Les noves tecnologies i l’agricultura.
Una perspectiva europea

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Agrofòrum. Abril 2014

L'Agricultura és una activitat profundament innovadora

- Ho va ser en els seus origens
- Ho ha estat en els darrers 150 anys
- Ho està sent actualment

- 50% de la innovació està en la llavor, 50% en les tècniques agronòmiques

Història de la millora genètica vegetal

Espècies salvatges

-10000 anys **Domesticació** — **Naixement de L'agricultura**

Plantes cultivades

1859 **Darwin: Teoria de L'evolució de les espècies**

1865 **Mendel: Lles de l'herència**

1. Introducció conscient de diversitat gènica
2. Selecció

Plantes millorades

1950 **Watson i Crick: Estructura de l'ADN**

1960-1970 **Millora de les tècniques de cultiu "in vitro"**

Introducció dirigida de caràcters

1984 **Primera transfèrencia de gens en plantes** — **Plantes transgèniques**

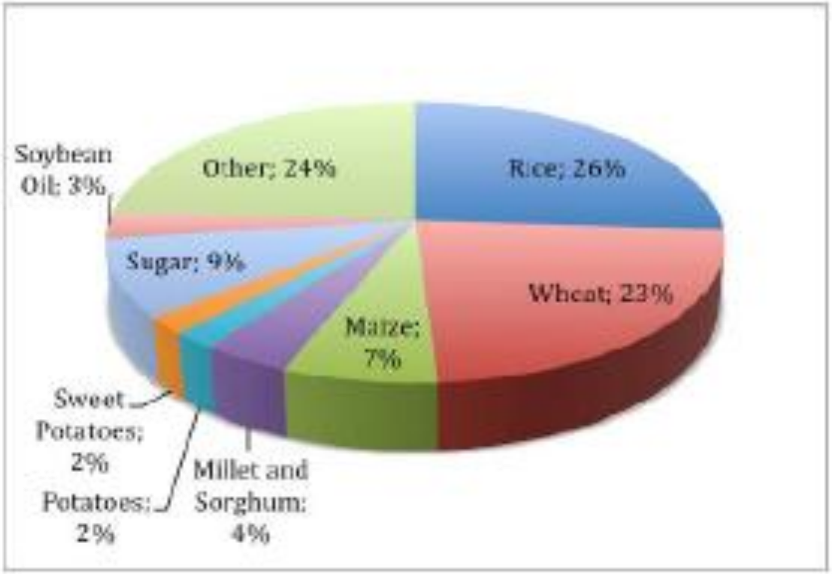
2001 **Primer genoma de plantes** — **Caràcters complexos**

Plantes de disseny

Plantes que mengem

The FAO estimated that at the end of the last century there were between 300 000 and 500 000 species of higher plants (i.e. flowering and cone-bearing plants), of which about half have been identified or described. About 30 000 are edible and about 7 000 have been cultivated or collected by humans for food at one time or another. Of these, approximately 120 species are important on a national scale, and 30 species provide 90% of the world's calorie intake[58]. At the time of the FAO survey, wheat covered 23% of the world's calorie needs, rice 26% and maize 7%[59]. During 2004 and 2006 wheat and maize production in the

Percentage of calorific intake by food group[58]



Quaternary International xxx (2014) 1–13

Contents lists available at ScienceDirect

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journal homepage: www.elsevier.com/locate/quaint

Teosinte before domestication: Experimental study of growth and phenotypic variability in Late Pleistocene and early Holocene environments

Dolores R. Piperno [a,b,*], Irene Holst [b], Klaus Winter [b], Owen McMillan [b]

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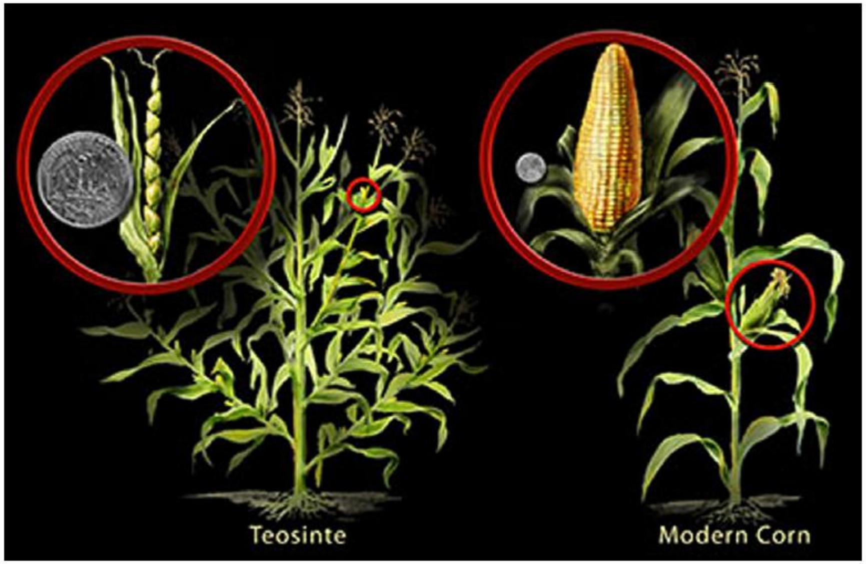
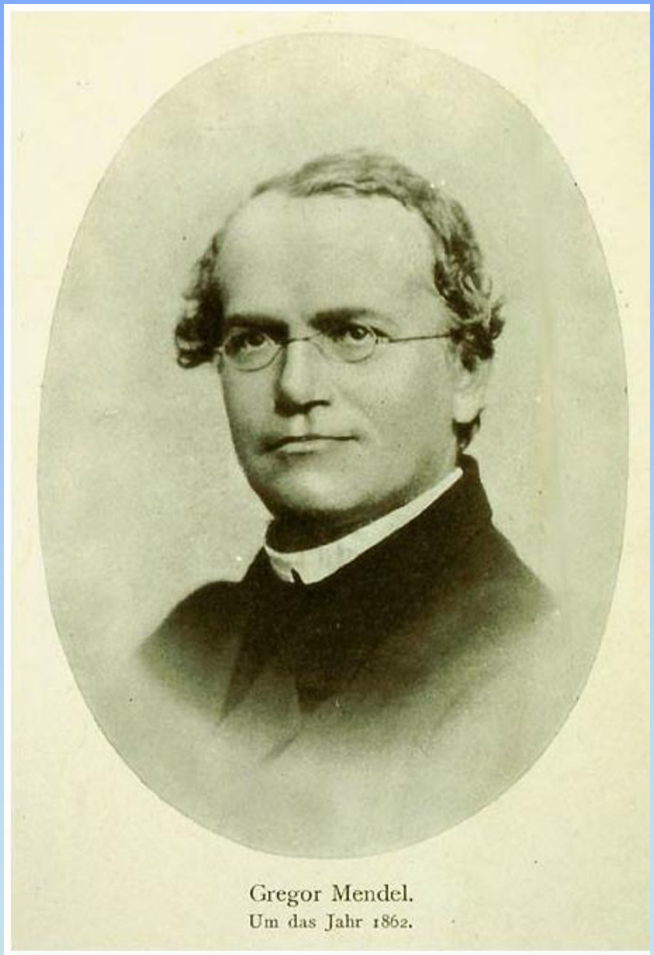
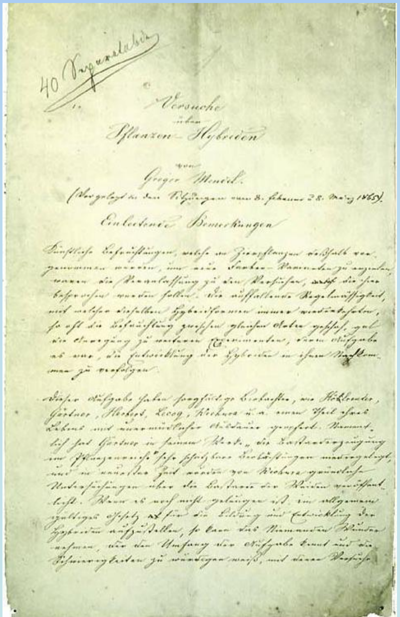
[b] Smithsonian Tropical Research Institute, Panama



Mendel: Les lleis de l’herència



1865



La Genètica aplicada a l'agricultura

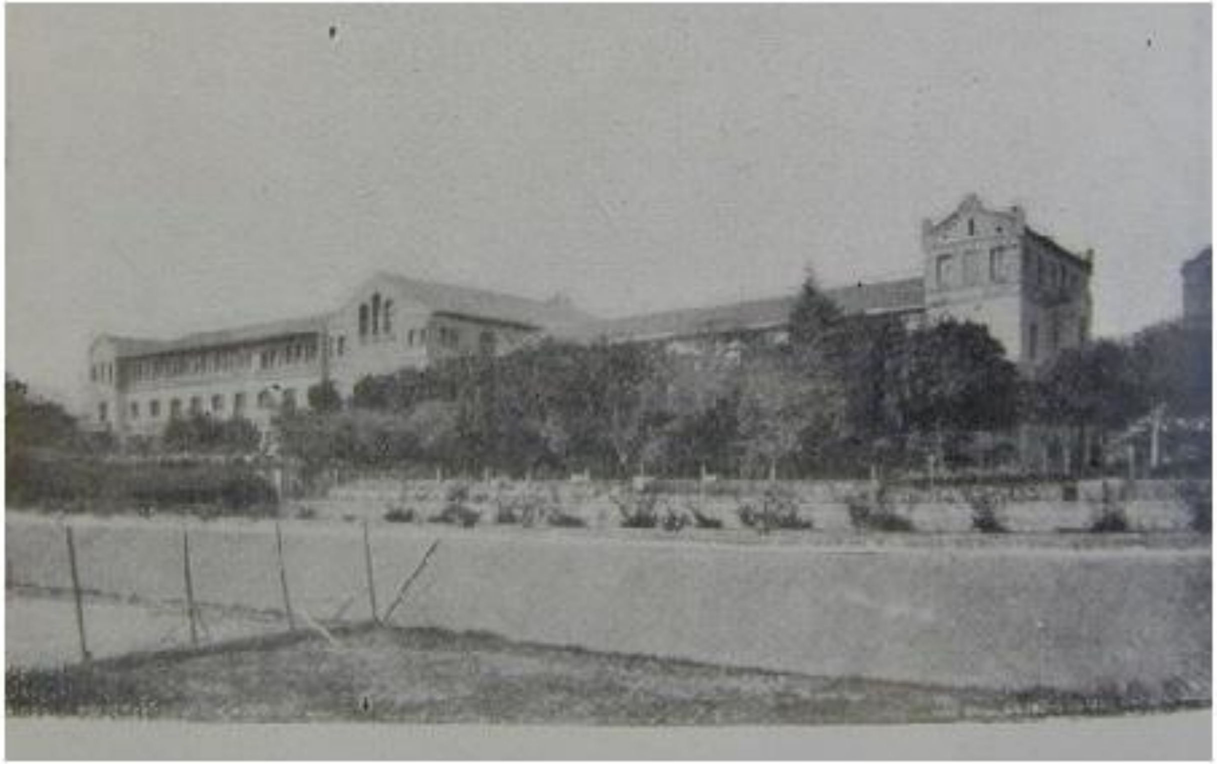
I

- 1716 **Mather** (U.S.A.) - Observed natural crossing in maize. Noted xenia, where ears of yellow maize planted next to red and blue maize had red and blue kernels in them the first year
- 1719 **Fairchild** - Created first artificial hybrid of Carnation x Sweet William, commonly known as Fairchildís mule
- 1727 **Vilmorin Company** (France) - Pedigree method Pedigree method of breeding sugar beets established. Contributed extensively to the development of plant breeding knowledge and improved cultivars for over 260 years
- 1753 **Linnaeus** Linnaeus - Published "Species Plantarum". Binomial nomenclature of plant taxonomy officially begins with his general list of plant species

II

- 1901 **Spillman** (U. S.) - Began hybridization program with wheat; noted recovery of parental types in F_2; sometimes credited as one of rediscoverers of Mendelís laws
- 1901-02 **Bateson and Punnett** - Called public attention to the importance of Mendelís work; first report of linkage (using garden pea)
- 1902 **DeVries** (Holland) - Proposed the mutation theory of evolution from evidence in *Oenothera*
- **Biffen** (England) - First inheritance studies on disease resistance;
- found that stripe rust resistance was due to a single gene
- 1903 ***Johannsen** - Developed the pure line pure line theory of selection
- 1904 **Hannig** - Contributed to the idea of embryo culture
- 1904-05 ***East and Shull** - Began inbreeding inbreeding experiments with maize
- 1905 **Shamel** - Reported yields of maize lines inbred for 3 generations and their hybrids; first report of hybrid made by crossing inbred lines
- 1905-07 **Williams** (Ohio) - Developed the remnant seed breeding plan for maize
- 1906 **Bateson** - introduced the term "genetics"

Introducció de la Genètica a Espanya



Escola Superior d'Agricultura de Barcelona, 1911

La revolució verda. Norman Bourlaug

Producció de cereals

1949-51	680 milions de tones
1995-97	2.025 milions de tones

Variabilitat genètica

- Conservació
- Anàlisi i aprofitament de la variabilitat existent
- Creació de nova variabilitat per mutagènesi
- Creació de nova variabilitat per modificació genètica

Modificació genètica de plantes. Primeres publicacions

article

Nature **303**, 209 - 213 (19 May 1983); doi:10.1038/303209a0

Expression of chimaeric genes transferred into plant cells using a Ti-plasmid-derived vector

LUIS HERRERA-ESTRELLA[*], ANN DEPICKER[*], MARC VAN MONTAGU[*] & JEFF SCHELL[*†]

[*]Laboratorium voor Genetica, Rijksuniversiteit Gent, B-9000 Gent, Belgium
[†]Max-Planck-Institut für Züchtungsforschung, D-5000 Köln 30, FRG

Foreign genes introduced into plant cells with Ti-plasmid vectors are not expressed. We have constructed an expression vector derived from the promoter sequence of nopaline synthase, and have inserted the coding sequences of the octopine synthase gene and a chloramphenicol acetyltransferase gene into this vector. These chimaeric genes are functionally expressed in plant cells after their transfer via a Ti-plasmid of *Agrobacterium tumefaciens*.

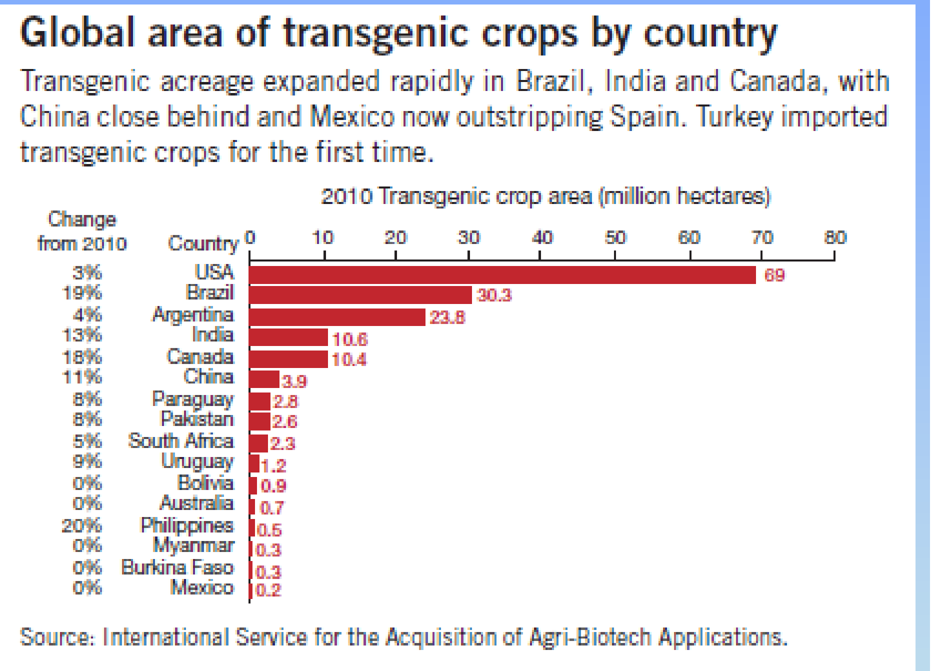
Cell. 1983 Apr;32(4):1033-43. Related Articles, Links

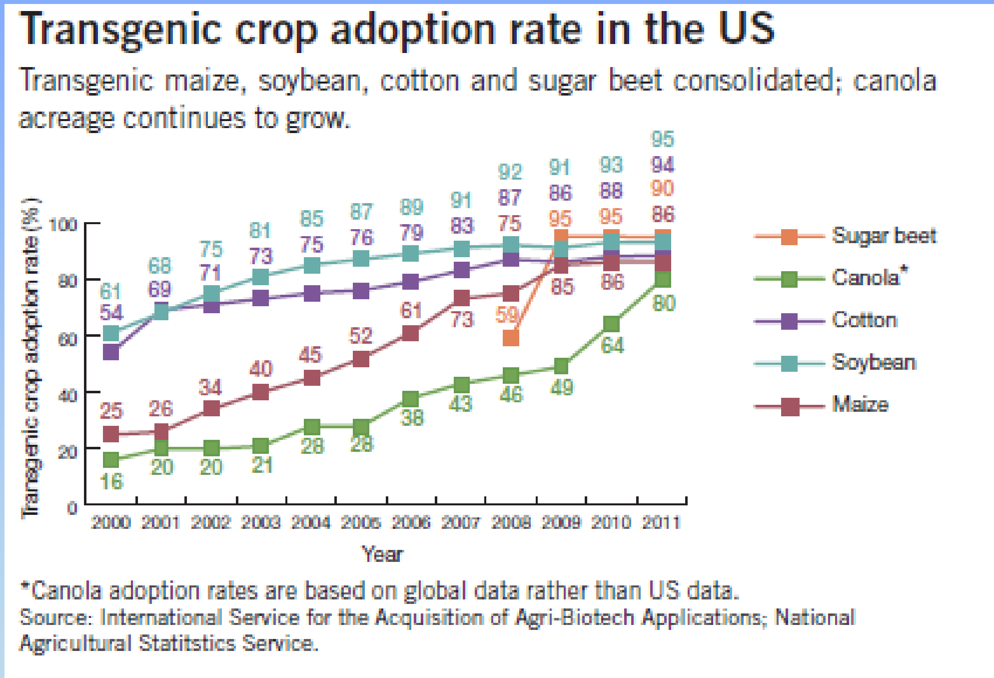
Regeneration of intact tobacco plants containing full length copies of genetically engineered T-DNA, and transmission of T-DNA to R1 progeny.

Barton KA, Binns AN, Matzke AJ, Chilton MD.

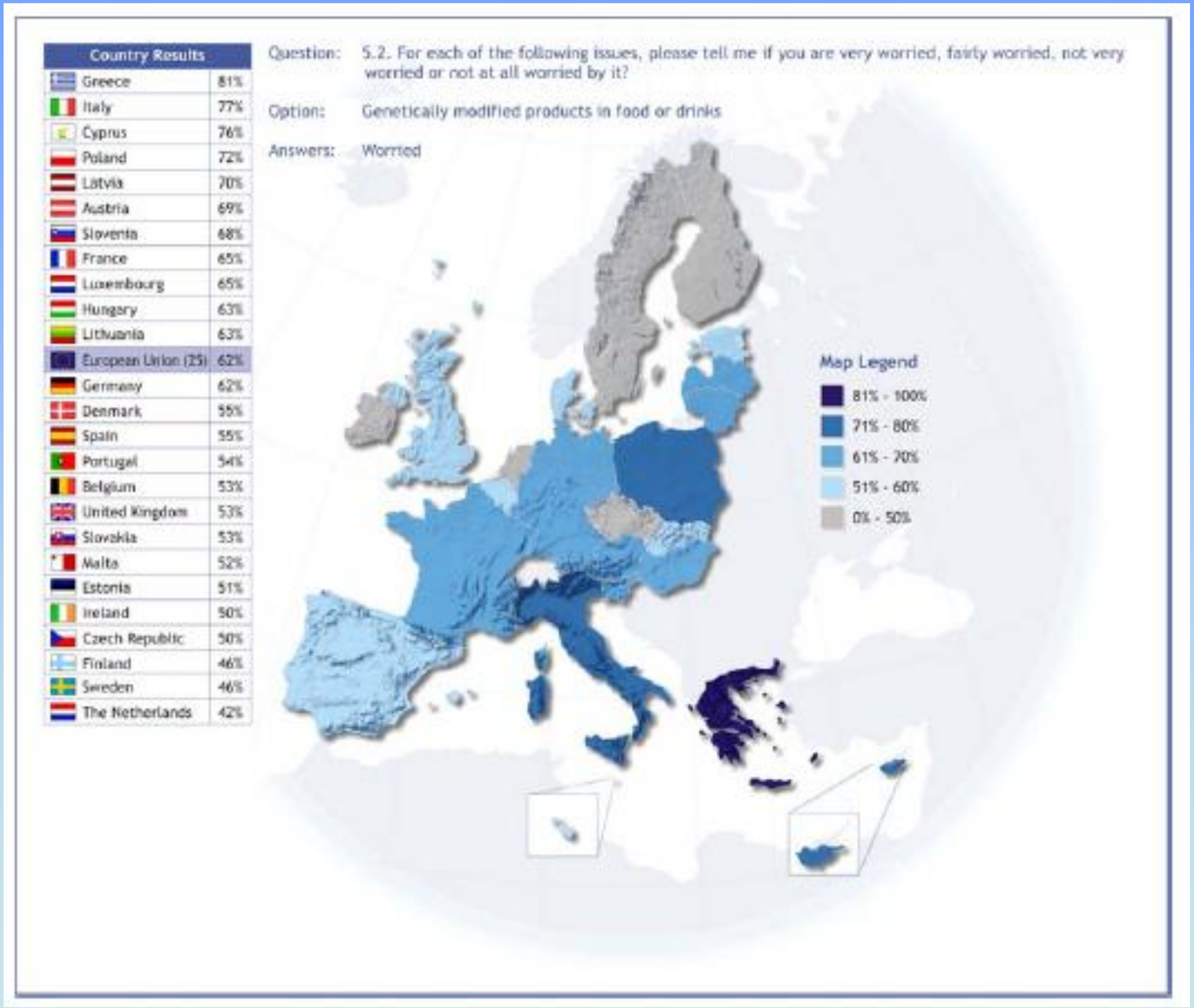
Cloned DNA sequences encoding yeast alcohol dehydrogenase and a bacterial neomycin phosphotransferase have been inserted into the T-DNA of Agrobacterium tumefaciens plasmid pTiT37 at the "rooty" locus. Transformation of tobacco stem segments with the engineered bacterial strains produced attenuated crown gall tumors that were capable of regeneration into intact, normal tobacco plants. The yeast gene and entire transferred DNA (T-DNA) were present in the regenerated plants in multiple copies, and nopaline was found in all tissues. The plants were fertile, and seedlings resulting from self-pollination also contained intact and multiple copies of the engineered T-DNA. Expression of nopaline in the germinated seedlings derived from one regenerated plant was variable and did not correlate with the levels of T-DNA present in the seedlings. Preliminary evidence indicates that nopaline in progeny of other similarly engineered plants is more uniform. The disarming of pTiT37 by insertions at the "rooty" locus thus appears to produce a useful gene vector for higher plants.

Dades 2010-2011

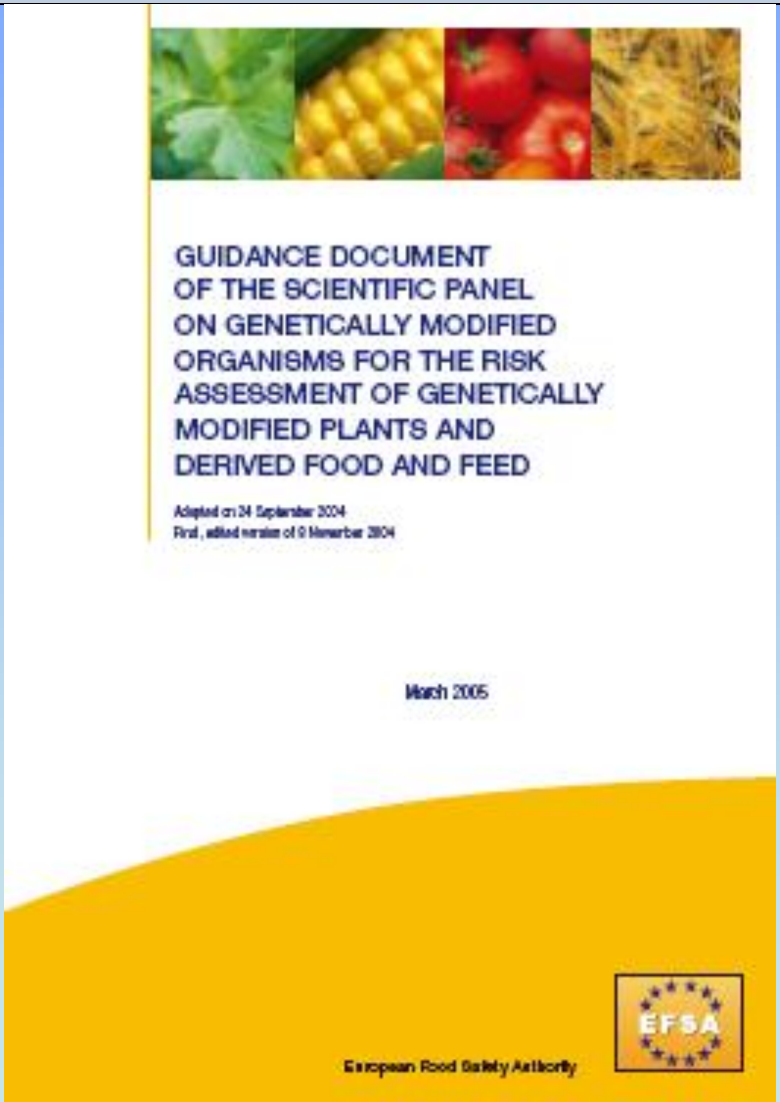




Eurobaròmetre 2006

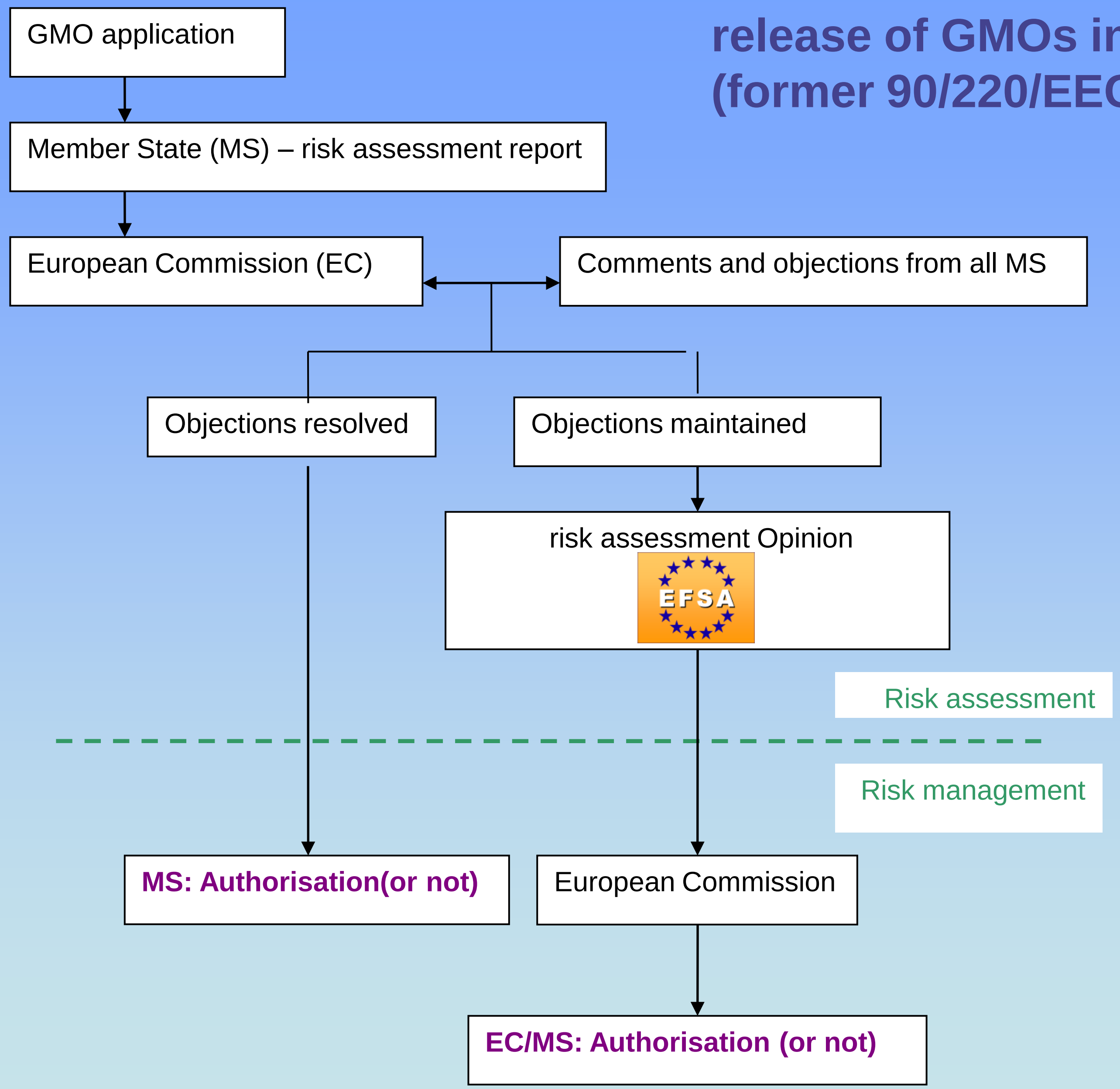


Guia d'EFSA per a l'anàlisi del risc associat a les plantes transgèniques i productes derivats per a consum animal o humà

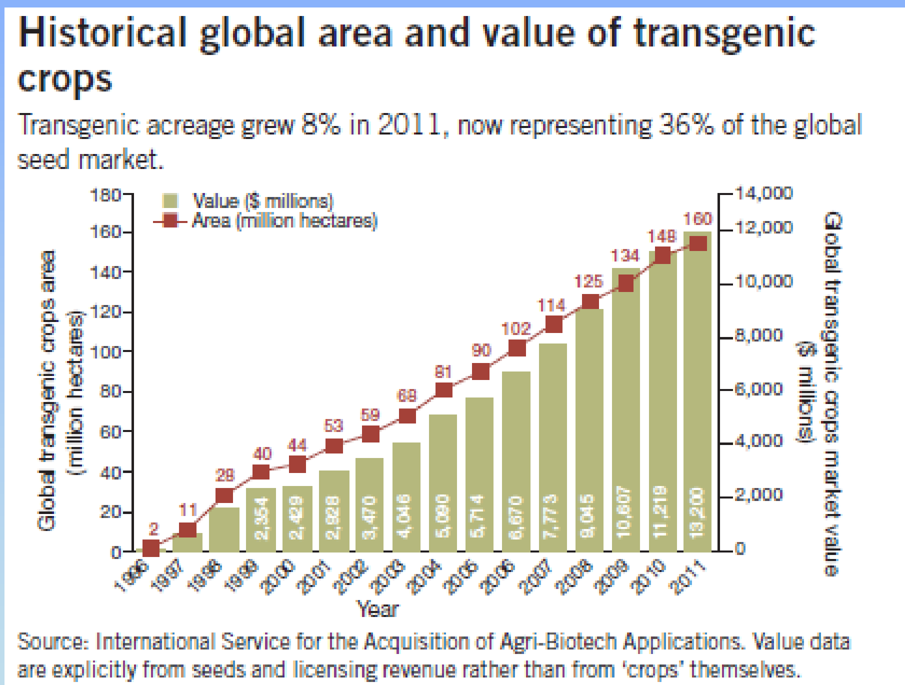


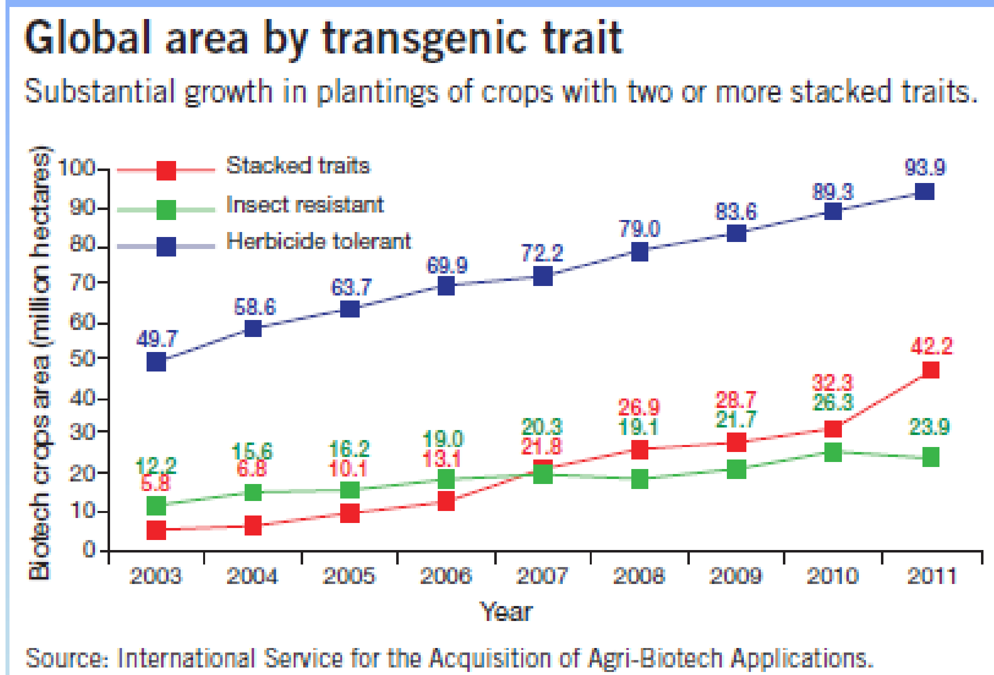
- Adoptada el 24 de setembre de 2004
- Revisada el decembre 2005 (PMEM)
- Nova revisió en curs (2008) Completada el
  - Desembre 2006 (Renovacions)
  - Març 2007 (Events combinats)

Directive 2001/18/EC – deliberate release of GMOs into environment (former 90/220/EEC)



Dades per 2011. Economia.





Concentració de companyies de llavors

MONSANTO

syngenta GLOBAL

DUPONT
The miracles of science

Seminis.

NFC
NEW FARM CROPS

PIONEER.
A DUPONT COMPANY

ASGROW
We Breed Better Beans

S&G

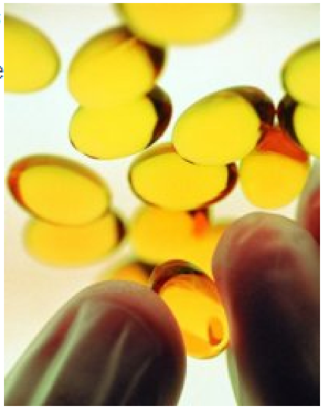
DEKALB
STRONG ROOTS. STRONG YIELDS.

HILLESHÖG

La discussió sobre les patents

Biotechnology in European patents - threat or promise?

Split views and a growing market



Opinions on patents in this field are divided, with unfettered scientific progress at one end of the spectrum and the basic values accepted by society at the other. While many see an important contribution to social progress, others are mainly concerned by potential risks and ethical questions.

Despite all the disagreement, biotechnology is a growing discipline with a remarkably strong market. In 2006, global turnover was estimated at $60 billion, up 15 per cent from 2005.

This growth is also reflected in the number of biotechnology patents. For several years now, biotechnological inventions have consistently ranked among the ten largest technical fields in terms of patent applications filed with the European Patent Office (EPO).

History in patents

The EPO's position

The essence of Directive 98/44/EC was incorporated into the Implementing Regulations to the European Patent Convention (EPC) as Rules 23b-e. This part of European patent law now provides the ground rules for considering the patentability of biotechnology applications – alongside the principal criteria valid for all patents.

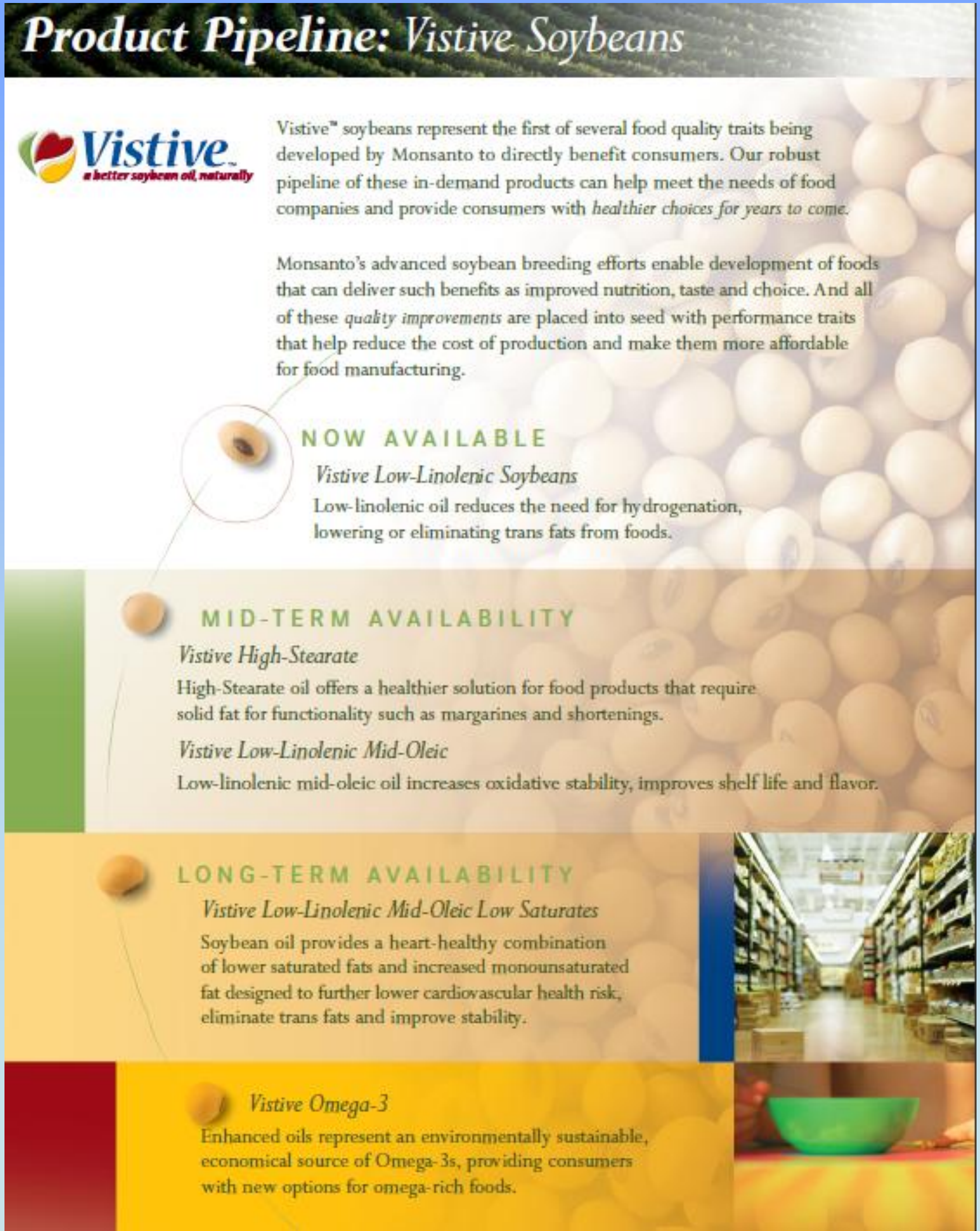
The EPO holds no political views of its own on biotechnology patents. As the executive organ of the European Patent Organisation, it examines patent applications on the basis of the relevant law, in other words the EPC.

Articles 52 and 53(b) EPC say what can and what cannot be patented. Biotechnical inventions are basically patentable, but with the following exceptions:

- **methods for treatment** of the **human or animal body** by surgery or therapy, and diagnostic methods practised on the human or animal body
- **plant** and **animal varieties**
- **essentially biological** processes for the production of plants and animals.

Article 53(a) also prohibits the patenting of any invention whose commercial exploitation would be contrary to public order or morality.

Modificacions dels olis



Product Pipeline: *Vistive Soybeans*

Vistive
a better soybean oil, naturally

Vistive™ soybeans represent the first of several food quality traits being developed by Monsanto to directly benefit consumers. Our robust pipeline of these in-demand products can help meet the needs of food companies and provide consumers with *healthier choices for years to come.*

Monsanto's advanced soybean breeding efforts enable development of foods that can deliver such benefits as improved nutrition, taste and choice. And all of these *quality improvements* are placed into seed with performance traits that help reduce the cost of production and make them more affordable for food manufacturing.

NOW AVAILABLE

Vistive Low-Linolenic Soybeans

Low-linolenic oil reduces the need for hydrogenation, lowering or eliminating trans fats from foods.

MID-TERM AVAILABILITY

Vistive High-Stearate

High-Stearate oil offers a healthier solution for food products that require solid fat for functionality such as margarines and shortenings.

Vistive Low-Linolenic Mid-Oleic

Low-linolenic mid-oleic oil increases oxidative stability, improves shelf life and flavor.

LONG-TERM AVAILABILITY

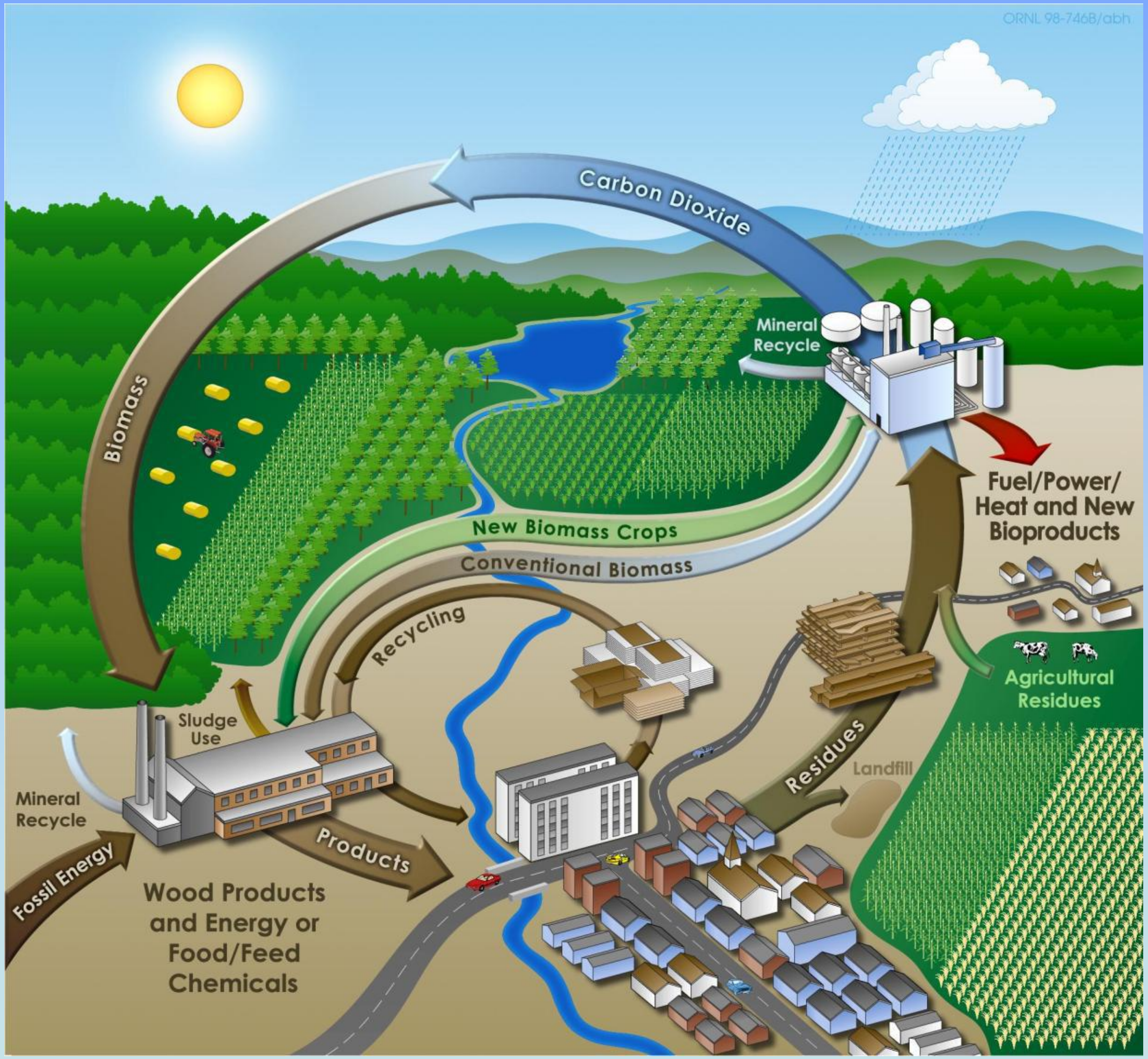
Vistive Low-Linolenic Mid-Oleic Low Saturates

Soybean oil provides a heart-healthy combination of lower saturated fats and increased monounsaturated fat designed to further lower cardiovascular health risk, eliminate trans fats and improve stability.

Vistive Omega-3

Enhanced oils represent an environmentally sustainable, economical source of Omega-3s, providing consumers with new options for omega-rich foods.

Nous usos. Biocombustibles



Diferents tipus d'agricultura. Etiquetes europees

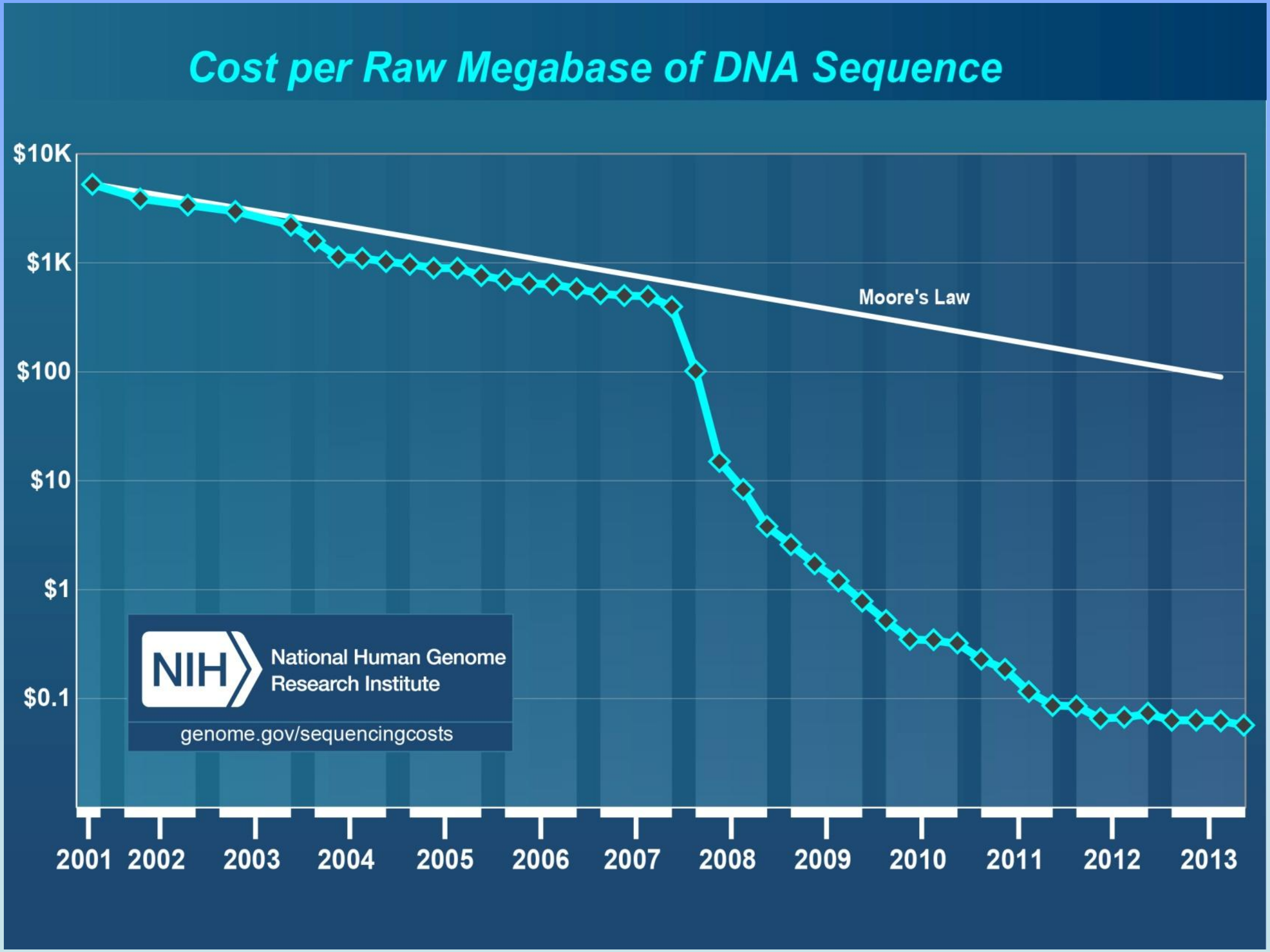
Coexistència

- Recomendación de la Comisión
- de 23 de julio de 2003
- sobre las Directrices para la elaboración de estrategias y mejores prácticas nacionales con el fin de garantizar la coexistencia de los cultivos modificados genéticamente con la agricultura convencional y ecológica
- [notificada con el número C(2003) 2624]
- (2003/556/CE)
- 1. INTRODUCCIÓN
- 1.1. Concepto de coexistencia
- El cultivo de organismos modificados genéticamente (OMG) en la Unión Europea es probable que tenga consecuencias en la organización de la producción agrícola. Por un lado, la posibilidad de la presencia accidental (no intencionada) de cultivos modificados genéticamente (MG) en cultivos que no hayan sufrido esta modificación, y viceversa, plantea la cuestión de cómo se puede asegurar la elección del productor respecto a los diferentes tipos de producción. En principio, los agricultores deberían poder cultivar los tipos de cultivos agrícolas que escojan, ya se trate de cultivos modificados genéticamente, convencionales o ecológicos. Ninguno de estos tipos de agricultura debería excluirse en la Unión Europea.
- Por otro lado, este asunto está relacionado también con la elección de los consumidores. Para que los consumidores europeos puedan disfrutar de una auténtica capacidad de elección entre alimentos modificados genéticamente y alimentos que no hayan sufrido esta modificación, no sólo debería existir un sistema de trazabilidad y etiquetado que funcione correctamente, sino también un sector agrario que pueda suministrar los diferentes tipos de bienes. La capacidad del sector alimentario para ofrecer a los consumidores un elevado grado de elección es paralela a la capacidad del sector agrario de mantener diferentes sistemas de producción.
- La coexistencia se refiere a la capacidad de los agricultores de poder escoger en la práctica entre la producción de cultivos convencionales, ecológicos y modificados genéticamente, en cumplimiento de las obligaciones legales sobre etiquetado y las normas de pureza.

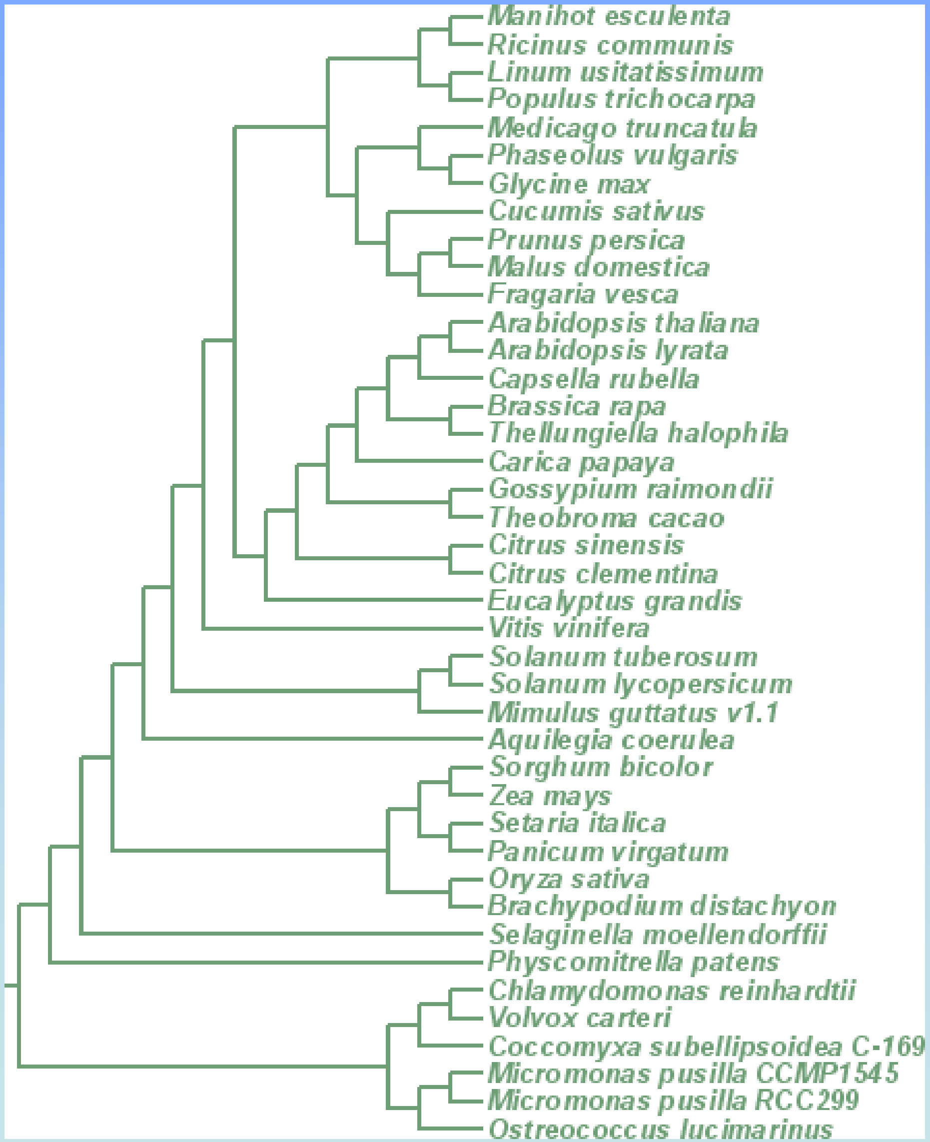
L’era dels genomes

- Coneixement de genomes sencers
- Estudi de caràcters complexes
- Noves espècies

Cost de la seqüenciació de DNA



Phytozome 2013



Variation in plant genome size

- **~8510 studied species**
- **~ 2000X difference**

63 Mbp

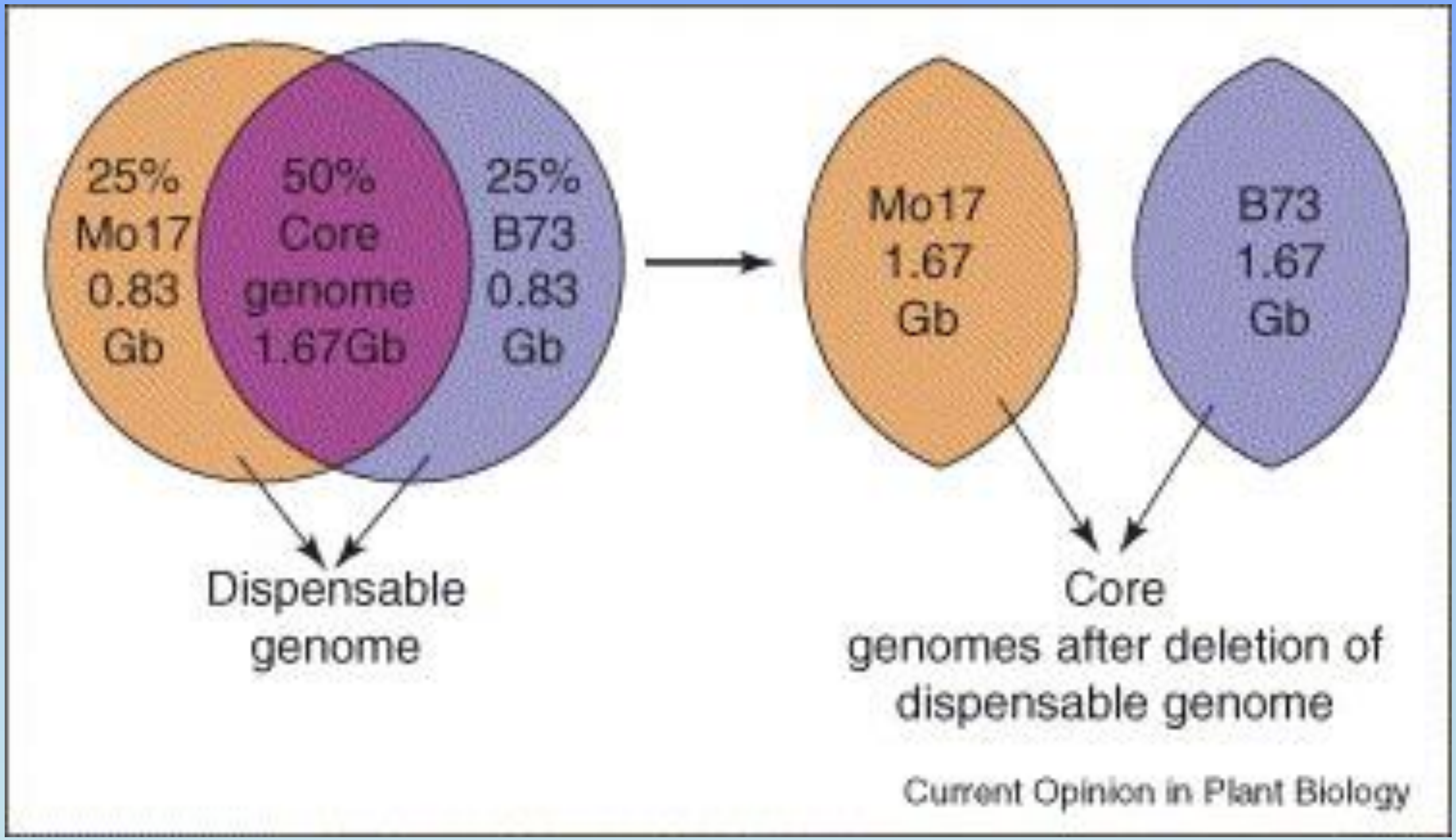
Genlisea margaretae

124000 Mbp

Fritillaria assyriaca

http://www.rbgkew.org.uk/cval/database1.html

Comparison between maize genomes. The nuclear genome.



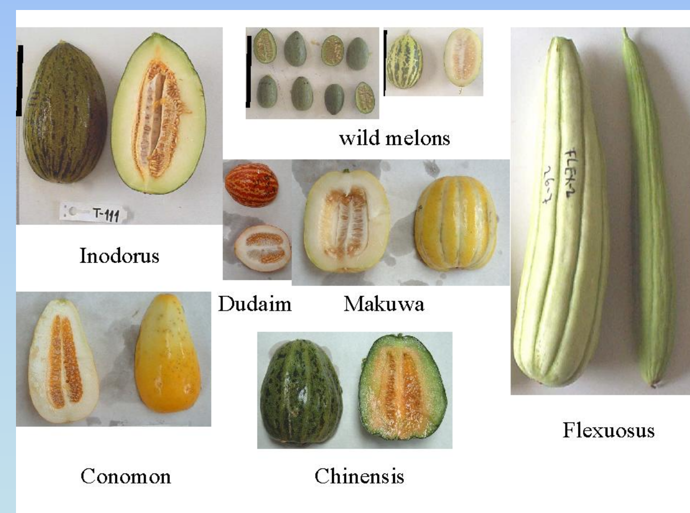
Morgante M, De Paoli E, Radovic S. Curr Opin Plant Biol. 2007 10:149-55

El genoma del meló

- Segon cultiu hortícola a Espanya
- 5è productor mundial
- Espècie amb molta història genètica però poca informació molecular
- Interès internacional creixent
- Genoma petit

2x=2n=24

- Espècie amb molt polimorfisme
- Transformació factible
- Família cucurbitàcees



- Interès industrial

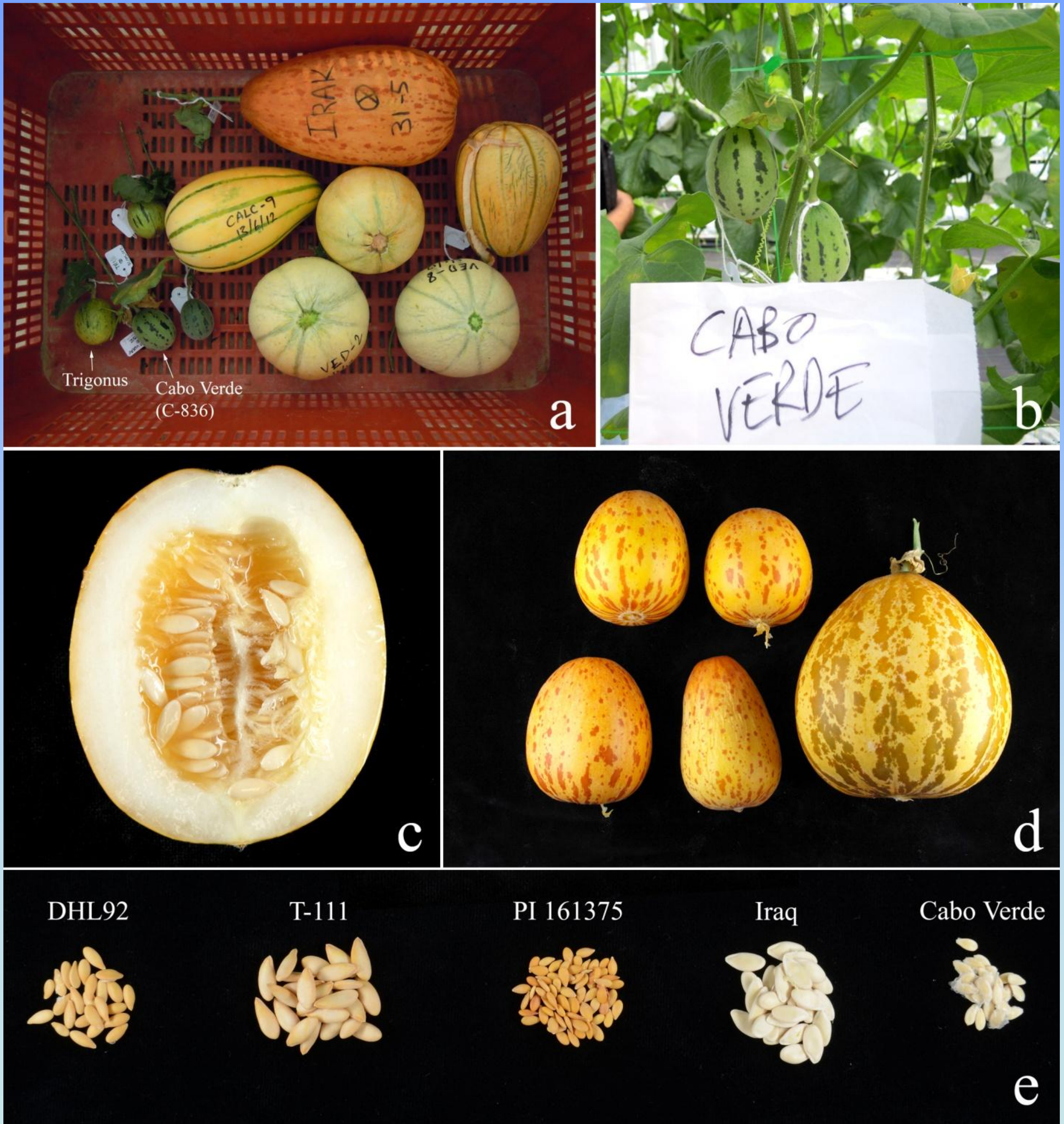
- Model de fruit no climactèric

The genome of melon (*Cucumis melo* L.)

Jordi Garcia-Mas[a,1], Andrej Benjak[a], Walter Sanseverino[a], Michael Bourgeois[a], Gisela Mir[a], Víctor M. González[b], Elizabeth Hénaff[b], Francisco Câmara[c], Luca Cozzuto[c], Ernesto Lowy[c], Tyler Alioto[d], Salvador Capella-Gutiérrez[c], Jose Blanca[e], Joaquín Cañizares[e], Pello Ziarsolo[e], Daniel Gonzalez-Ibeas[f], Luis Rodríguez-Moreno[f], Marcus Droege[g], Lei Du[h], Miguel Alvarez-Tejado[i], Belen Lorente-Galdos[j], Marta Melé[c,j], Luming Yang[k], Yiqun Weng[k,l], Arcadi Navarro[j,m], Tomas Marques-Bonet[j,m], Miguel A. Aranda[f], Fernando Nuez[e], Belén Picó[e], Toni Gabaldón[c], Guglielmo Roma[c], Roderic Guigó[c], Josep M. Casacuberta[b], Pere Arús[a], and Pere Puigdomènech[b,1]

[a]Institut de Recerca i Tecnologia Agroalimentàries, Centre for Research in Agricultural Genomics Consejo Superior de Investigaciones Científicas-Institut de Recerca i Tecnologia Agroalimentàries-Universitat Autònoma de Barcelona-Universitat de Barcelona, 08193 Barcelona, Spain; [b]Centre for Research in Agricultural Genomics Consejo Superior de Investigaciones Científicas-Institut de Recerca i Tecnologia Agroalimentàries-Universitat Autònoma de Barcelona-Universitat de Barcelona, 08193 Barcelona, Spain; [c]Centre for Genomic Regulation, Universitat Pompeu Fabra, 08003 Barcelona, Spain; [d]Centre Nacional d'Anàlisi Genòmica, 08028 Barcelona, Spain; [e]Institute for the Conservation and Breeding of Agricultural Biodiversity, Universitat Politècnica de Valencia, 46022 Valencia, Spain; [f]Departamento de Biología del Estrés y Patología Vegetal, Centro de Edafología y Biología Aplicada del Segura, Consejo Superior de Investigaciones Científicas, 30100 Murcia, Spain; [g]Roche Diagnostics Deutschland GmbH, 11668305 Mannheim, Germany; [h]Roche Diagnostics Asia Pacific Pte. Ltd., Singapore 168730; [i]Roche Applied Science, 08174 Barcelona, Spain; [j]Institut de Biologia Evolutiva, Universitat Pompeu Fabra-Consejo Superior de Investigaciones Científicas, 08003 Barcelona, Spain; [k]Horticulture Department, University of Wisconsin, Madison, WI 53706; [l]US Department of Agriculture–Agricultural Research Service, Horticulture Department, University of Wisconsin, Madison, WI 53706; and [m]Institució Catalana de Recerca i Estudis Avançats, 08010 Barcelona, Spain

PNAS


IRAK
31-5
CALC-9
13/6/12
VED-8
VED-2
Trigonus
Cabo Verde
(C-836)
a
CABO
VERDE
b
c
d
DHL92
T-111
PI 161375
Iraq
Cabo Verde
e

Reaping the benefits

Science and the sustainable intensification of global agriculture

October 2009

CELEBRATE 350 YEARS

THE ROYAL SOCIETY

1 Introduction

Summary

Food security is an urgent challenge. It is a global problem that is set to worsen with current trends of population, consumption, climate change and resource scarcity. The last 50 years have seen remarkable growth in global agricultural production, but the impact on the environment has been unsustainable. The benefits of this green revolution have also been distributed unevenly; growth in Asia and America has not been matched in Africa. Science can potentially continue to provide dramatic improvements to crop production, but it must do so sustainably. Science and technology must therefore be understood in their broader social, economic and environmental contexts. The sustainable intensification of crop production requires a clear definition of agricultural sustainability. Improvements to food crop production should aim to reduce rather than exacerbate global inequalities if they are to contribute to economic development. This report follows other recent analyses, all arguing that major improvements are needed to the way that scientific research is funded and used.

Informe francès Febrer 2014

CGAAER
Conseil général de l'alimentation de l'agriculture et des espaces ruraux

Controverse documentée
à propos de quelques idées reçues
sur l'agriculture, l'alimentation et la forêt

épisode n°1

**« Nous ne pourrons pas nourrir
9,5 milliards de personnes en 2050 »**

Février 2014 Mission n° 13083

Nous ne pourrons pas nourrir 9,5 milliards de personnes en 2050

Sommaire

« En politique, ce qui est cru est plus important que ce qui est vrai » disait Talleyrand. Et le Cardinal de Retz considérait qu'« on ne sort de l'ambiguïté qu'à son détriment »…

Informe de les Acadèmies Europees

GM Science Update

A report to the Council for Science and Technology

March, 2014

Professor Sir David Baulcombe, University of Cambridge
Professor Jim Dunwell, University of Reading
Professor Jonathan Jones, Sainsbury Laboratory
Professor John Pickett, Rothamsted Research
Professor Pere Puigdomenech, University of Cambridge/ Barcelona

Informe al Govern del Regne Unit. Març 2014

theguardian
TheObserver

There's no choice: we must grow GM crops now

Almost a billion people face starvation and that problem will worsen unless we use the most effective technologies

- Observer editorial
- The Observer, Sunday 16 March 2014

Government science advisers warned last week that European rules covering the growing of GM crops are no longer fit for purpose. Photograph: David Levene

Feeding the swelling numbers of people on our planet is one of the most serious challenges facing our leaders today. By 2050, it is likely Earth's population will have reached 9 billion. Finding food for such numbers will not be easy. Science will not solve the problem on its own, of course, but clearly it has a key role to play. Without new technologies, future generations will starve. It is as straightforward as that.

t 4: Conclusions and recommendations

ımary

- **GM crops have the potential to contribute substantially to advances in agriculture** that are necessary to achieve sustainable and sufficient global food production in the face of challenges from population, climate change, and environmental degeneration. Conventional plant breeding is not likely to meet this challenge and cannot take advantage of innovation in synthetic biology.

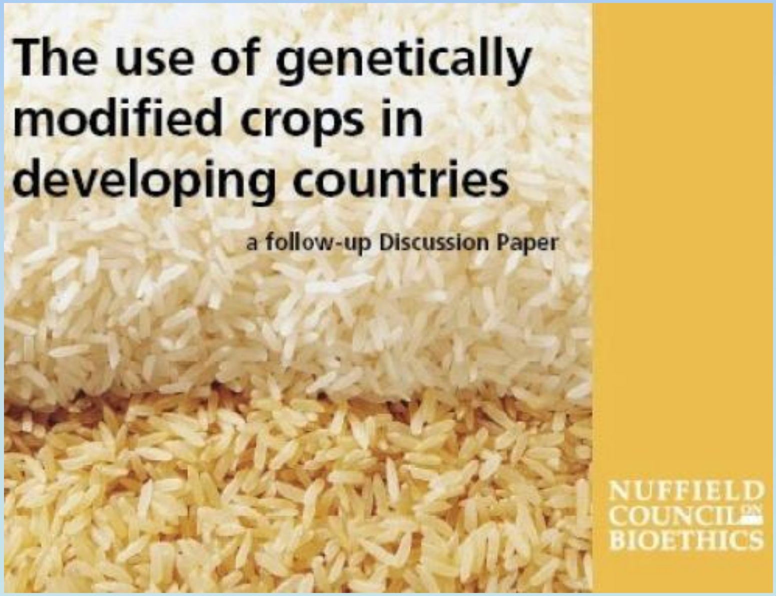
- **To realize the potential of GM crops, the R & D pipeline needs to be strengthened and the European regulatory process improved.**

- The R & D pipeline would benefit from **a programme that promotes preliminary evaluation in the field of the practical potential of genes defined in academic laboratories that could be useful in crops.** This programme referred to as PubGM would enable and facilitate **field testing of new GM crops** either in partnership with companies or so that the public sector could validate traits before commencing partnerships with companies.

- Many new plant breeding techniques developed since the EU GMO definitions were adopted in 1990, were not foreseen, and some plants with a particular novel trait will be captured by the legislation, whilst others will not. Given that there is no evidence for intrinsic risks associated with GM, it is not useful to have a regulatory framework that is based on the premise that GM crops are more hazardous than those produced by conventionally bred plants. As proposed by EASAC, **a future regulatory framework should be product rather than process based so that it is consistent and applies to the novelty of the characteristics of new plant varieties.**

- **Approval for commercial cultivation should be made on a national level as happens at present with pharmaceuticals.** This would safeguard against potential losses and damage to European agriculture that follow from the failure to adopt GM crops, and enable appropriate regulation of new technologies such as genome editing and synthetic biology for crops.

Discussions ètiques



The European Group on Ethics in Science and New Technologies to the European Commission

Ethics of modern developments in agriculture technologies

- Opinion No 24 -

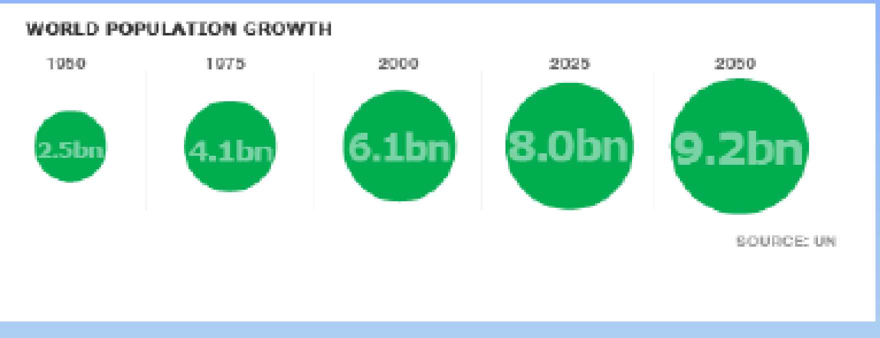
- 17 December 2008 -

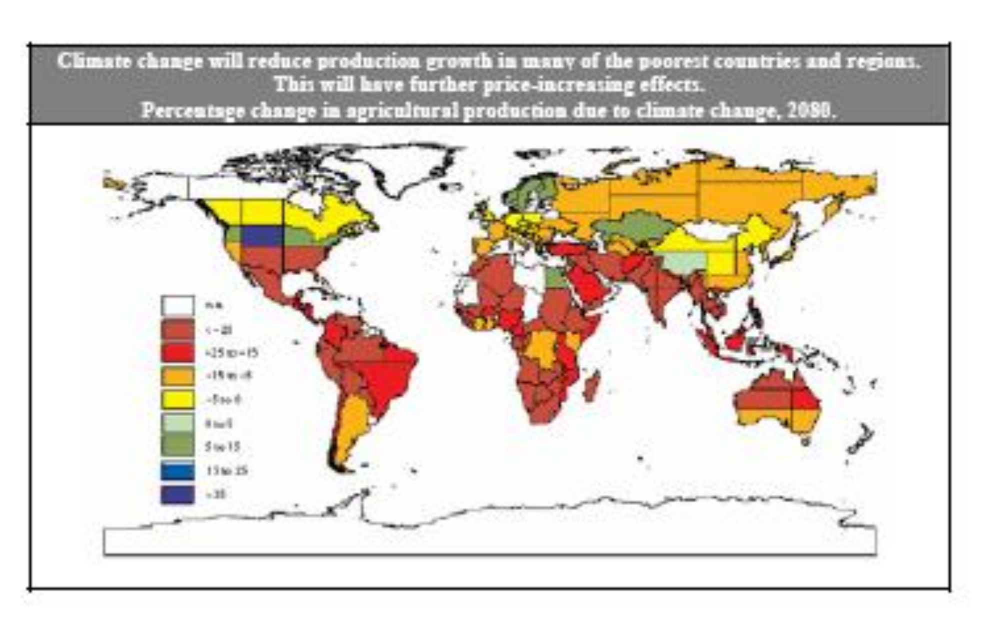
Unes prioritats

- Aliments suficients
- Aliments segurs
- Nivells similars d’alimentació a les generacions futures (sostenibilitat)

- Aliments saludables
- Aliments d’acord amb el nostre gust i la nostra cultura

Una eqüació complexa





1990/2005 ratios of per capita consumption (FAO)	India	China	Brazil	Nigeria
Cereals	1.0	0.8	1.2	1.0
Meat	1.2	2.4	1.7	1.0
Milk	1.2	3.0	1.2	1.3
Fish	1.2	2.3	0.9	0.8
Fruit	1.3	3.5	0.8	1.1
Vegetables	1.3	2.9	1.3	1.3

WSFS 2009/2
Noviembre de 2009

منظمة الأغذية والزراعة للأمم المتحدة | 联合国粮食及农业组织 | Food and Agriculture Organization of the United Nations | Organisation des Nations Unies pour l'alimentation et l'agriculture | Продовольственная и сельскохозяйственная организация Объединенных Наций | Organización de las Naciones Unidas para la Agricultura y la Alimentación

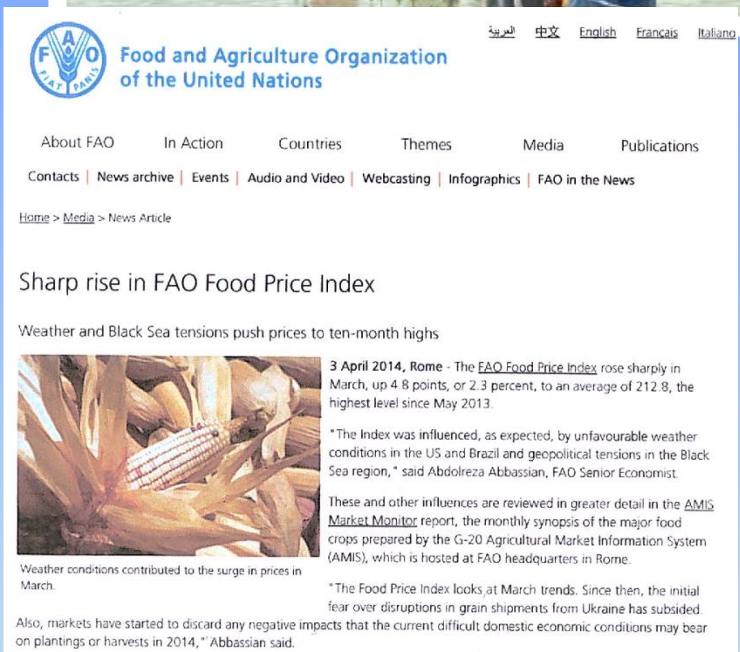
Cumbre Mundial sobre la Seguridad Alimentaria

Roma, 16–18 de noviembre de 2009

DECLARACIÓN DE LA CUMBRE MUNDIAL SOBRE LA SEGURIDAD ALIMENTARIA

4. Se calcula que la producción agrícola tendrá que aumentar en un 70 % de aquí al 2050 para alimentar a una población mundial que se prevé que superará los 9 000 millones de personas para entonces. Simultáneamente, será preciso adoptar medidas para garantizar a todas las personas acceso —físico, social y económico— a alimentos suficientes, inocuos y nutritivos, con especial atención a dar pleno acceso a las mujeres y los niños. Los alimentos no deberían emplearse como instrumento de presión política y económica. Reafirmamos la importancia de la cooperación y la solidaridad internacionales, así como la necesidad de abstenerse de adoptar medidas unilaterales que no sean acordes con el Derecho internacional y la Carta de las Naciones Unidas y que pongan en peligro la seguridad alimentaria. Abogamos a favor de mercados abiertos, pues son un elemento esencial de la respuesta a la cuestión de la seguridad alimentaria mundial.

5. El cambio climático supone graves riesgos adicionales para la seguridad alimentaria y el sector agrícola. Se prevé que sus efectos revestirán especial peligro para los pequeños agricultores de los países en desarrollo, especialmente los países menos adelantados, y para las poblaciones que ya son vulnerables. Las soluciones para hacer frente a los desafíos planteados por el cambio climático deben comprender opciones de mitigación y un firme compromiso a la adaptación de la agricultura, incluso mediante la conservación y el uso sostenible de los recursos genéticos para la alimentación y la agricultura.



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Sharp rise in FAO Food Price Index

Weather and Black Sea tensions push prices to ten-month highs

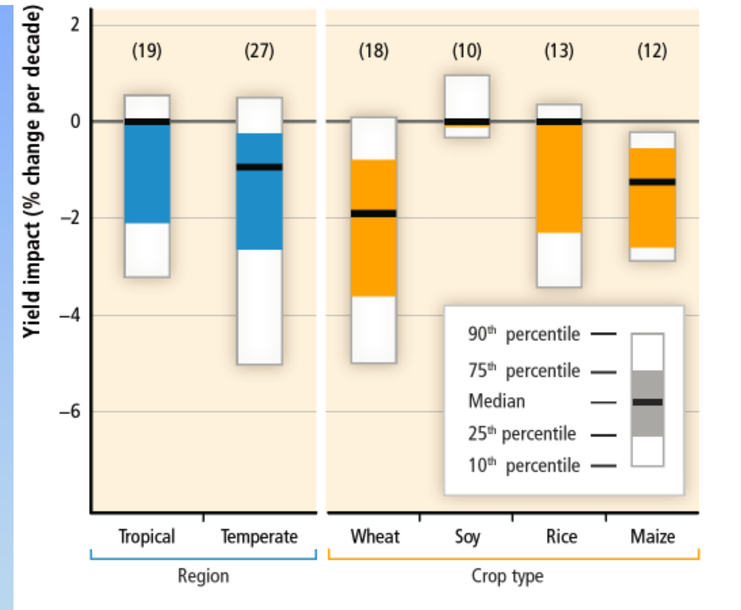
Weather conditions contributed to the surge in prices in March.

3 April 2014, Rome - The FAO Food Price Index rose sharply in March, up 4.8 points, or 2.3 percent, to an average of 212.8, the highest level since May 2013.

"The Index was influenced, as expected, by unfavourable weather conditions in the US and Brazil and geopolitical tensions in the Black Sea region," said Abdolreza Abbassian, FAO Senior Economist.

These and other influences are reviewed in greater detail in the AMIS Market Monitor report, the monthly synopsis of the major food crops prepared by the G-20 Agricultural Market Information System (AMIS), which is hosted at FAO headquarters in Rome.

"The Food Price Index looks at March trends. Since then, the initial fear over disruptions in grain shipments from Ukraine has subsided. Also, markets have started to discard any negative impacts that the current difficult domestic economic conditions may bear on plantings or harvests in 2014," Abbassian said.



Based on many studies covering a wide range of regions and crops, negative impacts of climate change on crop yields have been more common than positive impacts (*high confidence*). The smaller number of studies showing positive impacts relate mainly to high-latitude regions, though it is not yet clear whether the balance of impacts has been negative or positive in these regions (*high confidence*). Climate change has negatively affected wheat and maize yields for many regions and in the global aggregate (*medium confidence*). Effects on rice and soybean yield have been smaller in major production regions and globally, with a median change of zero across all available data, which are fewer for soy compared to the other crops.

Una situació paradòxica

- L'agricultura és una activitat profundament innovadora
- Cal innovar si volem respondre als reptes que es presenten en el futur proper

- A Europa no hi ha percepció de la necessitat d'incrementar o mantenir els nivells de producció agrícola
- Reflexió, diàleg i coexistència de mètodes de conreu són essencials si no volem perdre la nostra capacitat d'innovar