Biodiversity and the future of food security

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CONABIO

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Food security and food sovereignty

• **Security**: When all people, all the time have physical, social and economical access to sufficient, safe and nutritious food to satisfy its dietary requirements and food preferences for an active, healthy life (FAO)

• **Sovereignty**: The right of people to healthy and culturally appropriate sustenance, produced with ecologically sustainable methods and the right to choose its own agricultural and alimentary systems (*La via campesina*, 2007)
1. How the population of mid-21st century will be fed, will define the degree of conservation of the remaining natural ecosystems in the Planet
Agriculture: the greatest factor of ecosystem loss
Intact forests 8,000 years ago
Intact forests today
Sólo 15% de los polígonos tienen > 20 km². La mayoría de áreas remanentes tienen vegetación secundaria.

CONABIO 2011
Motozintla, Chis. 2005
2. High-tech agriculture, as it is applied today, is ecologically and economically unsustainable. Its social, economical and environmental externalities are unacceptable.
Marine dead zone in the Gulf of Mexico (15,000 km²)

Bottom-water dissolved oxygen across the Louisiana shelf from July 22-28, 2013

Data source: N.N. Rabalais, Louisiana Universities Marine Consortium, R.E. Turner, Louisiana State University
Funded by: NOAA, Center for Sponsored Coastal Ocean Research
• They have doubled in each of the last 4 decades
  • A 16-fold increment!
El aumento de algunos servicios frecuentemente conlleva la degradación de otros, generando nuevos “ganadores y perdedores”.

Transforming an ecosystem for a good that increases human well-being means gaining a benefit, but also the loss of an ecosystem service.
Valor neto actual [mercado] / hectárea

Manglar: $823  
G. Camarón: $8,340

Nota: tasa de descuento 10%
Fuente: Sathirathai and Barbier 2001
Valor neto actual [real] / hectárea

Manglar: $35,696
G. Camarón: -$5,443

Nota: tasa de descuento 10%
Fuente: Sathirathai and Barbier 2001
Changes in the coastline in Campeche

2,000 ha lost to the sea

Imagen SPOT 2010
3. Given the ecological diversity of megadiverse countries (often with a large ethnic/cultural diversity) no single agricultural system may solve the problems of food security
Mexico is a megadiverse country, with over 30 different ecosystems, and is one of the 4 Vavilov centers of plant domestication in the World.
Present day indigenous people’s territories
### Linguistic diversity

<table>
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Maize, bean, cotton, tomato, squashes/pumpkin, chilis, vainilla, cacao, nopales, chayote, green tomato, agave, avocado, ...
All-Crop Wild Relatives in Mexico in SNIB

Parientes silvestres

Kilómetros
Squashes, Pumpkins, Calabaza (Cucurbita sp.)

Cultivated species:
* Cucurbita argyrosperma
  subsp. argyrosperma (calabaza pipiana)
Cucurbita ficifolia (chilacayote)
Cucurbita maxima (zapallo)
* Cucurbita moschata (calabaza de castilla)
* Cucurbita pepo subsp. pepo (calabacita)
* Domesticated in México and having wild relatives in the country

Wild species in Mexico:
Cucurbita argyrosperma subsp. sororia, C. cordata, C. digitata, C. foetidissima, C. lundelliana, C. okeechobeensis subsp. martinezi, C. palmata, C. pedatifolia, C. pepo subsp. fraterna, C. radicans, Cucurbita x scabridifolia

Bean, Frijol (Phaseolus sp.)
Cultivated and domesticated species having wild relatives in Mexico:
Phaseolus acutifolius (teparí, escumite)
Phaseolus coccineus (ayocote)
Phaseolus dumasus (acalete, gordo)
Phaseolus lunatus (ib, patashete)
Phaseolus vulgaris (común)

Plus approximately 40 wild species inside the Phaseolus genera
Projects on crops and wild relatives supported by CONABIO

---|---|---|---|---|---|---|---|---|---|---|---

- **cotton**
- cotton, brassicas, pumpkins and pines
- maize landraces and its wild relatives
- cotton, amaranth, cempasuchil, pumpkins, chayotes, chilis, green tomato, vanilla, xoconostles.
- genetic diversity of maize landraces
- Cotton conservation program
- cotton, beans
- genetic diversity of pumpkins
- diversity and uses maize landraces
- teosintles
- cocoa, sunflower, tomato, potato, papaya, etc.
- maize risk map

Estimated cost of projects $36,720,000.00 Mexican pesos
2,127,000.00 EUROS

- Finalized or ongoing projects
- Projects in preparation
Integrated National Project on crops and their wild relatives

• Will comprise a broad range of:
  – **disciplines**: from molecular biology to ethnobotany, from agro-economy to agro-sociology.
  – **actors**: farmers (campesinos), scientists, extensionists, gov’t. decision makers, industry, etc.
  – **funding**: federal and state resources, international programmes.

  ▪ Must have a long term vision
4. A broad range of technologies suited to the environmental characteristics of each region are needed. It is necessary to know, understand and help improve, when necessary, the traditional technologies with full participation of the farmers.
The State of Food and Agriculture

Innovation in family farming

http://www.fao.org/3/a-i4040e.pdf
FAO in its last Report (2014) mentions:

• About 570 million family food producing units produce the largest proportion of food in the world

• They are by far the dominant form of agriculture in the world

• They occupy 70 to 80% of agricultural land and produce more than 80% of the value of food stuffs
Share of farms by region, country or group

- 24% India
- 35% China
- 9% East Asia and the Pacific, excluding China (14)
- 6% South Asia, excluding India (6)
- 7% Europe and Central Asia (14)
- 9% Sub-Saharan Africa (41)
- 3% Middle East and North Africa (12)
- 4% Latin America and the Caribbean (26)
- 4% High-income countries (46)
Share of farms, by income group

47% Upper-middle-income countries (47)
36% Lower-middle-income countries (38)
13% Low-income countries (30)
4% High-income countries (46)
Share of farms, by land size class

- 72% <1 ha
- 12% 1–2 ha
- 10% 2–5 ha
- 3% 5–10 ha
- 1% 10–20 ha
- 2% >20 ha
More public-funded research in agriculture is needed

- Public funded agricultural research has fallen sharply since the last 3-4 decades as well as extension services
- Research should focus also on sustainable intensification and the maintenance and use of agricultural biodiversity
Public expenditures on agricultural R&D, by income group

Billion constant 2005 PPP dollars

- Low-income countries
- Lower-middle-income countries
- Upper-middle-income countries
- High-income countries

Note: Data exclude countries in Eastern Europe and the former Soviet Union. Source: FAO.
Agricultural R&D is crucial but most takes place in only a few countries.

Geographic distribution of public expenditure on agricultural R&D, 2009:

- 13% United States of America
- 5% Middle East and North Africa
- 5% Latin America and the Caribbean, excluding Brazil
- 5% Brazil
- 5% Asia and the Pacific, excluding China and India
- 7% India
- 19% China
- 6% Sub-Saharan Africa
- 35% High-income countries, excluding United States of America
5. The genetic diversity of the native cultivars results from thousands of years of selection under domestication. The diversity of their wild relatives represents millions of years of natural selection: they both are the most valuable and irreplaceable source of responses for food production under climatic changes.
Essential building blocks for innovation:
(according to the FAO)

- well-run local government institutions,
- efficient agricultural advisory services,
- productive research and development centres,
  - efficient producers’ organizations,
- cooperatives and other community-based organizations,
- and – at the most basic level – an education system that fosters students’ capacity to create and innovate

BUT NOTHING IS SAID ABOUT THE GENETIC ADAPTABILITY OF CROPS...
Mexico is a center of origin and diversity of maize. 59 native races collected 1940-2010

Data base of 22,931 registers collected in all agricultural ecosystems in Mexico
From teocinte to all native races, across a wide range of environments: from sea level to 3,000 m, from hot dry tropics to wet cold mountains.
There is no technology capable of repeating, substituting or improvising such reservoirs of genetic variability
6. The world’s gene-banks can only preserve “a few frames of the film” of the millennial process of genetic diversification under domestication. It is imperative to maintain *in situ*, and carefully study, these processes where they still exist, e.g. the milpa in Mexico
Valuation of the process of evolution under domestication

- Neither the process of domestication, nor the genetic variability of crops and relatives, seems to represent a value in today’s national economies.
- Yet there are many examples of such value (e.g. potato blight in the XIX century).
- The process of domestication of crops and their wild relatives, represent an evolutionary service essential to confront climate change.
A very simple model

Cultural value
- identity
- cuisine

Economic value
- Offer
- Demand
- Prices
- Consumer surplus
- Producer surplus

Social value
- social cohesion
- safety
- collective action

agronómico value
- yields
- adaptation

biological value
- evolution
- plasticity
An ecosystem built by humans
A few of the edible plants of importance which originated as “weeds” of the milpa

- *Ustilago maydis* *(huitlacoche)*
- *Amaranthus spp.* *(alegría, huautle, quintonil)*
- *Phaseolus vulgaris, lunatus, coccineus, acutifolius* *(varios frijoles)*
- *Physalis coscomatl* *(tomatillo)*
- *Sechium edule* *(chayote)*
- *Salvia spp.* *(chia)*

- *Capsicum spp.* *(chiles)*
- *Chenopodium ambrosoides* *(epazote)*
- *Cucurbita pepo, moschata, maxima, argyrosperma* *(calabazas)*
- *Lycopersicum esculentum* *(jitomate)*
- *Portulaca oleracea* *(verdolaga)*
Thank you