Maize and biodiversity: effects of transgenic maize in Mexico[1]

Commission for Environmental Cooperation of North America
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Main Conclusions

Background of GM maize in Mexico
The elevated levels of poverty, the fact that large portions of the population depend exclusively on agriculture for their income and food security, and a significant indigenous population are factors that distinguish rural Mexico from agricultural United States or Canada. As the Mexican economy transitions from a rural and agricultural base to a mostly urban base sustained by manufacturing and services, Mexico faces a "rural crisis" of poverty, migration and displacement. In regions where *criollo* maize is cultivated, the cultural memory and recent political history have fostered the perception in indigenous communities of inequities and injustice coming from *mestizo* Mexicans, the U.S. and power elites. The issue of the impact of transgenic maize on *criollo* maize has been compounded by historic problems and offences that affect Mexican *campesinos* and which are not directly related to the issue of improved maize or traditional varieties. On the other hand, it is possible that those that defend the extensive use of genetic engineering and unrestricted trade have vested interests in scientific and technological development, trade, political influence or agribusiness in Canada, the United States and Mexico.

All these issues are interwoven in the debate about the effects of the presence of transgenes in Mexican maize landraces. Those responsible for making decisions must be careful to acknowledge the impact of broader issues in the opinions and interests of both those who defend as well as those who oppose transgenic maize in Mexico. Thus, the controversy surrounding the GM maize can either reflect underlying positions or be taken advantage of for political purposes by the defenders or opponents of transgenic crops.

Gene Flow

Gene flow between varieties of maize and its wild relatives in Mexico

1. It has been demonstrated experimentally and theoretically that gene flow between varieties of *criollo* maize – and also between traditional and modern varieties – occurs. All maize varieties, *Zea mays* ssp. *mays,* are interfertile and produce fertile progeny.

2. Various descriptive studies have demonstrated that gene flow between maize and *teocintle* occurs, but it is not known for sure how long the maize genes persist in the *teocintle* populations once hybridization has taken place in the field.

3. Gene flow is important to the dynamic process that affects the genetic resources of maize in the cornfields (*in situ*) in Mexico. C*ampesinos* often exchange seeds, plant mixtures of seeds from various sources, including occasionally modern hybrid varieties, and

[1] Conclusion and recommendation section, excerpted from the full report. This is an unofficial translation of the original document.

frequently allow and promote cross pollination among different varieties when these are cultivated close to each other. Despite gene flow, *campesinos* have the capacity to select and perpetuate various *criollo* varieties and cultivars.

Presence and sources of transgenes in Mexico

4. Transgenes have been introduced in some traditional maize varieties in Mexico. This was confirmed by scientific research sponsored by the Mexican government. However, peer reviewed summaries of this work have not been published and the information divulged until now has been vague. Nonetheless, without a doubt transgenes are already present in the Mexican maize and will propagate.

5. It was foreseen that, once present in a region, the transgenes – like other alleles of modern varieties – will be incorporated into local varieties. Whether or not with time the new alleles (be they transgenic or not) increase or diminish in frequency will depend on a variety of factors (see below).

6. Live transgenic maize constantly enters Mexico, especially in the form of grain importations, but also carried by migrant workers that return from the United States. The probable principal source of the present transgenes in the varieties of Mexican maize is the grain cultivated in the United States.

7. Based on the proportion of transgenic maize that is cultivated today in the United States, it is calculated that between 25 to 30 per cent of the Mexican imports of U.S. maize is transgenic. In the United States, after being harvested, transgenic maize is not labeled nor separated, but rather it is mixed with non-transgenic grain. The two varieties of most commonly cultivated transgenic maize in that country have two genetically modified traits respectively: 1) *Bt* transgenes for resistance to the larvae of certain insects; and 2) other transgenes for resistance to certain herbicides (see http://www.isb.vt.edu/) Furthermore, the cultivation of some transgenic varieties with male sterility has been deregulated in the United States, where the cultivation of certain varieties of maize used for the commercial production of industrial compounds is permitted. The cultivation of transgenic maize is constantly increasing in Canada and the United States. Currently new types of transgenic maize are being developed and it is probable that in the coming years their cultivation will be permitted in those countries.

8. The cultivation of a class of (*Bt*) transgenic maize named Starlink™ is banned in the United States. In 2000, after it was approved for exclusive use as animal feed, Starlink™ maize was widely cultivated; however, inadvertently it was introduced into U.S. food supply. No adverse effects for health or the environment have been associated with this event. The Starlink™ *Bt* transgene is still found in low levels in the U.S. grains system, but it is not known if it is present in Mexican *criollo* maize varieties, though it seems improbable. Until now no peer reviewed studies have been published.

9. In the United States and Canada, experimental cultivation on a small-scale of un-regulated and non-commercial maize varieties with dozens of other transgenic traits takes place (see http://www.isb.vt.edu/ and http://www.inspection.gc.ca/english/sci/biotech/gen/pntvcne.shtml). In comparison with the transgenes of wide commercial cultivation, it is much less probable that these other transgenes are propagated in Mexico, since they are cultivated in small plots and both the

U.S. Department of Agriculture as well as the Canadian Food Inspection Agency (agencies in charge of regulating the experimental cultivation in those countries) impose strict confinement requirements on experimental transgenes. It is not known if transgenes of the first experimental cultivation in Mexico (before 1998) are present in Mexican maize; however, it is considered not very probable.

10. A probable route of transgenic introgression (that is to say, of transgene propagation and persistence) into native varieties is that *campesinos* from rural communities plant imported transgenic grains that have fallen into their hands from a government agency (for example, Diconsa, S.A. of C.V.). In fact, it is known that *campesinos* occasionally plant seeds from Diconsa with the local varieties of *criollo* maize. Cross pollination can take place between modern cultivars and traditional maize that grow in proximity to each other and flower at the same time. *Campesinos* store and exchange grain, some of which can be transgenic, and thus, the cycle of gene flow can repeat itself and the transgenes can propagate even more.

Persistence of transgenes in landraces and teocintles

11. The new alleles introduced by the gene flow can persist or not in the recipient populations, depending on: 1) if the gene flow is a sole event or if it is recurrent; 2) the rate of the gene flow; and 3) the size of the recipient population and if the new allele is locally damaging, beneficial or neutral. These principles are applicable to both conventional genes and transgenes.

12. The transgenes that are beneficial and neutral in terms of selection have the potential of persisting indefinitely in the *criollo* varieties of maize. It is foreseeable that the frequency of the transgenes will increase if the *campesinos* prefer these traits or if the transgenes give the plant a reproductive advantage.

13. The *Bt* transgenes could be favored in the selection processes of the recipient populations if they protect the plants from the damage of certain plagues of insects. On the other hand, the transgenes that are herbicide tolerant will be neutral for selection unless the recipient population is treated with the herbicide in question, in which case it gives it an adaptive advantage. These predictions are based on the premise that, in addition to the desired trait, the transgenic variety does not register any other change in its phenotype.

14. The removal of transgenes with extensive introgression in traditional varieties can be extremely difficult if not, in fact, impossible.

15. It is not known for sure whether the transgenes or other genes of the crops can persist permanently in *teocintle* populations once hybridization has taken place.

Expected effects of transgenes in the genetic diversity of landraces and teocintles

16. There is no reason to foresee that a transgene will have more or fewer effects in the genetic diversity of landraces or *teocintles* than other genes of modern crops used in a similar fashion.[2] The scientific definition of genetic diversity alludes to the sum of all the variants of each gene in the genetic reservoir of a given population, variety or species.

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[2] Bellon, M.R. and J. Berthaud, 2004. "Transgenic maize and the evolution of landrace diversity in Mexico. The importance of farmers' behavior". *Plant Physiol.* 134(3).

The genetic reservoir of maize is made up of tens of thousands of genes, many of which vary in and between populations. Since maize is a cross-pollinated plant with a very high frequency of genetic recombination, it is not very probable that the transgenes will substitute – if at all – more than a quite small portion of the native genetic reservoir. Rather, the transgenes would add to the dynamic mix of genes present in local varieties, including the conventional genes of modern crops. Therefore, the introgression of some individual transgenes will hardly have a significant biological effect on the genetic diversity of the *criollo* varieties of maize.

17. Note: Another section of this report discusses the possible ecological effects of transgenes that *could* differ from the effects of other genes of the crop, as well as the fact that some people think that transgenes could be damaging to human health, the native varieties themselves or the environment, and, therefore, perceive transgenes as a form of genetic contamination. Both issues are different from the question of how transgenes affect the genetic diversity and future cultivation of the grain.

18. Modern agricultural practices have real and important effects on the genetic diversity of the *criollo* varieties of Mexican maize. For example, the economic pressures associated with modern agriculture and the current asymmetries and the economy of commercial exchange of maize between Mexico and the United States could cause farmers and small agriculturalists to abandon the use of native varieties. The specific problem of the genetic erosion of maize is the result of the interaction of many socioeconomic factors, and given this panorama the potential direct or indirect effects of transgenic maize are not clear.

19. To conserve the genetic diversity of the *criollo* varieties of maize in an optimal state it is necessary to combine *in situ* and *ex situ* conservation practices. *Ex situ* conservation of the diversity of local varieties is not enough in and of itself, since traditional varieties are entities in constant evolution. Similarly, just *in situ* conservation (by *campesinos*) is not enough to preserve genetic diversity, since it does not necessarily include all the diversity of the past.

Biodiversity

1. Biodiversity is a term that is applied to all species, its genetic variability and the communities and ecosystems where these exist.

2. According to the Convention on Biological Diversity, biodiversity has "ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values" which are essentials for human life.

3. The diversity of maize in Mexico is maintained fundamentally thanks to the local and indigenous rural communities. That system allows for the conservation of the genetic resources of maize that makes up the basis of the food and agricultural production. In the last six or seven decades, various institutions in Mexico, such as the Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP), the Centro Internacional de Mejoramiento de Maíz y Trigo (Cimmyt), the institutions of higher learning and some foreign institutions, especially in the United States, have contributed to this genetic diversity by generating a huge quantity of new varieties of maize.

4. The varieties of *criollo* maize in Mexico have been produced in a dynamic form and changed continually as a result of human and natural selection. It is not a question of static or separate entities, rather the term "*criollo* maize" refers to the diverse regional varieties in Mexico.

5. With specific regards to the biodiversity of maize in Mexico, three aspects are of particular interest:
   a. The genetic diversity of maize and the species of *teocintle*, all of which are from the genus *Zea*.
   b. The diverse groups of plants and animals that usually live in the fields where the maize is grown.
   c. The biodiversity of the surrounding natural communities and ecosystems.

6. All of these three aspects pose important questions and lead to the following conclusions:
   a. There is no evidence that suggests that the inheritance mechanisms of transgenes in Mexican maize or in *teocintles* differ from the current patterns in other organisms or from the behavior of genes and genetic elements in general.
   b. No negative or positive effects of transgenic maize have been noted in plants or animals that frequent or live in the Mexican cornfields or plots; however, it is still necessary to do specific studies.
   c. The biological characteristics of maize and of *teocintles* are such that it seems not very probable that they propagate in neighboring communities, whether they are transgenic or not. However, the effects of GM maize on insects - be they target species or not – that travel from one cornfield to another and back and forth from adjacent natural communities are not known.
   d. Agriculture, regardless of how it is practiced, reduces the general level of biodiversity compared to what was its pristine state. The question remains if intensive and concentrated agriculture has a greater impact on biodiversity than less intensive, less productive and more disperse productive systems.

7. The scientific research and analysis of the last 25 years has shown that, in the short or long term, the gene transfer process from one organism to another does not involve any intrinsic threat for health, biodiversity or the environment. Consequently, what must be examined to determine the risks of benefits of an organism or variety are its characteristics, independent of whether the new genes are transgenic or not.

Health

1. There is no empirical evidence that the process of producing GM crops is damaging or beneficial *in and of itself* for animal or human health. What should be evaluated are the negative and positive effects of the products of transgenic plants, as well as the negative and positive effects of any form of improved crop, including those resulting from conventional production methods.

2. The volume of maize consumed in Mexico as well as the forms of consumption differ enormously from most other countries. The grain is fundamental for the Mexican diet, which is why the transgenic maize that has already been approved as well as that which is proposed for future introduction to Mexico merits special consideration.

3. The production of certain drugs and industrial compounds not suitable for human or animal consumption in food crops presents risks for human health that are unique in their type. This issue is particularly worrisome in the case of maize, which is a staple food produced by open pollination.

4. Public opinion expressed in the symposium of the CEC and in the submitted written comments indicates that the Mexican people are profoundly concerned about the toxicity of GM maize. This concern merits a policy response that could include specific research as well as information and public education campaigns.

Socio-cultural aspects

The system of maize in Mexico

1. Decisions about national policy and the effects of the world maize markets, especially with regards to U.S. exports to Mexico, point to the fact that Mexico is not self-sufficient in maize production.

2. The maize industry in Mexico is a highly complex and structured system (which includes a variety of actors such as millers, importers, transporters and small and large scale tortilla store owners.) The chain of maize supply in Mexico includes a far-reaching mix, reserve and exchange of seed and of grain amongst these actors.

3. The experimental cultivation and selection of maize seed are millenary traditions thanks to which the numerous local varieties of the grain have been generated. The varieties of Mexican maize are neither static nor homogeneous in genetic terms; they are constantly being modified by those who use them and who produce them. As part of this process, sometimes genes from improved or modern varieties are deliberately or inadvertently introduced into the *criollo* maize.

4. *Campesinos* – small producers that cultivate plots of less than five hectares, usually on temporary lands, and that include private owners as well as holders of usufruct rights on communal lands, *ejidos* and indigenous communities – make up two thirds of the maize producers in Mexico.

5. The *campesinos* have access to fertile grains stored in government silos for industrial processing and animal consumption, and they can sow that grain or experiment with it intentionally or not.

6. The *campesinos* believe that the freedom to exchange seeds, to store them for later cultivation and experimenting with new seeds is fundamental for the conservation not just of local varieties, but also for their cultural identity and their communities.

7. In general, amongst *campesinos* there are no formal systems for *in situ* or *ex situ* conservation of *criollo* maize for the express purpose of preserving genetic diversity. However, in indigenous communities there are some formal systems for *in situ* storage of specific varieties for cultivation and reproduction.

8. It has not been specifically shown that the traits of tolerance to herbicides and resistance to insects of the current varieties of GM maize are beneficial for the *campesinos* in Mexico and, as such, these traits do not seem to correspond to the *campesinos'* most urgent needs.

The cultural importance of maize and public opinion about GM maize

9. Maize has important cultural, symbolic and spiritual value for the majority of Mexicans, which is not the case for people in Canada or the United States. The evaluation of the risk posed by GM maize in Mexico is necessarily linked to those values.

10. Even though some people think that *teocintle* is a weed that reduces productivity, in many zones it is kept in the cornfields because it is considered the "mother of the maize" plant. Due to this situation, *teocintle* is a source of genetic variability for the different wild species of the genus *Zea* and for the landraces and cultivated varieties of maize.

11. Some of the population of the state of Oaxaca, especially the *campesinos,* consider that the presence of any transgene in the maize constitutes an unacceptable risk for traditional agricultural practices, as well as for cultural, symbolic and spiritual values of maize. This perception of a threat is independent of the scientifically studied potential or real effects on human health, genetic diversity and the environment.

12. Furthermore, for many people in rural Mexico, the introgression of a transgene of maize is unacceptable and is considered "contamination," as was expressed in written documents and oral presentations during the process of Article 13.

13. The evaluation of the risk of GM maize in Mexico is intricately linked to the central role of maize in Mexican history and culture, including the belief and values systems of the indigenous communities.

14. The initiatives of the breeders of new crops or of the Mexican government to communicate or demonstrate the possible benefits of GM maize for *campesinos* and small producers have been few and insufficient.

15. Until now, there is no evidence that the introgression of the traits of the current varieties of GM maize cause significant damage for the health or environment of the United States or Mexico. However, this matter has not been studied in the context of the Mexican ecosystems.

16. Many of the *campesinos* and community organizations that have voiced their concern about gene flow of transgenes see GM maize as a direct threat to political autonomy, cultural identity, personal security and biodiversity. Many *campesinos* do not receive any direct benefit from the current varieties of GM maize.

Public institutions and processes

17. Just as in the rural communities there is a scarcity of information on the tenets of plant genetics and gene technology, inside the scientific and political communities the information about the social and cultural concerns in the countryside is very scant. Because of these information gaps, it is difficult to design policies that are both scientifically based and socially acceptable.

18. The introgression of GM maize in Mexico by way of the legal importation and officially authorized grains from the United States has occurred in the absence of formal processes of divulging information to and obtaining consent from rural communities. The lack of consultation is understandable since the introduction of GM maize in rural communities was an unanticipated outcome of its importation as food or the informal exchange of seeds, and in no way formed part of a governmental plan to introduce such crops.

19. Many persons that live in rural communities and many NGOs distrust governments and the institutions in charge of biosafety (according to the conclusions of the process of Article 13). The Mexican regulatory bodies have been stopped from implementing laws, *in part* because some NGOs oppose experimental cultivation of GM plants. Despite everything, trustworthy and opportune information has not been divulged to those interested in the possible implications of genetic modification technologies.

20. The responses recorded in the public symposium organized by the CEC suggest that forums such as those hosted by the Mexican government for expressing citizen concerns about GM maize or for communicating information about the possible benefits, have not been suitable for the *campesinos* of Oaxaca and the remote areas.

Political climate in Mexico regarding GM maize

21. Among the three countries of NAFTA, the capacities for scientific research, regulatory evaluation and the implementation of policies differ profoundly, even when the capacity of Mexico will improve thanks to a project of more than one million U.S. dollars financed by the United Nations Development Program (UNDP) and the Global Environment Fund (GEF), with the purpose of helping Mexico prepare policies on biosafety. The citizens are not aware or do not understand the official position of the Mexican government on GM maize nor the functions and responsibilities of the specific governmental agencies in its regulation.

22. The Mexican public institutions have not carried out evaluations of the environmental, health, social or economic risks of the maize transgenes that have succeeded in introducing themselves into Mexico, in contrast to what has occurred in the United States and Canada. Neither U.S. nor Canadian regulatory agencies are doing formal evaluations of the consequences of the transgenes beyond their borders.

23. Currently there are no mechanisms for the systematic monitoring of transgenes in Mexico.

24. The policy of a moratorium on the commercial planting of GM maize has been undermined by the unauthorized cultivation of imported maize, and it does not fulfill its objective if importation of fertile, unlabeled and not separated GM maize from the United States is allowed.

25. With the ratification of the Protocol on Biosafety, Mexico showed its commitment with the implementation of the "precautionary approach" *in the regulation of transborder movement of living modified organisms.*

26. Even when a conventional analysis of the risks of the case of the GM maize *imported* into Mexico can be undertaken, given the Mexican context, it is convenient to incorporate precautionary assumptions in the scientific assessment and management of all the risks, as well as recognizing the importance informed consent plays in the acceptance of such risks.

27. In the context of the international trade agreements, if Mexico wishes to heed the socioeconomic concerns of the *campesino* producers, there are firm arguments, at least *prima facie*, to consider that it would be "socially acceptable' to protect the *campesinos* and their traditional varieties of maize, as well as to protect the needs of other groups that could be affected by changes in the current policy. It is clear that the maximum reduction of the risks of introgression of transgenes in the local varieties of Mexican maize could be achieved with a total ban of importing live modified organisms in the form of GM maize. However, the economic costs and commercial restrictions of this measure, both for the U.S. and for Mexico could turn out to seem unacceptably high.

Recommendations

The following unanimous recommendations to the CEC Council were derived not only from the preceding main conclusions, but also from the reference volume, the commentaries received throughout the process – including those of the 2004 March Symposium – and the best professional judgment of the interdisciplinary and multi-sectorial advisory group in charge of formulating them.

Gene flow

1. It is necessary to do additional research to determine which specific transgenes have been introduced in the local varieties of Mexican maize and maybe in the wild populations of *teocintle*, as well as to determine the frequency of the introduction. Furthermore, it is necessary to fully disclose and explain the results of this research and to promote its publication in peer-reviewed specialized scientific journals.

2. In order to formulate policies on biosafety, strategies for biodiversity conservation and plans for the possible future application of genetic engineering in Mexico, it is necessary to determine to what degree the genes of modern cultivars (including transgenes) have been introduced, crossed and introgressed into local varieties and *teocintles* through pollen dispersion and seed flow in the context of modern and traditional systems of maize. The theoretical and experimental research should test specifically if the presence of individual genes of modern cultivars (including transgenes) has important biological effects on the genetic diversity of the landraces of maize or on the *teocintles*. In addition, the researchers should explicitly test the hypothesis that the transgenic material of grains supplied by various distributors, such as Diconsa, has been, and continues to be, the main source of transgenes present in *criollo* maizes.

3. The regulatory agencies of the three countries must formulate and put into practice better methods to detect and monitor the propagation of specific transgenes, such as unique marker genes (including the specific locus of the transgene) and the products of the transgene (for example, specific *Bt* proteins) that can be easily, reliably, and affordably recognized.

4. To formulate adequate regulatory policies and strategies of biodiversity conservation, subsequent research is required that would determine the consequences of gene accumulation (new multiple genes, including transgenes) through gene flow, in the fitness and yield of the recipient plants, as the cumulative effects of multiple genes can have consequences different from that of the individual genes, and this, in turn could influence the persistence of transgenes in the recipient populations of *criollo* maize and *teocintle*.

5. Until adequate research and evaluations are carried out about the risks and benefits of the effects of gene flow of transgenic maize on landraces and *teocintle*, and, more information is circulated among *campesinos* and rural communities, the present-day moratorium[3] should continue to be applied to the commercial cultivation of transgenic maize in Mexico. However, this moratorium should not be applied to experimental cultivation that has been carefully planned and controlled if solid scientific information is to be procured to answer the majority of the questions regarding the risk assessment of the transgenic maize varieties and their possible effects.

6. Given that the persistence and propagation of new genes depend in such a marked way on the gene flow rate, the Mexican government should strengthen the moratorium on the commercial cultivation of transgenic maize, minimizing the importation of live transgenic maize from countries that commercially grow it. For example, some countries have dealt with this problem by grinding transgenic grains at the port of entry.

7. The Mexican government must directly notify the local *campesinos* about the probability that the maize distributed by Diconsa contains transgenic material and that, therefore, and in accordance with the regulation in force, they should not plant it. This initiative should include clear and explicit labeling in the sacks, containers and silos in which Diconsa stores and transports the grain, as well as the firm commitment to educate the affected *campesinos* about this matter.

8. Possible methods should be evaluated and developed to eliminate transgenes from landraces in case it is decided that such action is desirable. The participation of small farmers in the development of these methods will be important.

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[3] In June 2003, given the need to respond to specific scientific questions with regards to the possible presence of GM maize in Mexican territory, the Mexican government lifted the *de facto* moratorium on experimental cultivation of transgenic maize. The Instituto Nacional de Ecología (INE), the Secretaría de Medio Ambiente y Recursos Naturales (Semarnat) and the Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (Conabio) are in the process of generating recommendations to define guidelines and conditions about how to carry out experimental release of genetically modified maize. In July 2004, the INE circulated a draft of these guidelines for their review among experts that participated in a workshop on the topic in December of the previous year. In a parallel fashion, the Secretaria de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (Sagarpa) has requested to the Subcomité Especializado de Agricultura (SEA), which belongs to the Comisión Intersecretarial de Bioseguridad y Organismos Genéticamente Modificados (Cibiogem) and is in charge of the risk evaluations on biosafety matters, to formulate specific guidelines to the experimental release of GM maize. Currently, no authorization requests are accepted for the release of maize for commercial purposes in Mexico.

9. Since traditional forms of gene flow in landraces promote genetic diversity and are the base of local food security, no policy to control the propagation of transgenic maize should interfere with this flow.

10. Both *in situ* and *ex situ* conservation of the genetic diversity of maize require more effective programs.

Biodiversity

1. The changing genetic nature of the maize and *teocintle* populations in Mexico has to be monitored in permanent form, both to have a registry of the present genes – transgenic or not – as well as to detect new genes established in the future. The monitoring system must provide the public with appropriate information.

2. The genetic diversity of the landraces of Mexican maize and *teocintle* has to be preserved, both in nature and in agriculture, as well as in *ex situ* crops, and in seed banks. Mexican, international and private sector financial resources must be allotted to this increasingly important initiative.

3. Capacity building in Mexico must be supported in order to create a pool of specialists in all areas of study and improvement of maize, from molecular genetics to ecology, including economics and social sciences.

4. Further research is required on the many aspects of the cultivation and improvement of maize in Mexico. Such research should pay special attention to the role and needs of the *campesinos*, which until now have been largely neglected.

5. It is urgent to examine and evaluate the direct and indirect effects of the cultivation of genetically modified maize in the communities of flora and fauna– many of which are very useful – formed around maize in the cornfields (*milpas*) and in other Mexican agricultural systems, and in the biodiversity of the neighboring natural communities.

6. The new advances in the cultivation of maize in Mexico should take into account the needs, as well as the possible benefits and risks, for the *campesinos*, small producers and large-scale commercial farmers.

7. The agricultural producers of all classes should participate in the development of new agricultural practices from the beginning of the process.

Health

1. It is urgent to research the ways in which the consumption of great quantities of maize could increase the hypothetical positive and negative effects of particular varieties or genetically modified varieties.

2. The modification of maize to produce drugs and certain industrial compounds not suitable for human and animal consumption should be prohibited, in accordance with the expressed intentions of the Mexican government. At the same time, the possibility of prohibiting such uses of maize in other countries should be seriously considered.

Socio-cultural aspects

1. The Advisory Group recommends that the NAFTA Parties adopt policies to reduce the identified risks to a level "as low as is reasonably achievable" (ALARA). This ALARA approach is a safety norm or widely recognized regulation used in relationship with risks to health and the environment in the NAFTA countries and in other parts of the world.[4] Given that certain transgenes are already present in Mexican maize and that the level of null risks is no longer an achievable norm, at this time it seems that the ALARA approach is in this moment the most reasonable.

2. Measures must be adopted to reduce the probabilities that non-authorized GM maize is planted in order to enforce the current moratorium on commercial planting of transgenic maize. An important and "reasonably achievable" reduction of *any* of the risks that could be demonstrated could be achieved if the following measures were enacted:

   a. A requirement that the imported maize from the United States and Canada is labeled, indicating any possible GM maize content or *"GM-free"* certification (currently Canada does not export maize in bulk to Mexico).

   b. A requirement that all imported maize to Mexico from Canada and the United States that is not *"GM-free"* certified is directly sent, without exception, to mills for processing. An implementation mechanism could be an obligatory system of "final use certification" for all such imports.

   c. Educational programs that target *campesinos* and urge them not to plant the seeds that could contain transgenics or any seed brought from the United States or from other countries where the GM maize is planted.

   d. Procedures to guarantee the participation of small producers in the development of new Mexican policies on biotechnology that are adequate and acceptable to all parties.

3. The Mexican government should implement a program of communication and consultation with *campesinos* on the benefits and risks of transgenic maize.

4. It is necessary to support *campesinos* in the protection and conservation of the unique biodiversity of the landraces of Mexican maize. This may involve direct payments to

[4] The ALARA approach is used for the control or management of exposure (both for an individual, a collective, for workers or for the citizenship in general) and emissions to the environment, at such low levels as the social, technical, economical, and practical considerations and public policy allow. The ALARA is not a limit in exposure, but a practice whose objective is to achieve applicable levels of exposure as low as possible. This offers a wider margin of error in case the control fails or is not adequate. In other words, the level of exposure to which a person can be subjected can increase, yet it would be below the acceptable limit. This approach is based on common sense and means that the exposure of workers and of the public in general is maintained below the regulated limits. The ALARA is much more than a simple phrase. It is a principle of work, a form of thought, a culture of professional excellence. In an ideal world, one could reduce to zero the exposure to dangerous materials. In the reality, to reduce the exposure to a null level is not always possible, because of certain social, technical, economic, and practical considerations or public policy resulting in the establishment of a low yet acceptable risk level. The US Nuclear Regulatory Commission is guided by ALARA practices to determine the radiation levels to which workers may be exposed.

campesinos willing to maintain their traditional agricultural practices and to adopt reproduction practices that preserve local varieties, in order to hinder or minimize the introgression of genes from other sources and localities.

5. It is necessary to develop and implement a program to guarantee the quality of *criollo* maize seeds. The *campesinos* could send their own seeds and whatever other material that they propose to use for planting to designated laboratories to investigate the presence of any transgenic trait. This measure could also include a national registry of producer *campesinos* and the creation of a management system (that could serve as a base for *campesinos* to protect their traditional knowledge, and to create a differentiated food product). If this were implemented, it would limit the introgression of new transgenes and would also detect and allow elimination of any transgene present in the seeds of *campesinos*.

6. It is necessary to increase the public support for *in situ* conservation of *criollo* maize diversity: by supporting community seed banks, training and extension programs for *campesinos*, the registry and the certification of traditional and local knowledge, as well as more scientific research on the nature and identity of the traditional varieties of maize.

7. It is necessary to harmonize the assessment and management of biosafety risks through greater coordination of research policies and regulation in Canada, the United States and Mexico, as proposed by the North American Initiative on Biotechnology. Information and knowledge about the attributes and risks of any new variety produced in the three countries must be provided before proceeding to its commercialization, in order to determine which – if any – methods of confinement could be necessary to impede the movement of certain LMOs over international borders. Ideally, this would include that the proponents of new products make simultaneous requests of regulatory revision in the three markets, even if in many cases this could not result as convenient in commercial terms for the simultaneous introduction of the new product in all the markets. In order to guarantee full control of compliance with the legislation, there must be a greater exchange of information among those responsible for regulation in the three countries, so that no product can be released without knowledge of the three governments. The ideal scenario is for harmonization to cover both the specific risks to some of the individual countries as well as those that are common to two or more of the countries.