benefits and risks of transgenes and their introgression. The major detrimental effect on teosinte populations, maize’s closely

related wild/weedy relative, is presently human population expansion and consumption pressures, not GMOs.

Currently available transgenes (Bt, other herbicide resistances) are marginally attractive in the United States and less so in Mexico, but future advances (25+ years) in drought tolerance and resistance to pests of stored grain could be helpful to *campesinos* if other environmental and economic constraints can be resolved. There is consensus that transgenic traits (including current ones, reasonably-proven ones such as virus-resistance and male-sterility, and newer traits still under development) will introgress into landraces via US imports, seed introduced by migrants and the continuity of the Mexico-US border; the speed with which this happens will depend on the degree to which the sources are adapted to Mexico and the usefulness of the transgenes. Most transgenes are unlikely to pose more threat to landraces than a new, successful cultivar, but each transgene needs assessment of its long-term cost/benefit to Mexico, and costs may only become apparent long term. Opportunities lost by not using or developing useful transgenes need consideration; this is very long-term planning, as time from gene isolation to farmer-deployment is about 15 years and the cost is enormous (about US$50 million per transgene). It is conceded that widespread employment of single genes is unwise, and today's transgenes share several common traits: common background from tissue culture, usually the same promotor, similar selective agents and terminal constructs. The remedy for crop uniformity is a dynamic local seed industry developing new varieties and persistence of *campesino* production for local self-sufficiency, both using Mexico's diversity of maize germplasm. This appears to have been discouraged by past governmental policies. Certainly, the recent budget proposal to discontinue funding to INIFAP and *Colegio de Postgraduados* would discourage private investment in that arena.

Private development of transgenic crops may slow as investments are directed to more lucrative medical markets. There is a limit to surcharges for transgenic seeds. One transgene is valued at about $20 per hectare, the next is unlikely to be economically viable at $20 more. Transgenes specifically useful to Mexico probably need to be developed by Mexicans. Minimal-cost, community breeding projects with few inputs have shown 20 percent on-farm yield increases while preserving local landraces. No transgene currently meets the 20 percent standard and, while a few hybrids do, they are not widely-enough adapted to spread broadly.

Production of industrial/pharmaceutical chemicals in maize carries risks of pollen- and seed-borne contamination; there is consensus that such endeavors are inappropriate except in extreme isolation, far removed from any place maize is now grown. Even then, risk of escape and contamination is not zero. Thus far, contamination costs, mostly from routine-, rather than industrial-transgenes, and mostly for organic growers, have been borne solely by the farmers, rather than by distributors or licensors of transgenics.

If some or all transgenes are barred from Mexico, then maize imports need monitoring, and whole or cracked maize imports from any country permitting use of transgenic maize would need to be prohibited. Monitoring of all imported, unprocessed maize would be

necessary as, once in commerce, tracing origins is difficult. Laboratories for quality control will need to be developed; these need unusual characteristics, if accurate monitoring of small amounts of gene flow (less than one percent) is to be done.

Some US maize transgenes are expected to flow into Mexico, despite regulations. A major question is whether transgene-owners will be due fees for use of transgenes by farmers growing native, open-pollinated landraces. This is very important to Mexican agriculture and of almost no consequence to industrialized farming or to transnational seed companies. The sensible answer is that no fees should be paid by Mexican farmers for use of Mexican open-pollinated maize. A minimal requirement for transgene suppliers would be provision for inexpensive, non-ambiguous testing of each experimental transgene construct.

An immediate roadblock facing the utilization of, say, Mexican-developed (and even royalty-free) transgenes aimed at characteristically Mexican *campesino* problems is that there are no seed distribution or agricultural extension programs in place to move such genes into local, open-pollinated landraces of maize adapted to the many ecological regions of Mexico. If transgenes are envisioned as eventually helping Mexican *campesinos*, then this roadblock would effectively prevent that from ever happening.

In the following sections, we sketch the background of maize farming in Mexico and address the following topics regarding Mexican maize:

1) The present status and future prospects of transgenic traits;
2) Their possible expansion across landrace germplasm;
3) Could they help with the most pressing problems faced by producers;
4) What risks are involved for Mexico (i.e., could these traits disrupt value, performance, diversity and integrity of landraces and their relatives, and could some impact ecological processes and have negative effects on the environment or on the economy);
5) Are the risks worthwhile or are there better alternatives; and
6) What preventive measures should be considered, what needs investigation, and what needs discussion with those at risk?