

BIOCULTURAL IMPACTS OF TRANSGENIC CROP RELEASE AT CENTERS OF ORIGIN AND DIVERSIFICATION: THE CASE OF MAIZE IN MEXICO

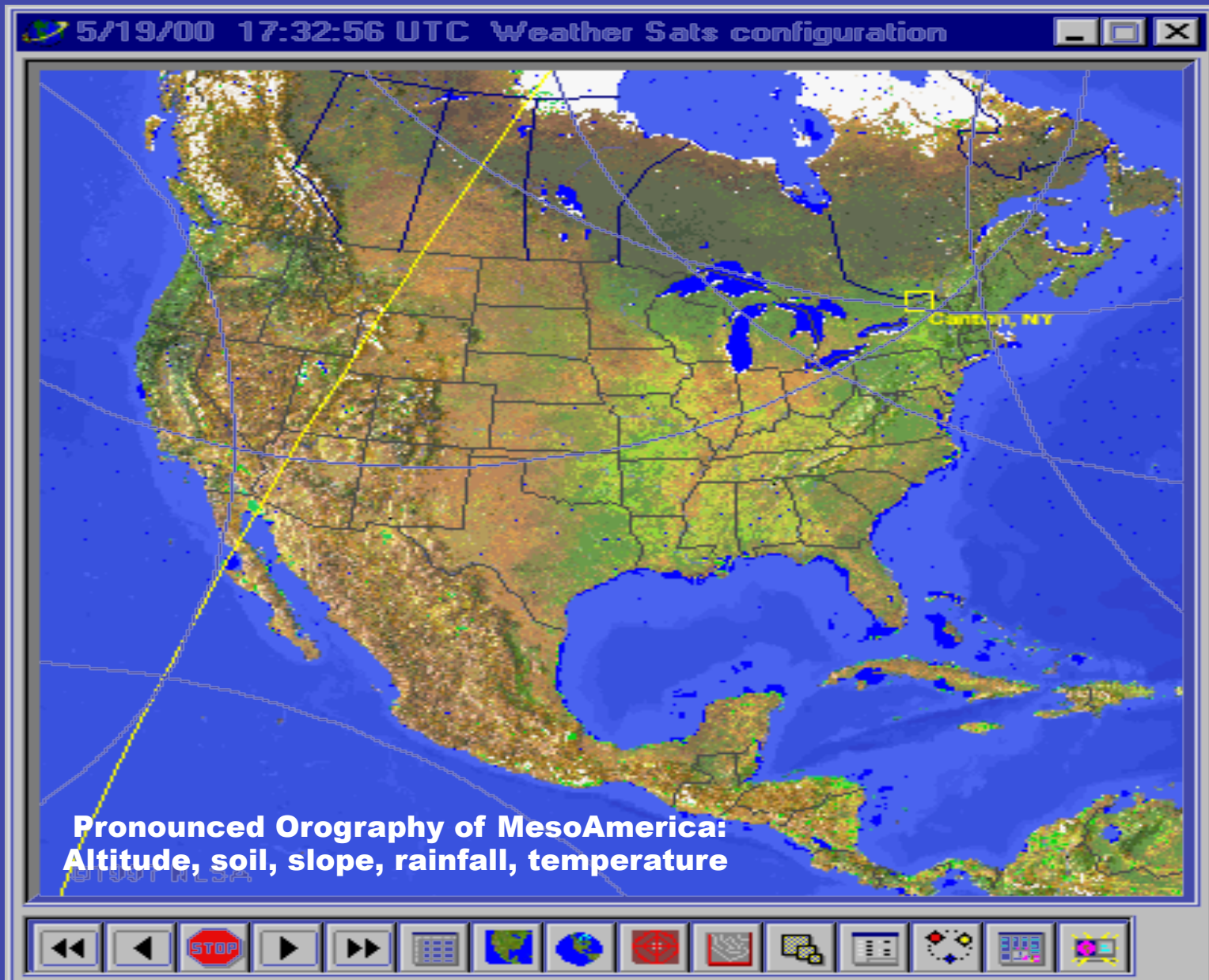
**Antonio Turrent, Alejandro Espinosa, and Eckart
Boege**

**Conferencia científica: “20 años de cultivos
transgénicos y 40 años de Ingeniería
Genética”**

UCCS, UCCSNAL, ENSSER, TWA

**CU-UNAM, Ciudad de México
December 2, 2016**

“The Northamerican maize agroecosystem”



Maíces mexicanos

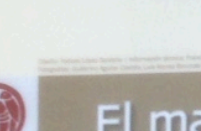
México es el centro de origen, domesticación y diversificación del maíz

húmedos
secos
cálidos
frios

La diversidad de maíces de México es el resultado de tres factores: su domesticación a partir de los teocintles, su cultivo en una gran variedad de ambientes: húmedos, secos, fríos y cálidos, desde el nivel del mar hasta 5,000 metros y la diversidad de prácticas agrícolas y de usos de más de 80 etnias indígenas y de muchos pueblos mestizos.

Uno de los sistemas agrícolas en los que se domesticó el maíz es la milpa, tradicional un complejo agroecosistema que incluye además del maíz, otros especies cultivadas como calabaza, frijol, chile, nabo, pepino, ajonjolí, guisante, papas, medicinales y una variedad de especies animales. Esto lo hace un sistema estable similar a un ecosistema natural.

México representa la mitad de su diversidad.



Chapalote

Olotón

Pepitilla

Palomero
Toluqueño

Nal-Tel

Ratón

Bolita

Arrocillo Zapalote Chico

Cacahuacintle

Chalqueño

Tuxpeño

Jala



Los teocintles son los progenitores silvestres del maíz. Las 60 razas de maíces de México son el resultado de la cuidadosa selección de diversos grupos indígenas por alrededor de 10,000 años y más recientemente también por los grupos mestizos. Cada raza está adaptada a climas, suelos, plagas distintas y a diferentes usos. Dentro de cada raza hay una gran variación. Este proceso continúa vigente en la actualidad.

El maíz es la base alimenticia de gran mayoría de los mexicanos. México se ha documentado y se lo menos 600 variedades distintas basadas en el maíz.

El maíz se utiliza para muchos productos como forraje para ganadería, productos industriales como almidones, edulcorantes, aceites, pigmentos, papel, bio-solventes, alcohólicos, cosméticos, también se le da uso experimental.

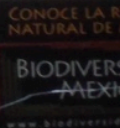
El maíz y los teocintles son un recurso de riqueza genética que se ha utilizado para el desarrollo de variedades adaptadas a situaciones como las creadas por el cambio climático.

El maíz es patrimonio biológico, agrícola, cultural y económico de México

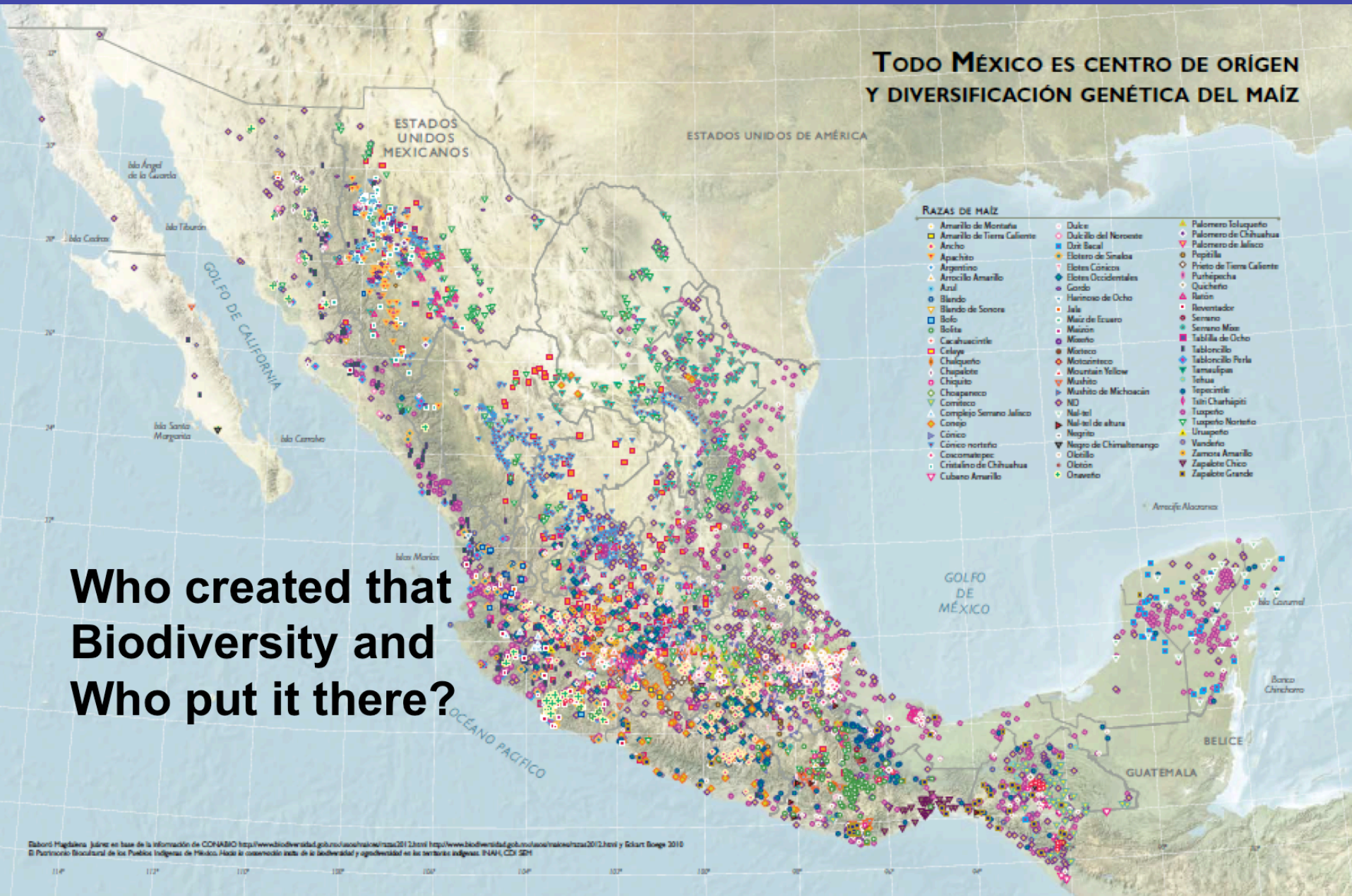
www.conabio.gob.mx



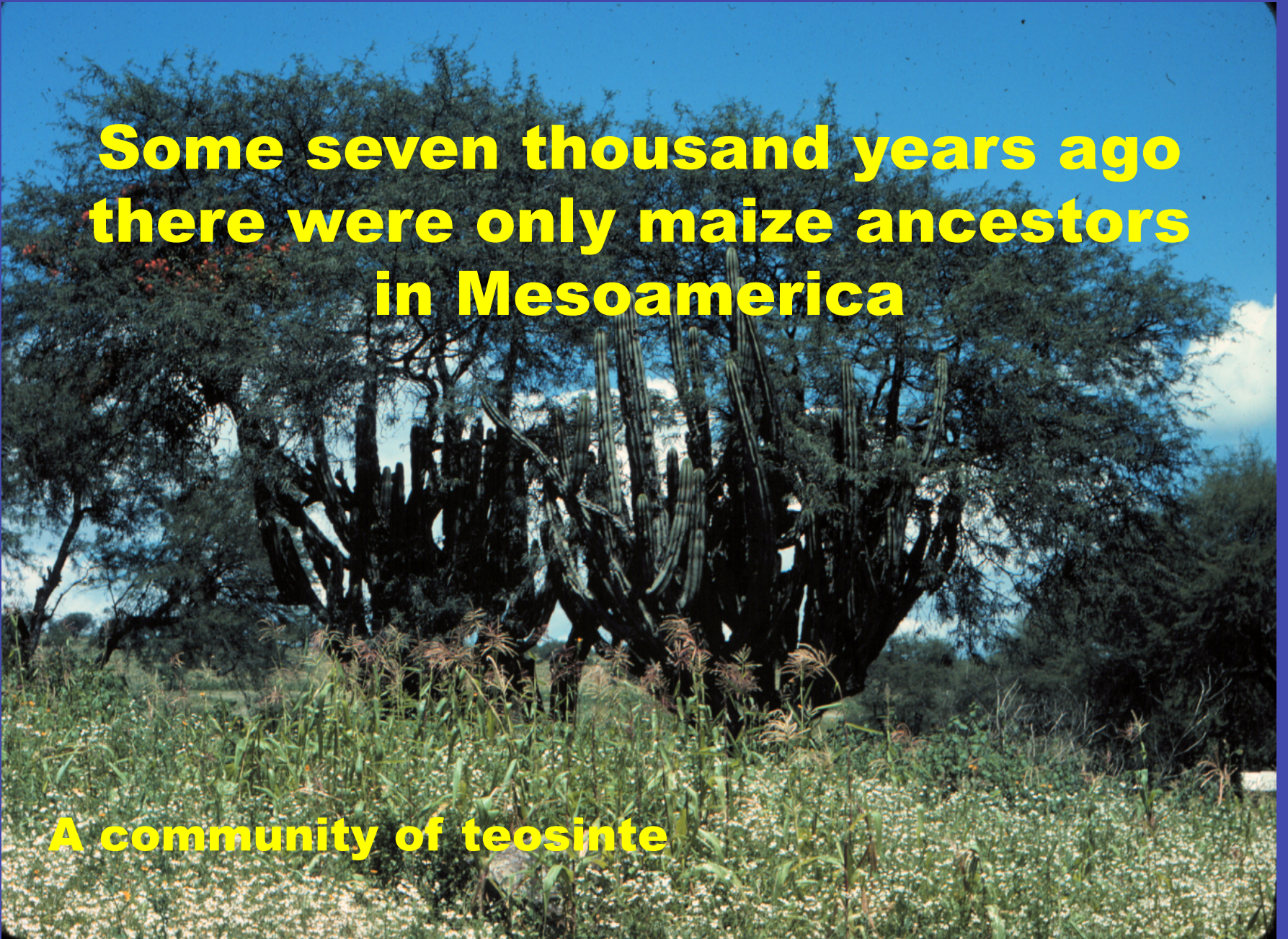
Comisión Nacional para el Conocimiento y Uso de la Biodiversidad



TODO MÉXICO ES CENTRO DE ORIGEN Y DIVERSIFICACIÓN GENÉTICA DEL MAÍZ



Who created that
Biodiversity and
Who put it there?



**Some seven thousand years ago
there were only maize ancestors
in Mesoamerica**

A community of teosinte



Figure 1. Teosinte distribution in Mexico.



OLDEST EAR RELICS FOUND IN OAXACA

**The Guilá Naquitz ear relics have non
disarticulating rachis, spikelets
perpendicular to rachis
and exposed kernels:
dated 6250 years ago**

**More advanced ears dated 700 years
later were found in the San Marcos
caves, now with two spikelets per knot.**

**How to deal with the biodiversity
bottleneck associated with
domestication? THE ANSWER WAS
BIODIVERSITY OF TEOSINTE**



Autochthonous maize breeding

The central elements of this procedure as described by Hernandez X. are:

1. Selection of ears and seeds by women as the steering mechanism for breeding in accordance with cultural consensus on the ideal type of ear and seed for each use.
2. Seed interchange and circulation of genetic materials among local plots, sampling ecological niches and year to year variation of biotic and abiotic stresses.
3. Frequent introduction of new genetic (allopatric) materials by ethnic farmers and hybridization with local seed.
4. Parallel, multilocation repetition of this process for prolonged periods of time.
5. Entire Mexican maize agroecosystem used as the critical operating genomic space.

By the time of encounter of the two worlds, modern maize had been developed already; AMB had been going on for over 4000 years.

Frequent traits of some native races of maize in Mexico

- High quality of kernel protein.
- High kernel oil content.
- Resistance to some field pests and diseases.
- Resistance to some pests and diseases in the granary.
- Adaptation to soil extreme acidity.
- Adaptation to soil high alkalinity.
- **Associative relations for biological Nitrogen fixation, resistance to root diseases, etc.**
- **Biological control of pests.**

**Adventitious roots of Oloton maize race.
Sierra Mazateca of Oaxaca.
Mucilaginous material**



Plants with outstanding vigor



Multipurpose associative relations of maize

More than 50% frequency of this character in the Olotón maize race of the Mazateca Sierra in Oaxaca

A MS thesis under Dr. Ronald Ferrera of the Postgraduate College

- Thirty six out of 46 mucigel isolates showed N fixing capacity. The genera involved were Pseudomonas, Azospirillum, Derxia, and Xanthobacter;
- Six mucigel isolates and three soil rhizosphere isolates showed antibiotic activity against genera Rhizoctonia, Sclerotium and Fusarium;
- Three out of 96 mucigel and rhizospheric soil isolates showed simultaneous activity in biological N fixation, antibiosis and dissolution of soil P. The genera involved were Azospirillum, Citrobacter and Enterobacter.

BIOLOGICAL PEST CONTROL, A CLEAN TECHNOLOGY

“Maize’s bud worm as an example”

(Dr. Fernando Bahena INIFAP-Uruapan)

- The Mexican arsenal of parasitoids of bud worm (*Spodoptera frugiperda* J.E. Smith) includes 40 species that coevolved with maize and bud worm. Twenty-five species of those parasitoids were found to control 60 % of infested plants in 85 fields of Michoacán in 2008.
- There are also bud worm pathogens, plant extracts and other environmentally friendly means for controlling this pest.
- Public investment to develop and apply this native defense arsenal would make economic and ecological sense.

NIXTAMALIZING PROCESS

(Alcaline cooking)

Appeared some 2000 years ago

COMPARED TO UNTREATED GRAIN:

- **Makes niacin (vitamin B3) available;**
- **Increases 7.5 times the amount of bioavailable Calcium;**
- **Decreases content of Phytic acid;**
- **Eliminates some grain mycotoxins,**

AT PRESENT, DIRECT CONSUMPTION OF NIXTAMALIZED MAIZE GRAIN ACCOUNTS FOR 53% CALORIC INTAKE AND 39% OF PROTEIN INTAKE IN THE NATIONAL DIET.

MAIZE IS USED IN 600 DIFFERENT DISHES, BEVERAGES AND TAMALES. MOST FOOD PREPARATIONS REQUIRE SPECIFIC

LANDRACES



Photos taken from internet. Public domain

The mega-diversity of the Mexican maize agroecosystem would not be adequately served by a short number of non transgenic or transgenic hybrids that would satisfy for Mexico jointly: a) food security, b) the pluricultural uses of maize as food, and c) a clean ecology.

It is common place that inter and intra-racial genetic diversity of maize land races is central to those objectives as well as for mankind.

Maize landraces are unchallenged in marginal agro-niches: drought, frost, high elevation, short season, and sierras.

Putative differences between two maize breeding strategies

Criteria	Autochthonous (Hernández X.)	Modern (Mendelian plus GMO)
Adaptation	To all agro-niches	To selected agro-niches
Biodiversity	Is a Strategic tool	Substituted by uniformity
Objective	Grain yield + organoleptic and nutritious properties of grain	Grain yield
Arena	All ethnic/mestizo farming units, 5000 years, parallel processing, open-cross-pollination	Professional, 100 years, scientific method, controlled hybridization
Access	Free seed interchange and self-production	Private property (royalties)
Resilience	Highly probable	Improbable

Can this splendid pre-Columbian system be helped rather than imperiled by modern science or by modern technology?

Who stands to gain and who stands to lose?

Do we know enough about possible outcomes of:

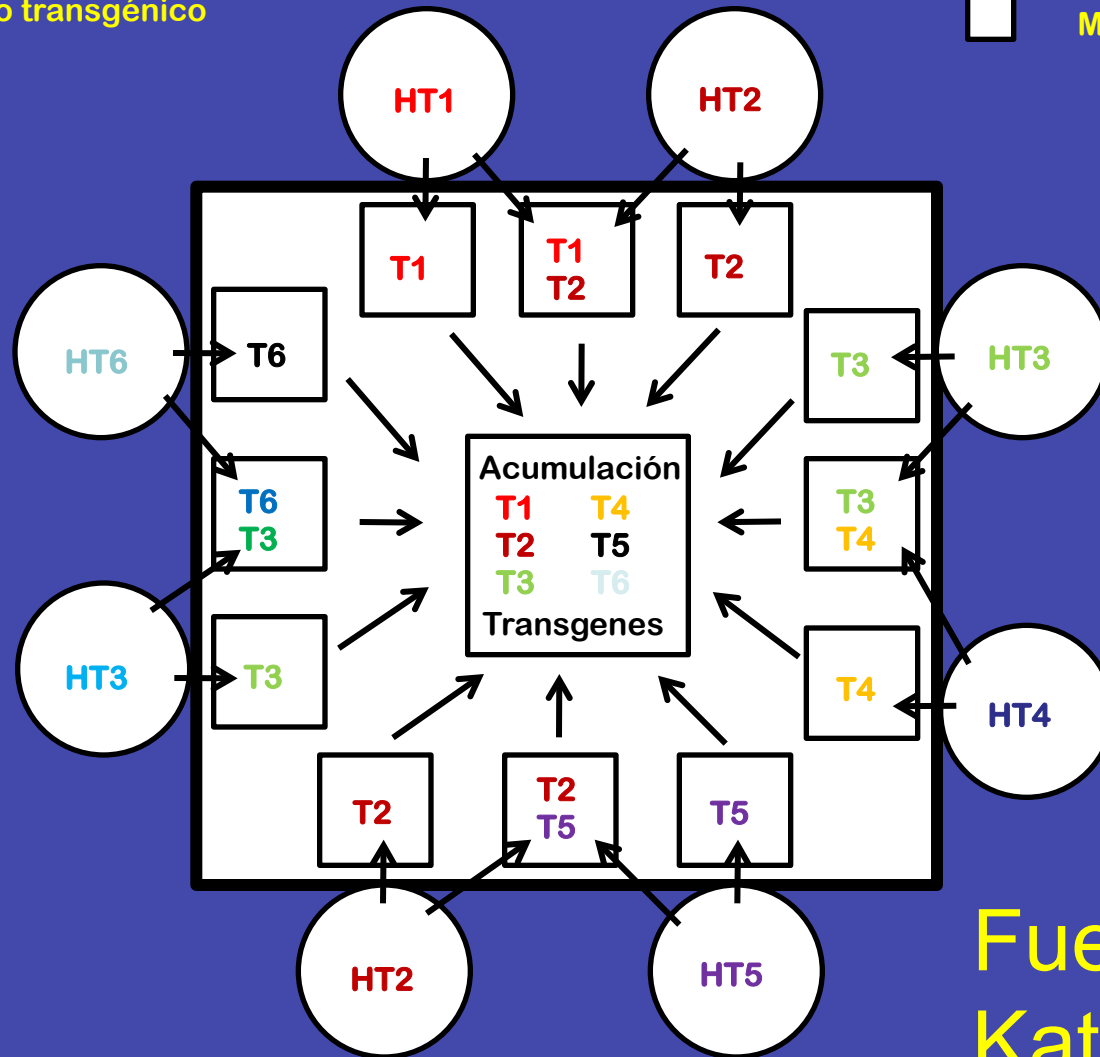
1. Infiltrating TG-DNA into AMB genomic space?

2. Allowing TG-DNA to accumulate at best as junk debris and at worst as a threat to native maize survival?

PROCESO DE CONTAMINACIÓN DEL MAÍZ NATIVO POR DIVERSOS TRANSGENES

T Transgen
HT Híbrido transgénico

○ Híbrido transgénico
□ Maíz nativo



A esto habrá que considerar el aumento numérico de cada uno de los diferentes transgenes y desarrollados *de novo* con el paso del tiempo.

Fuente:
Kato 2014

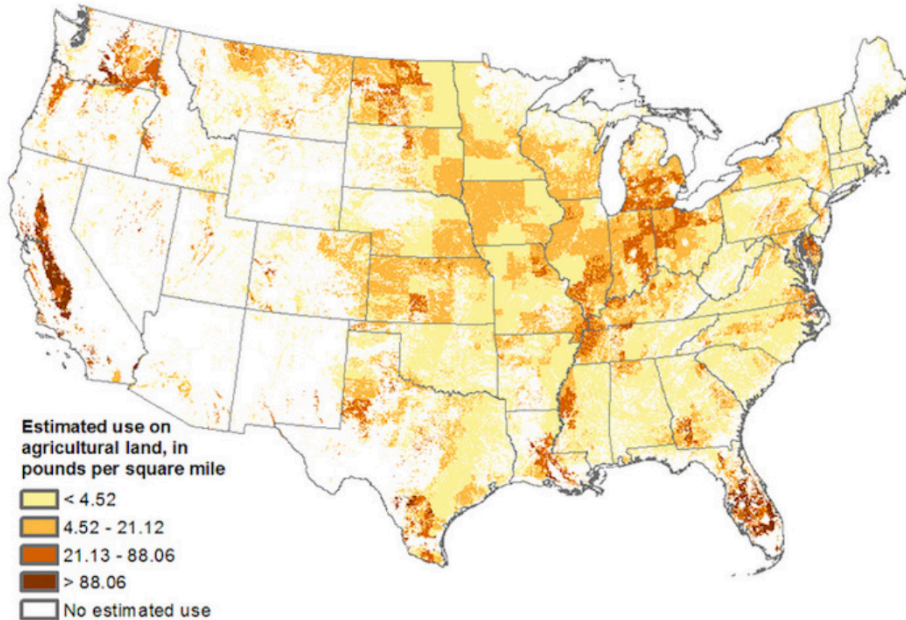
Mammary glands (F)



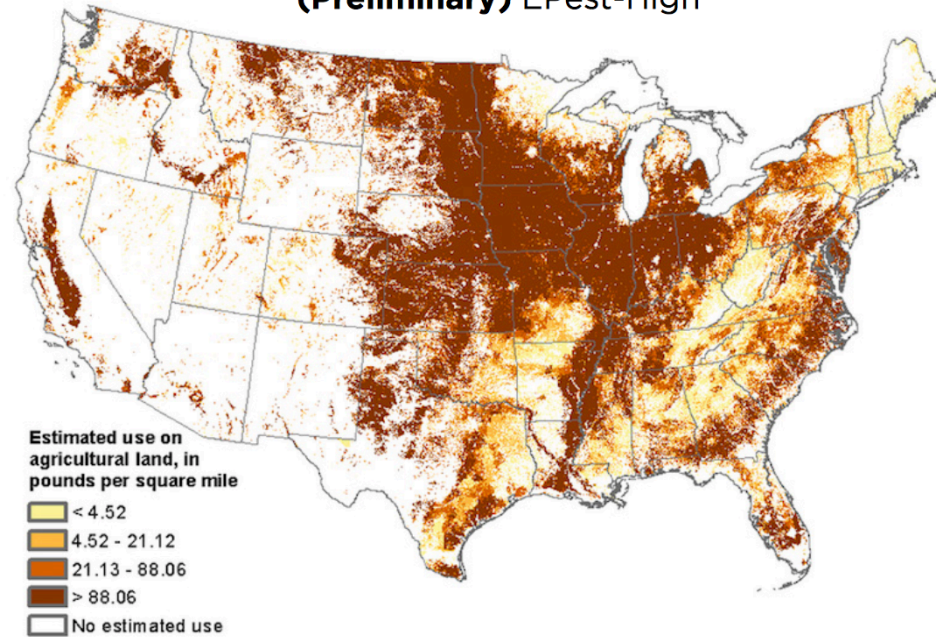
FUENTE: Seràlini *et al.* 2012. Food and Chemical Toxicology. 50:4221-4231
EVENTO TRANSGÉNICO NK 603

EVOLUCIÓN DEL USO DE GLIFOSATO EN EEUU

Estimated Agricultural Use for Glyphosate, 1992
EPest-Low



Estimated Agricultural Use for Glyphosate, 2014
(Preliminary) EPest-High



Food Democracy Now! Glyphosate: Unsafe on Any Plate

El riesgo pertinente para México es el que asumirá en la etapa avanzada de la transgenización de la producción de maíz

Características probables de la etapa de transgenización avanzada:

- Oligopolio total del mercado de semilla de maíz, ya toda OGM.**
- La diversidad genética intraespecífica sustituida por uniformidad genética.**
- Marco legal proclive a la industria multinacional de semillas transgénicas (IMST).**
- Cualquier semilla que contenga ADN transgénico es propiedad intelectual de la IMST.**
- Queda proscrito el intercambio de semillas, su venta y cruzamiento.**
- Es ilegal la autoproducción de semilla.**
- La administración genética de la semilla en manos de la industria.**
- El Estado paga subsidio a la IMST por el uso de sus maíces nativos transgenizados.**
- El grano transgénico sustituye al grano normal en la alimentación humana, como forraje y como insumo industrial.**
- El etiquetado de alimentos de origen transgénico no es obligatorio.**
- La industria no es responsable de cualquier daño a la sociedad (salud humana y/o a la ecología), a menos de que la causa-efecto sea demostrada científicamente.**

A COLLECTIVE DEMAND BY MEXICAN CITIZENS

Fifty-three Mexican citizens and twenty farmer and consumer organizations initiated legal proceedings against the Mexican government and five multinational seed companies three years ago.

The charge is that the human right of Mexicans to use native maize biodiversity as they see fit is threatened by the introduction of transgenic maize. This is a human right of this and future generations.

The plaintiffs demanded as a precautionary measure that as the trial proceeded, no further permits for planting transgenic maize should be granted. This precautionary measure was granted three years ago and it still is in effect at present.

CONCLUSIONS

- 1. Mexico needs from its precolumbian technologies: maize landraces for food security and pluricultural uses of maize as food, and biological pest control for a clean ecology.**
- 2. In the last 50 years, maize landraces have coexisted with modern maize (hybrids) using it as an allopatric source of germplasm; after all, genomes are the same.**
- 3. Should transgenic maize become the source of allopatric germplasm, transgenes would irreversibly accumulate in maize landraces, with effects yet to be known.**