Noves tecnologies en l'agricultura

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Centre de Recerca en Agrigenòmica. CSIC-IRTA-UAB
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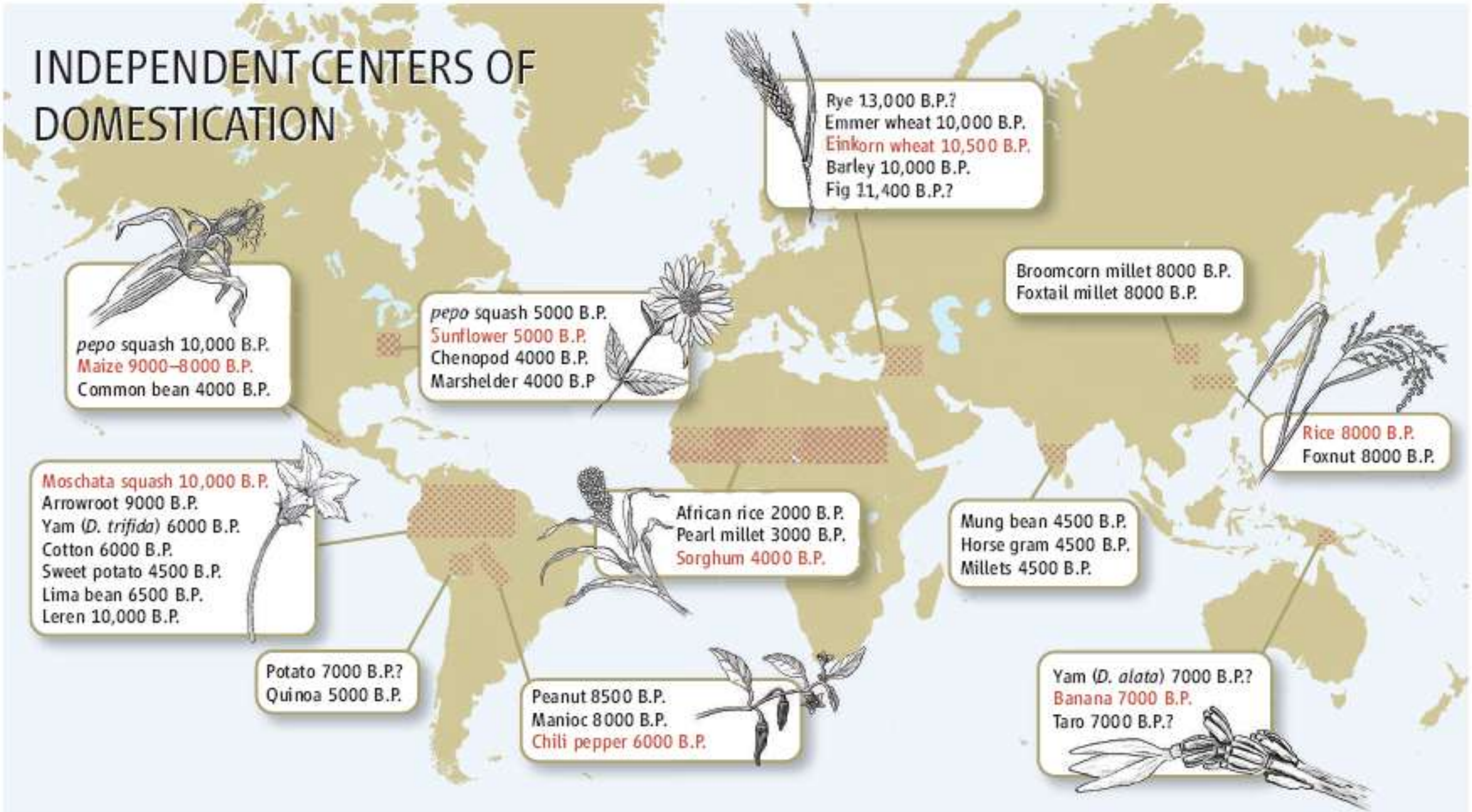
¿Perquè volem noves tecnologies en agricultura?

- Per tenir una agricultura més eficient
- Per tenir una agricultura més adaptada de cara a un futur canviant
- Per tenir una alimentació més d’acord amb les nostres necessitats
- Perquè sempre ho hem fet (i amb èxit)

Desarrollo de la mejora genética vegetal

		Especies salvajes	
-10000 años	Domesticación	↓	Nacimiento de La agricultura
		Plantas cultivadas	
1859	Darwin: Teoría de La evolución de las especies	↓	1. Introducción consciente de diversidad génica
1865	Mendel: Leyes de la herencia		2. Selección
		Plantas mejoradas	
1950	Watson y Crick: Estructura del ADN	↓	
1960-1970	Mejora de las técnicas de cultivo “in vitro”		Introducción dirigida de caracteres
1983	Primera transferencia de genes en plantas		Plantas transgénicas
2001	Primer genoma de plantas	Plantas de diseño	

Centros de domesticación de plantas



Multiple birth. People in many different parts of the world independently began to cultivate and eventually domesticate plants.

Evolution, consequences and future of plant and animal domestication

Jared Diamond

NATURE | VOL 418 | 8 AUGUST 2002 |

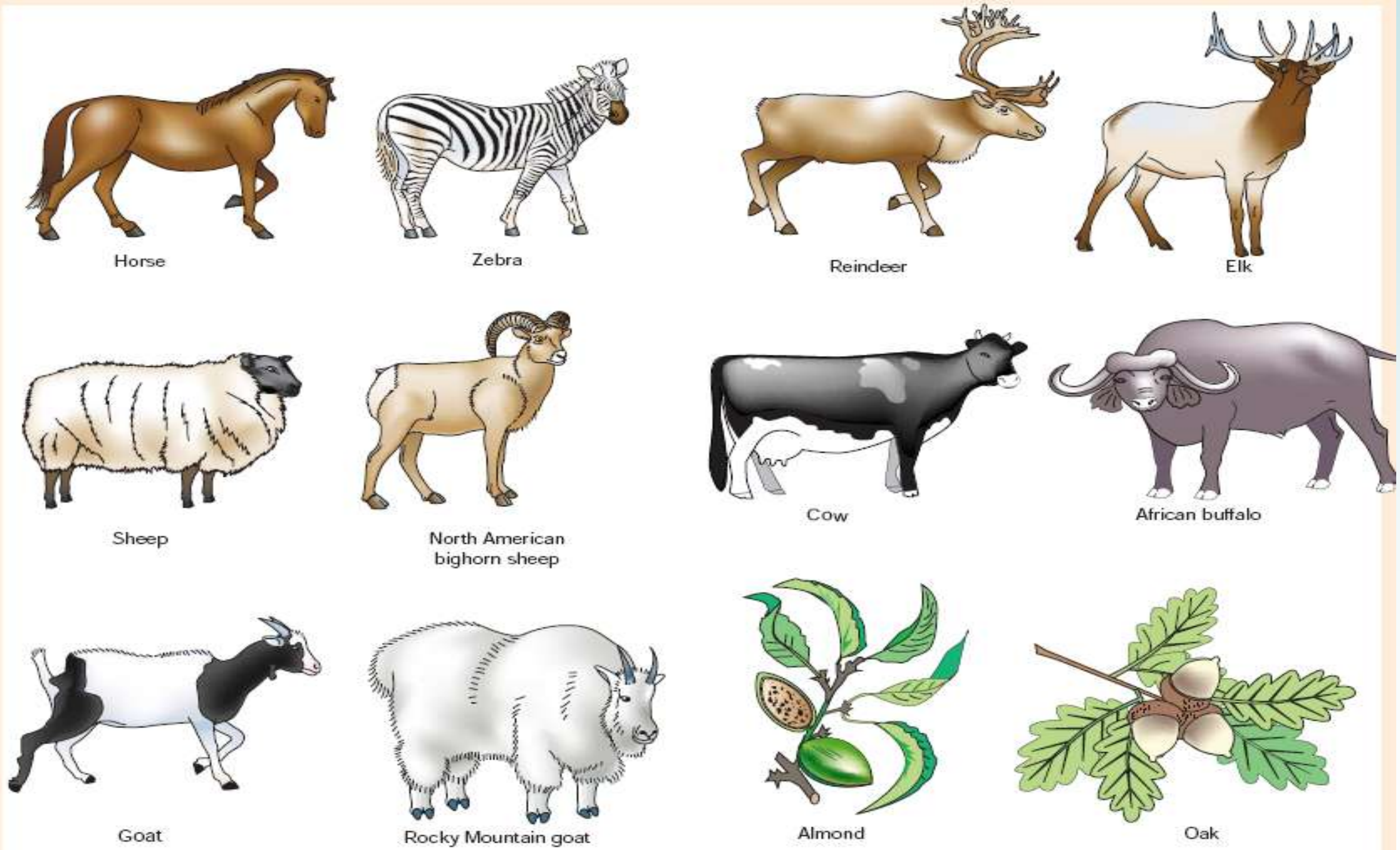
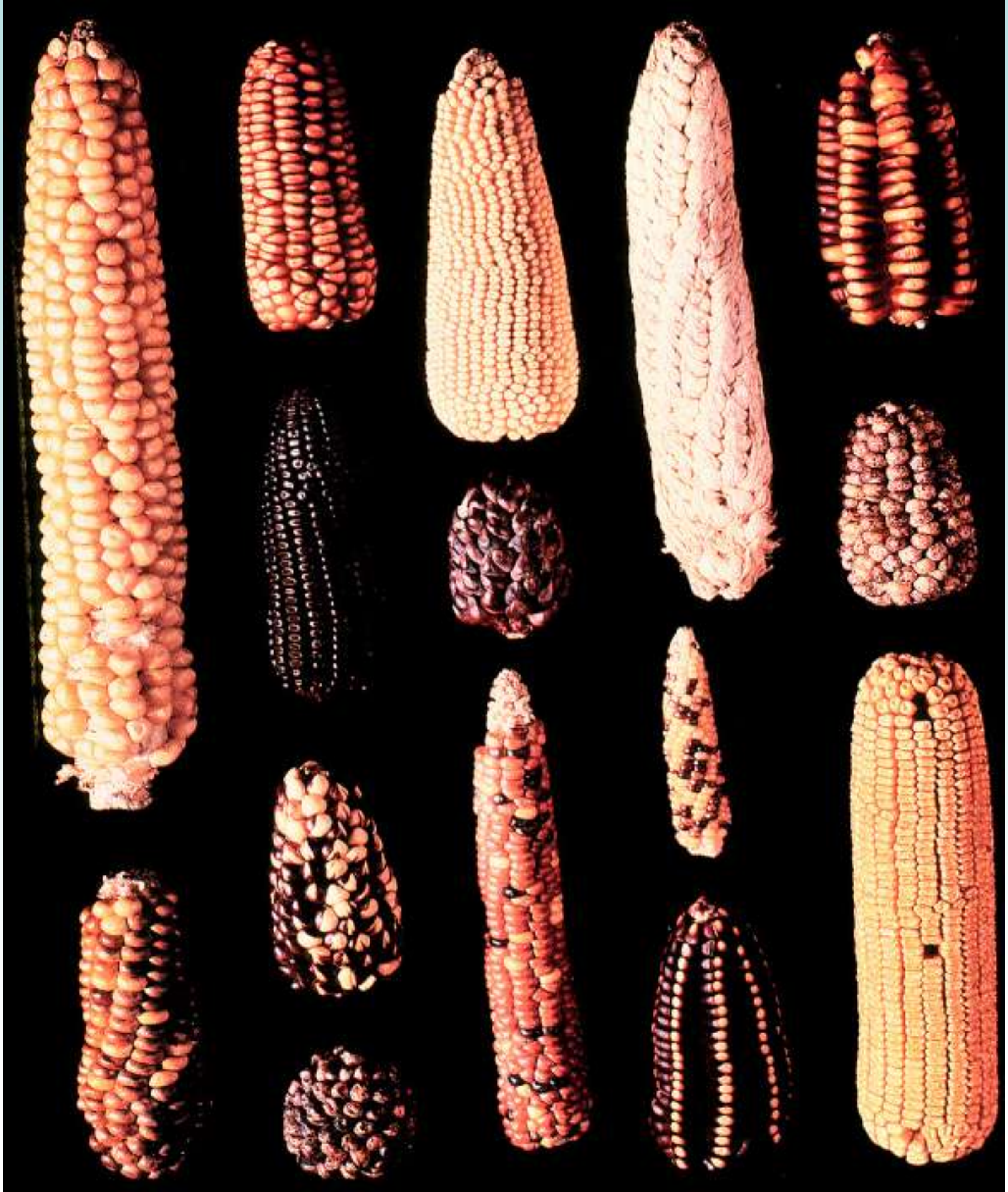


Figure 1 Comparisons of domesticated wild species (left of each pair) and their never-domesticated close relatives (right) reveal the subtle factors that can derail domestication.

El maiz, regalo de los dioses

All in the family. Maize and its wild ancestor teosinte (*left*) are closely related despite their differences.



Una preocupación actual

Domesticación del arroz

Rice Domestication by Reducing Shattering

Changbao Li, Ailing Zhou, Tao Sang*

Crop domestication frequently began with the selection of plants that did not naturally shed ripe fruits or seeds. The reduction in grain shattering that led to cereal domestication involved genetic loci of large effect. The molecular basis of this key domestication transition, however, remains unknown. Here we show that human selection of an amino acid substitution in the predicted DNA binding domain encoded by a gene of previously unknown function was primarily responsible for the reduction of grain shattering in rice domestication. The substitution undermined the gene function necessary for the normal development of an abscission layer that controls the separation of a grain from the pedicel.

fw2.2: A Quantitative Trait Locus Key to the Evolution of Tomato Fruit Size

Anne Frary,[1*] T. Clint Nesbitt,[1*] Amy Frary,[1†]
Silvana Grandillo,[1‡] Esther van der Knaap,[1] Bin Cong,[1]
Jiping Liu,[1] Jaroslaw Meller,[2] Ron Elber,[2] Kevin B. Alpert,[1]
Steven D. Tanksley[1§]

L. pimpinellifolium ***L. esculentum***

Science 289, 85-88. (2000)

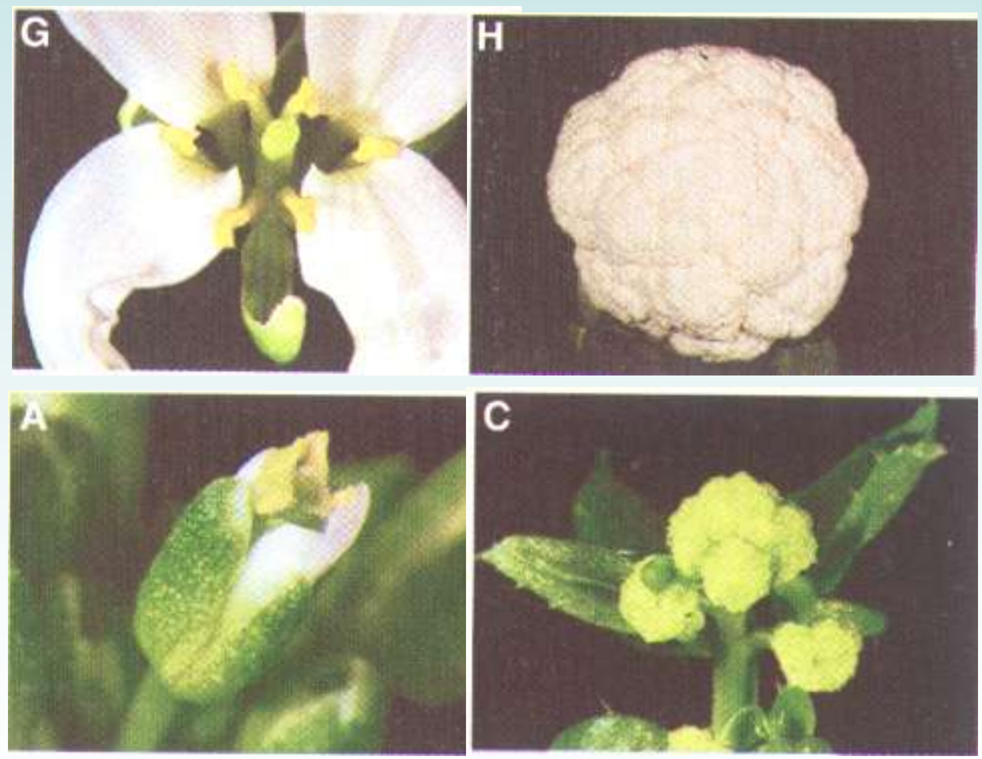
Molecular Basis of the *cauliflower* Phenotype in *Arabidopsis*

Sherry A. Kempin,* Beth Savidge,* Martin F. Yanofsky†

silvestre **mutant**

Brassica

Arabidopsis



Kempin et al (1995) Science 267, 522-525

¿Qué comemos?

- Comemos aquello que nos alimenta
- Comemos aquello que escogemos en función de nuestras necesidades, nuestras posibilidades, nuestras creencias y nuestros gustos

Pero también:

- Comemos aquello que podemos cultivar
- Comemos aquello que nos facilita una compleja cadena industrial

Los mayores cultivos

Proportions of major global cereals, roots, tubers and oil crops in 2007 (Area corresponds to total production). Source: FAOSTAT (2009)

Figure 1.1. Cereals, total 2,351,396,424 tonnes.

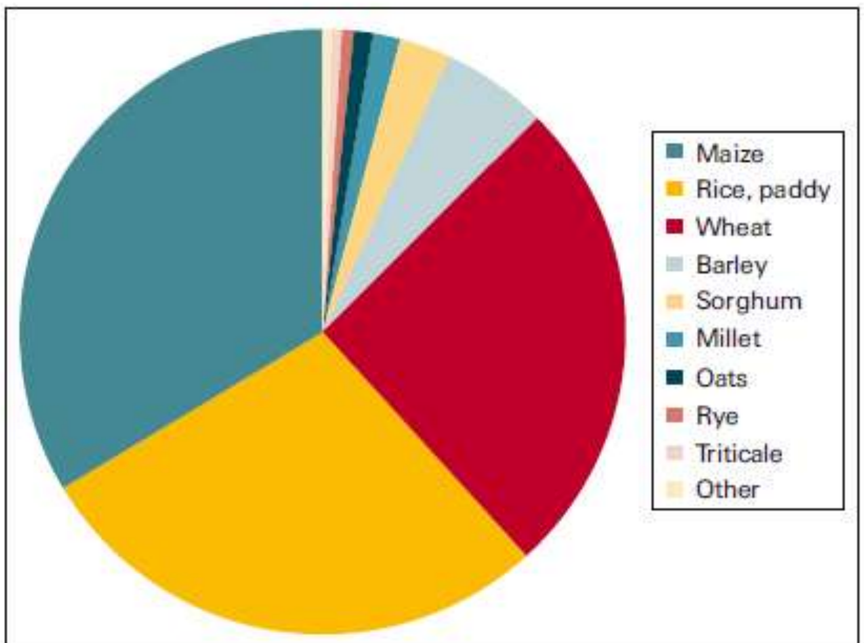


Figure 1.2. Roots and tubers, total 697,620,690 tonnes.

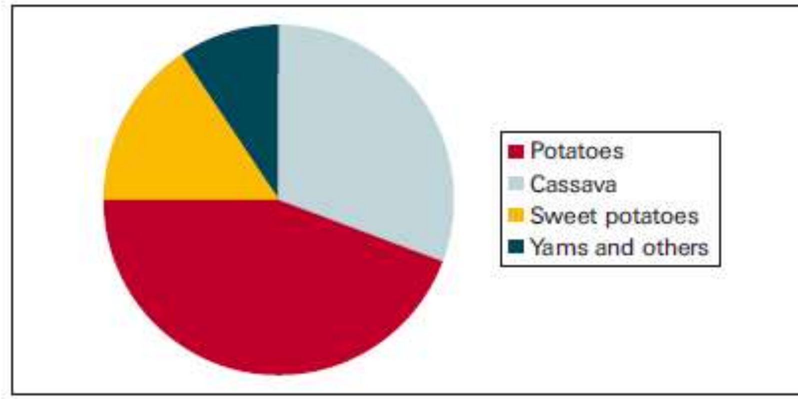
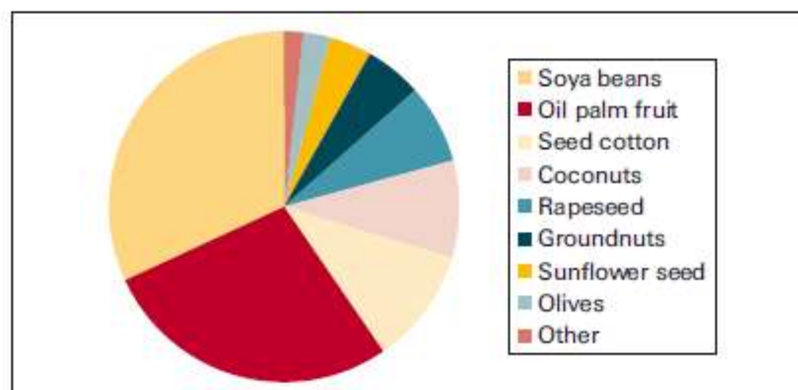


Figure 1.3. Oil crops, total 692,421,195 tonnes.



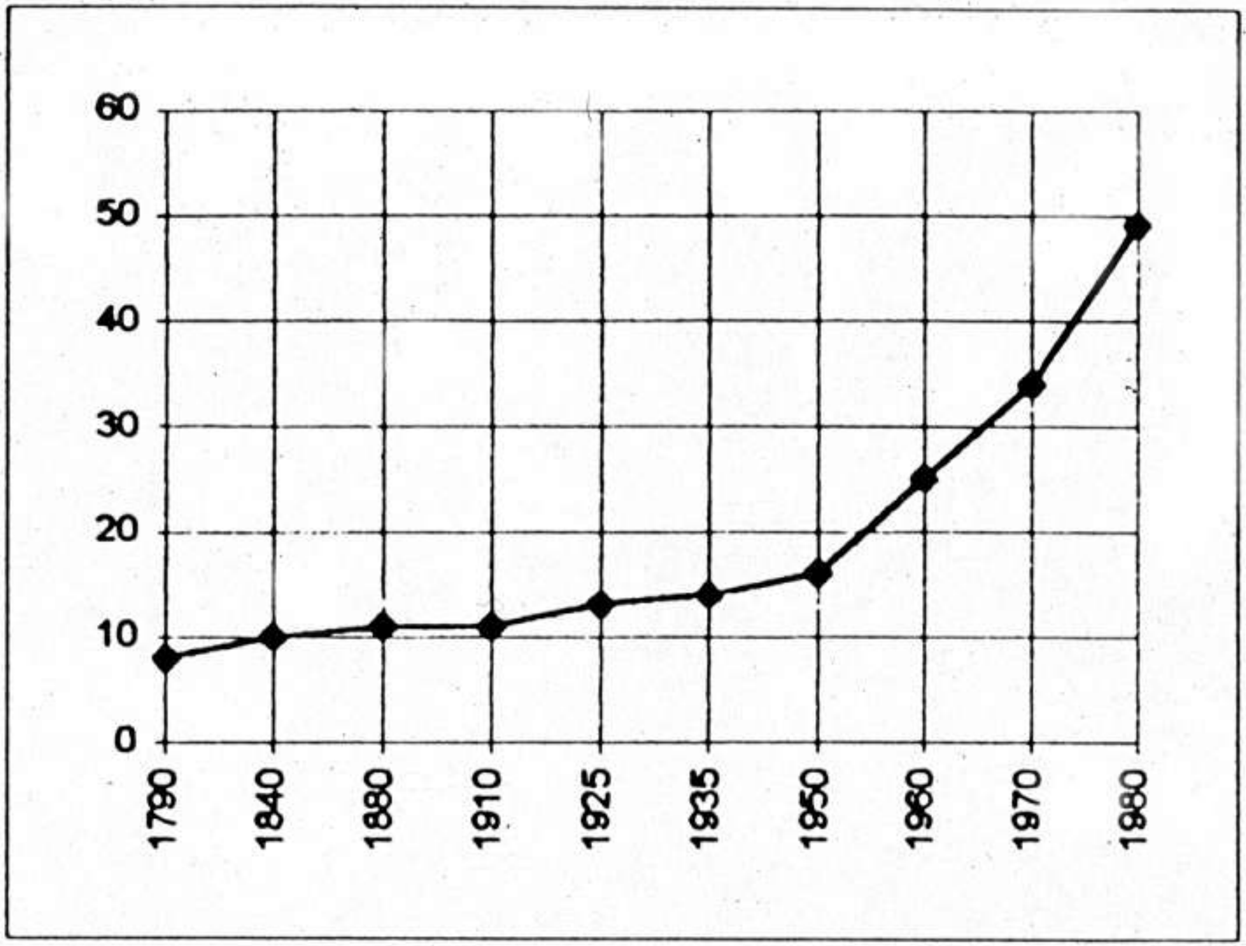


Figure 5. Évolution des rendements moyens en céréales en France de 1790 à 1980 (Rdt. q/ha) [12].

Tendencias a nivel mundial

Figure 1.4. Changes in per capita agricultural production, part 1 (1961–2005).

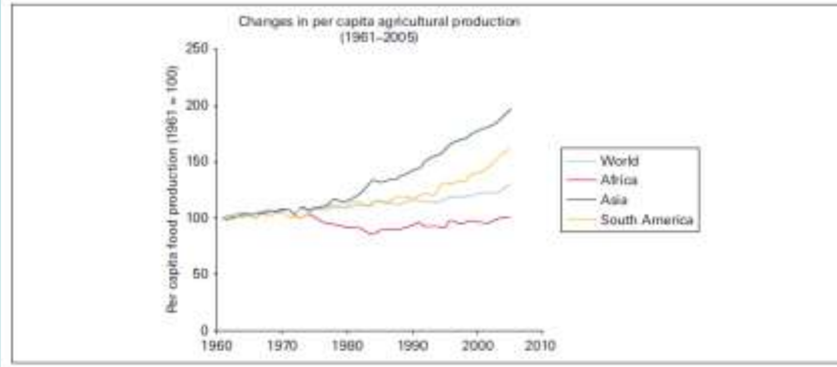


Figure 1.5. Changes in per capita agricultural production, part 2 (1961–2005).

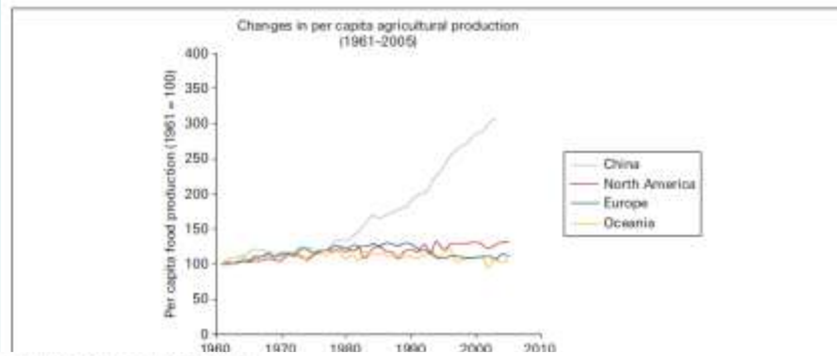


Figure 1.6. World fertiliser consumption (1961–2005).

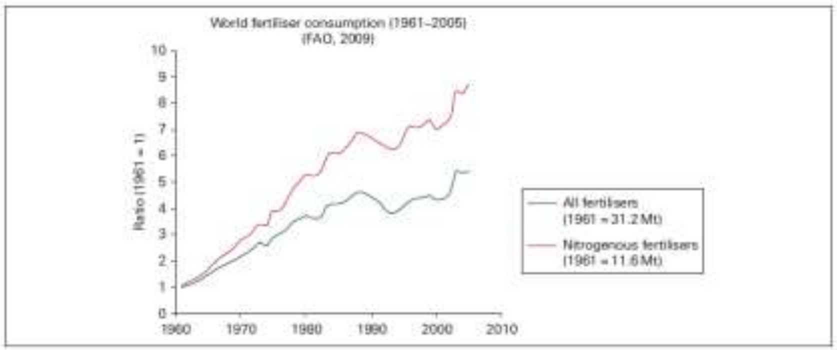


Figure 1.7. Irrigated area and agricultural machinery (1961–2006).

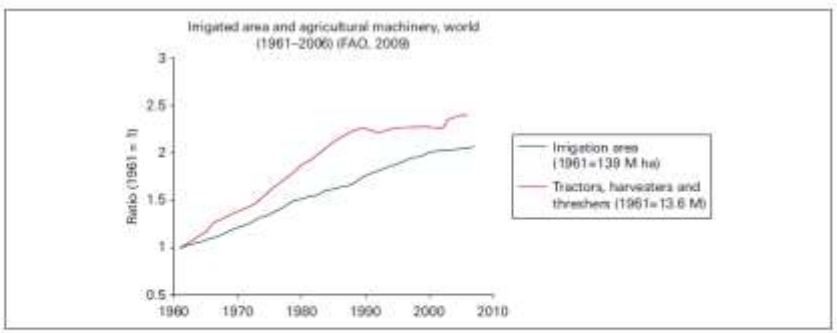
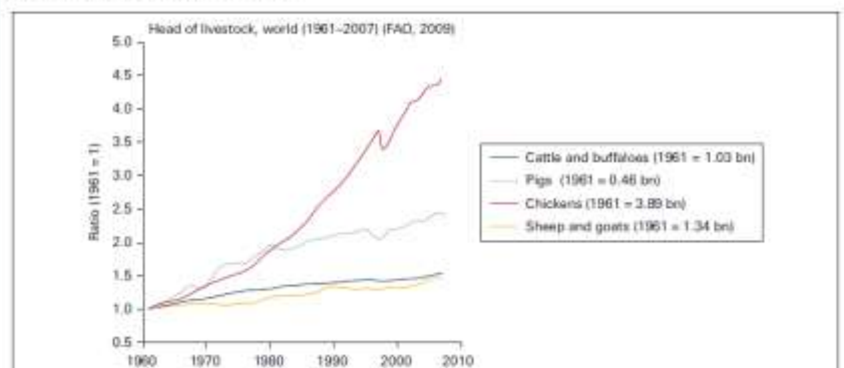
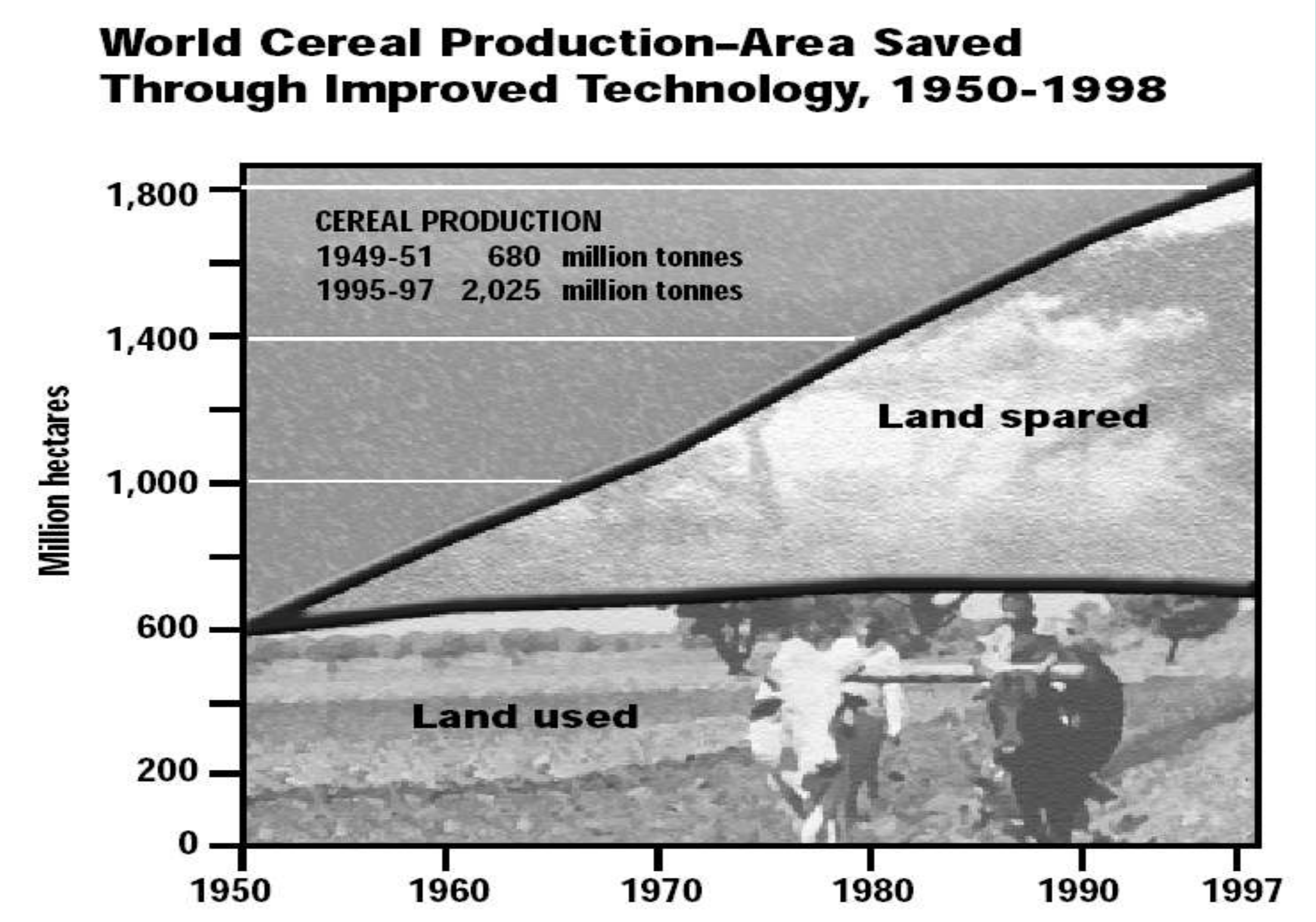


Figure 1.9. Head of livestock (1961–2007).



La revolución verde. Norman Bourlaug



Hace un año y medio!

- FAO calls for urgent steps to protect the poor from soaring food prices
- Action needed to improve access to inputs to boost local food production in most affected countries

- **17 December 2007, Rome –** FAO is urging governments and the international community to implement immediate measures in support of poor countries hit hard by dramatic food price increases.

  Currently 37 countries worldwide are facing food crises due to conflict and disasters. In addition, food security is being adversely affected by unprecedented price hikes for basic food, driven by historically low food stocks, droughts and floods linked to climate change, high oil prices and growing demand for bio-fuels. High international cereal prices have already sparked food riots in several countries.

2008 crop yield forecast. Maize

Favourable weather conditions and an increase in the planted area farmed should lead to a total cereals harvest close to 301m tonnes for this year in the European Union, 43m tonnes more than in 2007. This represents an increase of 16% on the 2007 harvest and 9% on the past five years' average production. This forecast, published today by the European Commission, is based on an updated analysis by the Joint Research Centre (JRC), using an advanced crop yield forecasting system.

The **yield** forecast for cereals is **5 tonnes per hectare** across the EU and thus significantly higher than last year and the average over the past five years. The total EU27 area used for cereals in 2008 is estimated to have increased by 5 % compared to 2007, due to a 0 % set-aside rate and high cereals prices.

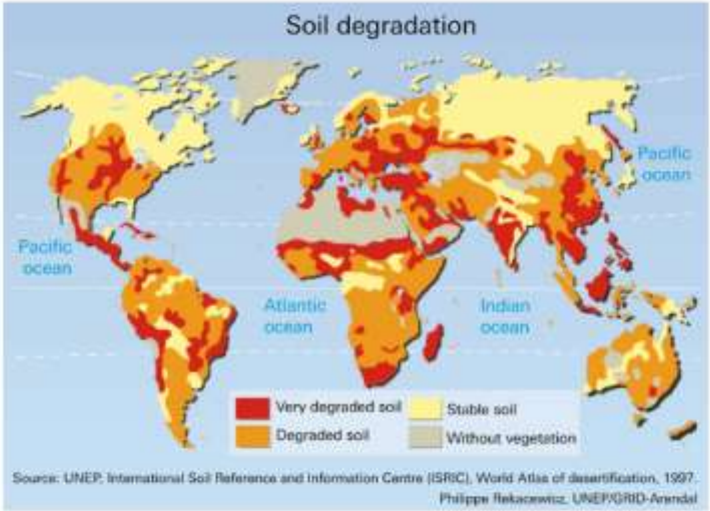
One of the greatest increases is in **Maize** yield, which is expected to be 20.1% higher than last year and 9.5% higher than the past five years' average, with very high yield increases for Romania (+122%), Bulgaria (+193%) and Hungary (+94%), countries that had been suffering from drought last year.

Amenazas para los cultivos

Table 2.1. Major pests of maize, rice and wheat.

Crop	Pests
Maize	Armyworms—common, fall, true (*Pseudaletia unipuncta, Spodoptera frugiperda, Pseudaletia unipunc*
	Borers—European corn, lesser cornstalk, potato stem, stalk (*Ostrinia nubilalis, Elasmopalpus lignosellus, Hydraecia micacea, Papaipema nebris*)
	Corn delphacid (*Peregrinus maidis*)
	Corn earworm (*Helicoverpa zea*)
	Corn flea beetle (*Chaetocnema pulicaria*)
	Corn leaf aphid (*Rhopalosiphum maidis*)
	Corn silkfly (*Euxesta stigmatis*)
	Cutworms—black, western bean (*Agrotis ipsilon, Striacosta albicosta*)
	Rootworm—corn, western corn (*Diabrotica virgifera, Diabrotica barberi*)
Rice	Rice gall midge (*Orseolia oryzae*)
	Rice bug (*Leptocorisa oratorius, L. chinensis, L. Acuta*)
	Hispa (*Dicladispa armigera*)
	Rice leaffolder (*Cnaphalocrocis medinalis, Marasmia patnalis, M. Exigua*)
	Stemborer (*Chilo suppressalis, Scirpophaga incertulas*)
	Rats (various species)
	Rice weevils (*Sitophilus oryzae*)
Wheat	Aphids (various species)
	Armyworms, cutworms, stalk borers and wireworms (various species)
	Cereal leaf beetle (*Oulema melanopa*)
	Flies—hessian, sawfly (*Mayetiola destructor, Cephus cinctus*)
	Mites (various species)
	Nematodes— cereal cyst, seed gall, root knot (*Heterodera avenae, Anguina tritici, Meloidogyne* spp.)
	Slugs, snails, grasshoppers, and crickets (various species)
	Stink bugs (various species)
	Thrips (various species)
	Wheat stem maggot (*Meromyza Americana*)
	White grubs (various species)

Figure 2.1. Global soil degradation. Source: UNEP (2009).



La Genética interviene en momentos decisivos

- En la domesticación de las plantas y los animales
- En las aplicaciones de las leyes de Mendel durante el siglo XX
- Cuando se aplica la Biología Molecular a partir de 1970
- La Genómica aparece al final del siglo XX

Arabidopsis thaliana

Chromosomes	5
DNA molecules lenght	115 Mb
Genes	25.498
Genes with EST	60 %
Gene density	4,5 Kb/g
Gene length	2 Kb

Arabidopsis thaliana

Chromosomes	5
DNA molecules lenght	115 Mb
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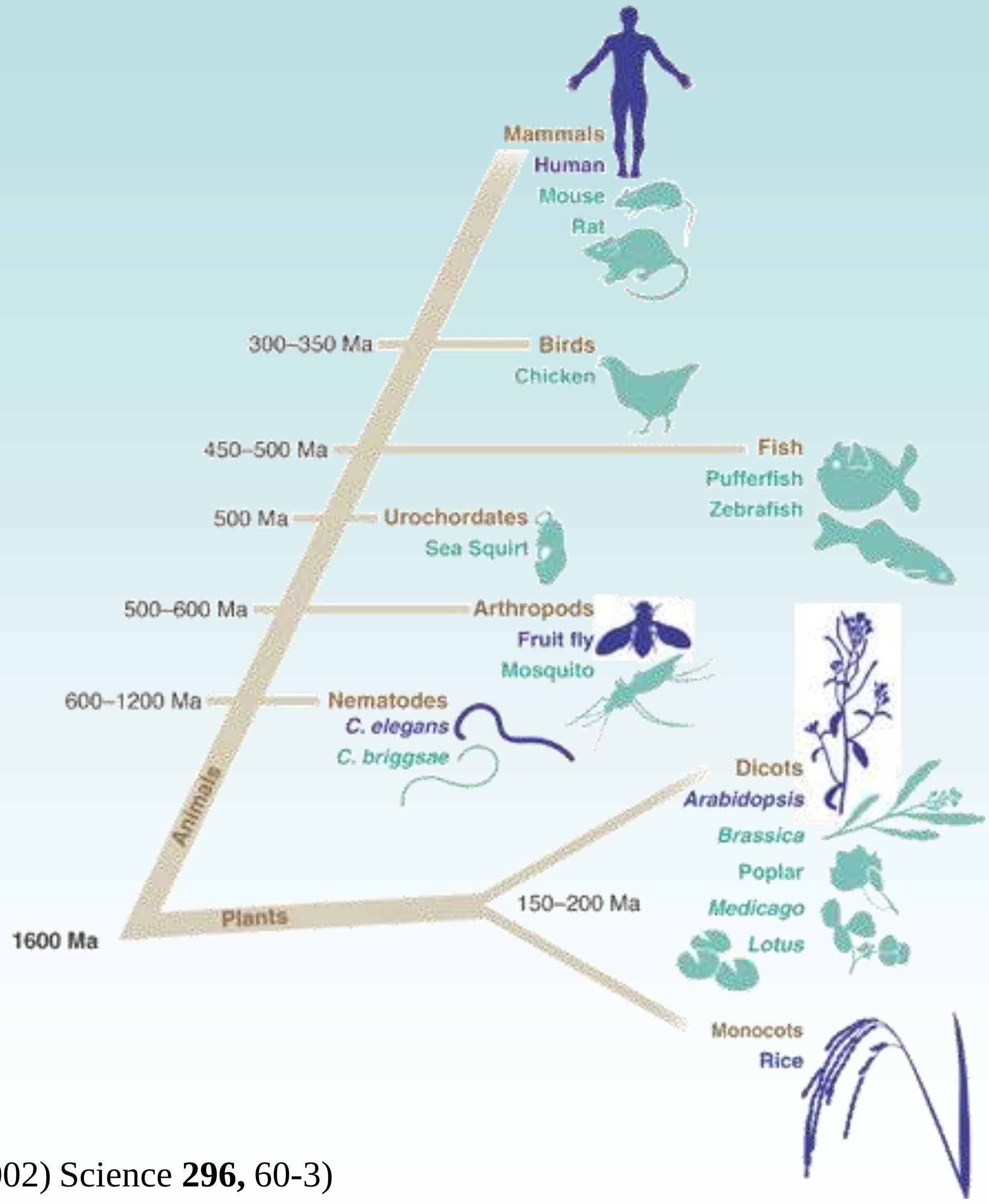
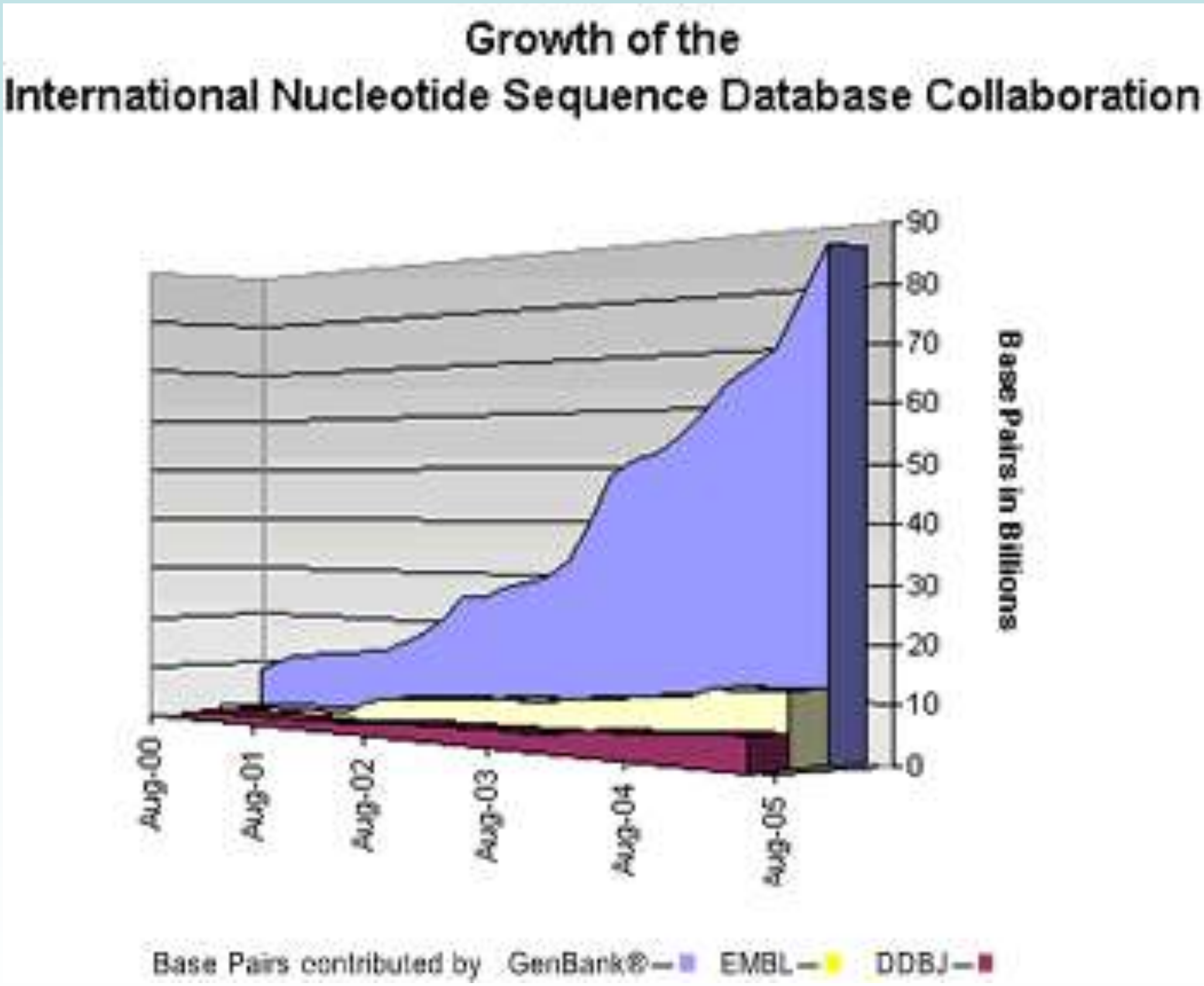
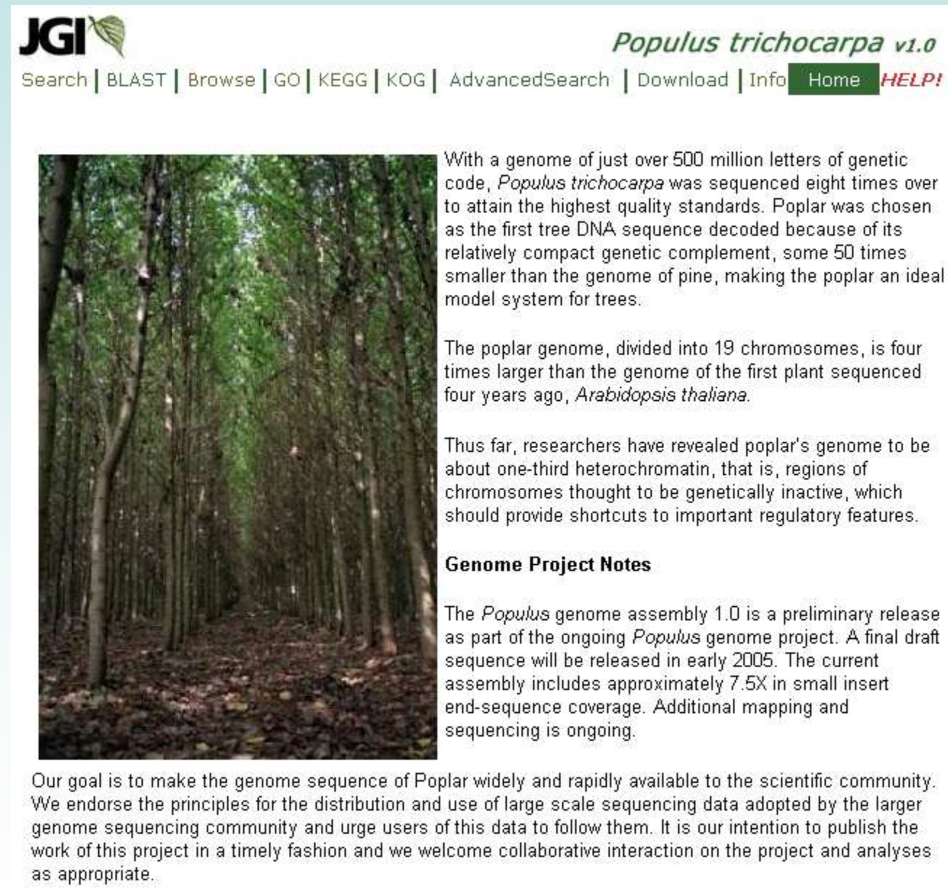
Phylogenetic relations in multicelular organisms



(J. Bennetzen, (2002) Science **296,** 60-3)


Growth of the
International Nucleotide Sequence Database Collaboration
90
80
70
60
50
40
30
20
10
0
Base Pairs in Billions
Aug-00
Aug-01
Aug-02
Aug-03
Aug-04
Aug-05
Base Pairs contributed by GenBank® EMBL DDBJ

Genoma del chopo



Genoma de la papaya transgénica

The draft genome of the transgenic tropical fruit tree papaya (*Carica papaya* Linnaeus)

Ray Ming[1,2]*, Shaobin Hou[3]*, Yun Feng[4,5]*, Qingyi Yu[1]*, Alexandre Dionne-Laporte[3], Jimmy H. Saw[3], Pavel Senin[3], Wei Wang[4,6], Benjamin V. Ly[3], Kanako L. T. Lewis[3], Steven L. Salzberg[7], Lu Feng[4,5,6], Meghan R. Jones[1], Rachel L. Skelton[1], Jan E. Murray[1,2], Cuixia Chen[2], Wubin Qian[4], Junguo Shen[5], Peng Du[5], Moriah Eustice[1,8], Eric Tong[1], Haibao Tang[9], Eric Lyons[10], Robert E. Paull[11], Todd P. Michael[12], Kerr Wall[13], Danny W. Rice[14], Henrik Albert[15], Ming-Li Wang[1], Yun J. Zhu[1], Michael Schatz[7], Niranjan Nagarajan[7], Ricelle A. Acob[1,8], Peizhu Guan[1,8], Andrea Blas[1,8], Ching Man Wai[1,11], Christine M. Ackerman[1], Yan Ren[4], Chao Liu[4], Jianmei Wang[4], Jianping Wang[2], Jong-Kuk Na[2], Eugene V. Shakirov[16], Brian Haas[17], Jyothi Thimmapuram[18], David Nelson[19], Xiyin Wang[9], John E. Bowers[9], Andrea R. Gschwend[2], Arthur L. Delcher[7], Ratnesh Singh[1,8], Jon Y. Suzuki[15], Savarni Tripathi[15], Kabi Neupane[20], Hairong Wei[21], Beth Irikura[11], Maya Paidi[1,8], Ning Jiang[22], Wenli Zhang[23], Gernot Presting[8], Aaron Windsor[24], Rafael Navajas-Pérez[9], Manuel J. Torres[9], F. Alex Feltus[9], Brad Porter[8], Yingjun Li[2], A. Max Burroughs[7], Ming-Cheng Luo[25], Lei Liu[18], David A. Christopher[8], Stephen M. Mount[7,26], Paul H. Moore[15], Tak Sugimura[27], Jiming Jiang[23], Mary A. Schuler[28], Vikki Friedman[29], Thomas Mitchell-Olds[24], Dorothy E. Shippen[16], Claude W. dePamphilis[13], Jeffrey D. Palmer[14], Michael Freeling[10], Andrew H. Paterson[9], Dennis Gonsalves[15], Lei Wang[4,5,6] & Maqsudul Alam[3,30]

The grapevine genome sequence suggests ancestral hexaploidization in major angiosperm phyla

The French–Italian Public Consortium for Grapevine Genome Characterization*

Nature advance online publication 26 August 2007 | doi:10.1038/nature06148; Received 5 April 2007; Accepted 7 August 2007; Published online 26 August 2007

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El genoma de la viña

These findings are summarized in Fig. 3: the triplicated arrangement is apparent after the separation of the monocotyledons and dicotyledons and before the spread of the Eurosid clade. Future genome sequencing projects for other clades of dicotyledons, such as Solanaceae or basal eudicots, will help in situating the triplication event more precisely, and eventually in establishing its precise nature (hexaploidization or genome duplications at distant times).

Public access to the grapevine genome sequence will help in the identification of genes underlying the agricultural characteristics of this species, including domestication traits. A selective amplification of genes belonging to the metabolic pathways of terpenes and tannins has occurred in the grapevine genome, in contrast with other plant genomes. This suggests that it may become possible to trace the diversity of wine flavours down to the genome level. Grapevine is also a crop that is highly susceptible to a large diversity of pathogens including powdery mildew, oidium and Pierce disease. Other *Vitis* species such as *V. riparia* or *V. cinerea*, which are known to be resistant to several of these pathogens, are interfertile with *V. vinifera* and can be used for the introduction of resistance traits by advanced backcrosses[27] or by gene transfer. Access to the *Vitis* sequence and the exploitation of synteny will speed up this process of introgression of pathogen resistance traits. As a consequence of this, it is hoped that it will also prompt a strong decrease in pesticide use.

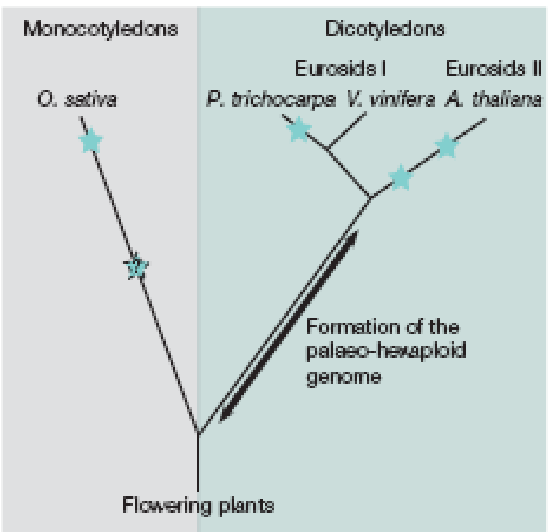


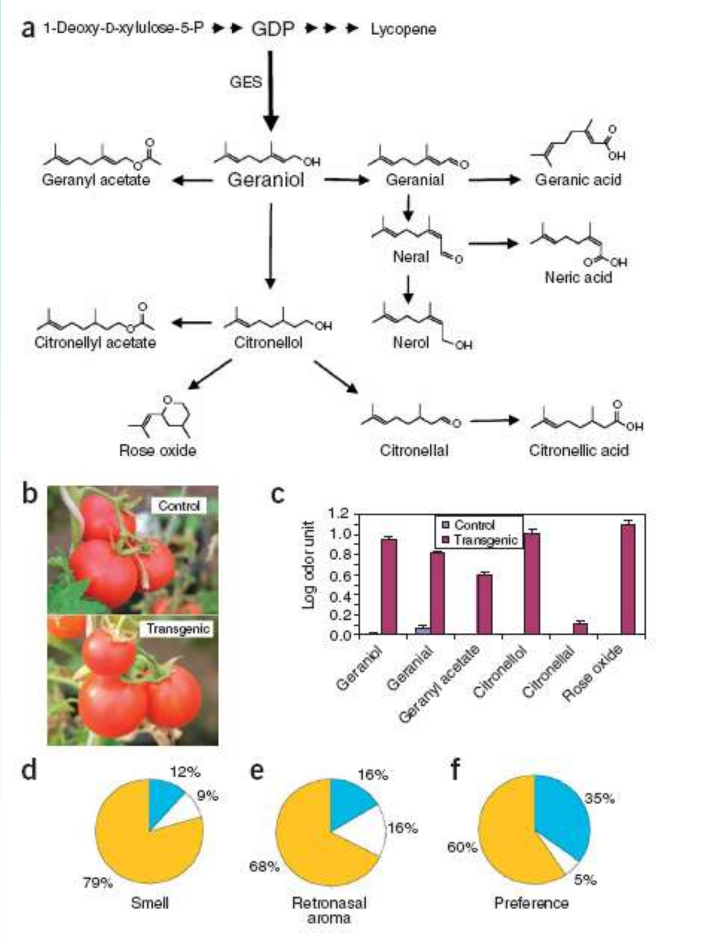
Figure 3 | Positions of the polyploidization events in the evolution of plants with a sequenced genome. Each star indicates a WGD (tetraploidization) event on that branch. The question mark indicates that ancient events are visible in the rice genome that would require other monocotyledon genome sequences to be resolved. The formation of the palaeo-hexaploid ancestral genome occurred after divergence from monocotyledons and before the radiation of the Eurosids.

Los genes del aroma

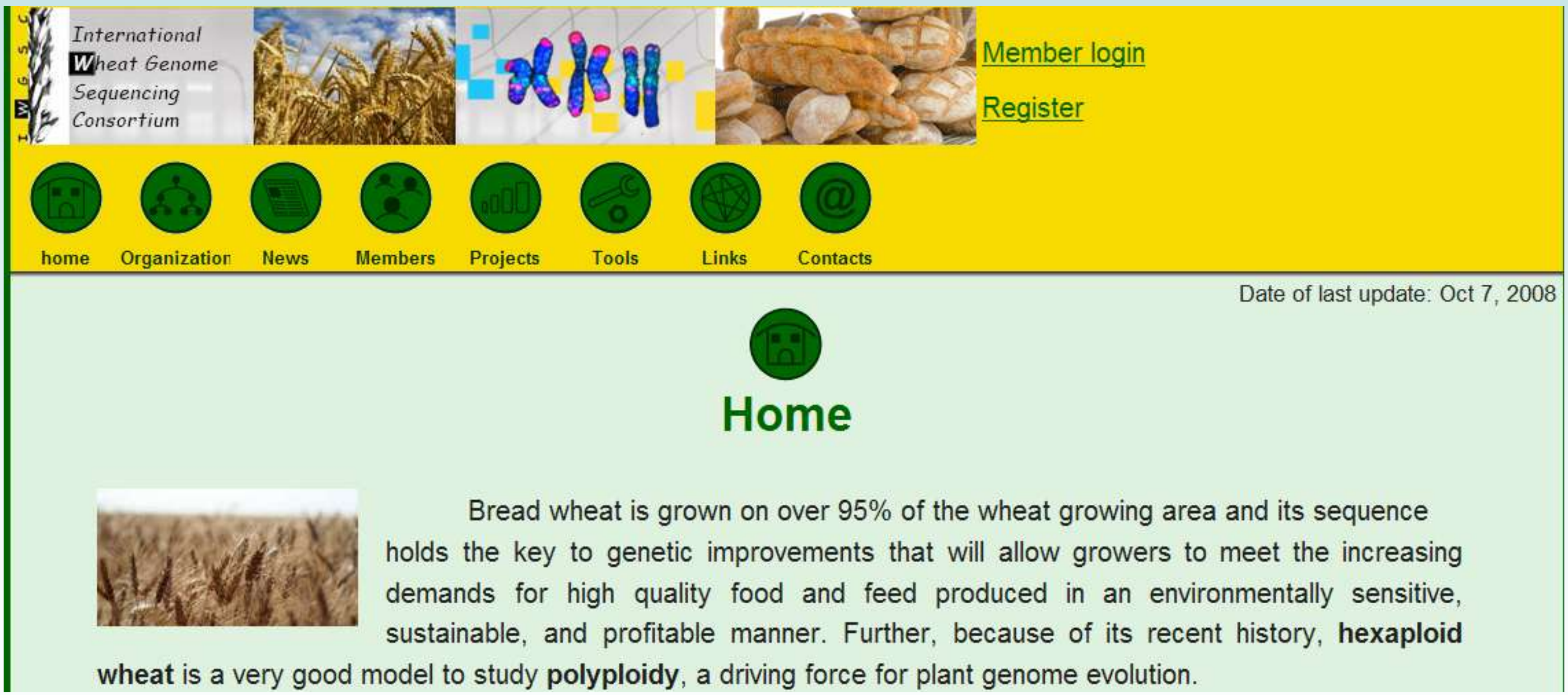
Enrichment of tomato flavor by diversion of the early plastidial terpenoid pathway

Rachel Davidovich-Rikanati[1,2], Yaron Sitrit[3], Yaakov Tadmor[1], Yoko Iijima[4,8], Natalya Bilenko[5], Einat Bar[1], Bentsi Carmona[1], Elazar Fallik[6], Nativ Dudai[1], James E Simon[7], Eran Pichersky[4] & Efraim Lewinsohn[1]

We have modified the flavor and aroma of tomatoes by expressing the *Ocimum basilicum* geraniol synthase gene under the control of the tomato ripening–specific polygalacturonase promoter. A majority of untrained taste panelists preferred the transgenic fruits over controls. Monoterpene accumulation was at the expense of reduced lycopene accumulation. Similar approaches may be applicable for carotenoid-accumulating fruits and flowers of other species.



Comienza el genoma del trigo


International Wheat Genome Sequencing Consortium

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Date of last update: Oct 7, 2008

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Bread wheat is grown on over 95% of the wheat growing area and its sequence holds the key to genetic improvements that will allow growers to meet the increasing demands for high quality food and feed produced in an environmentally sensitive, sustainable, and profitable manner. Further, because of its recent history, **hexaploid wheat** is a very good model to study **polyploidy**, a driving force for plant genome evolution.

El Projecte de Genómica de Cucurbitáceas

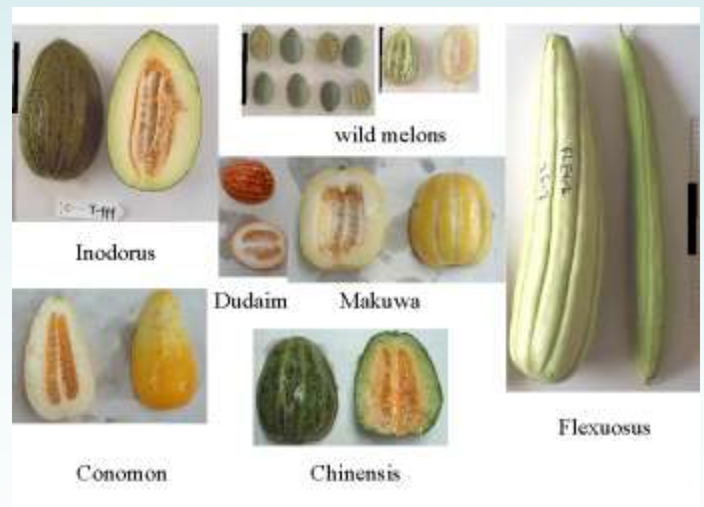
¿Por qué el melón ?

- Segundo cultivo hortícola en España
- 5º productor mundial

- Especie con mucha historia genética pero poca información molecular
- Interés internacional naciente

- Genoma pequeño 2x=2n=24

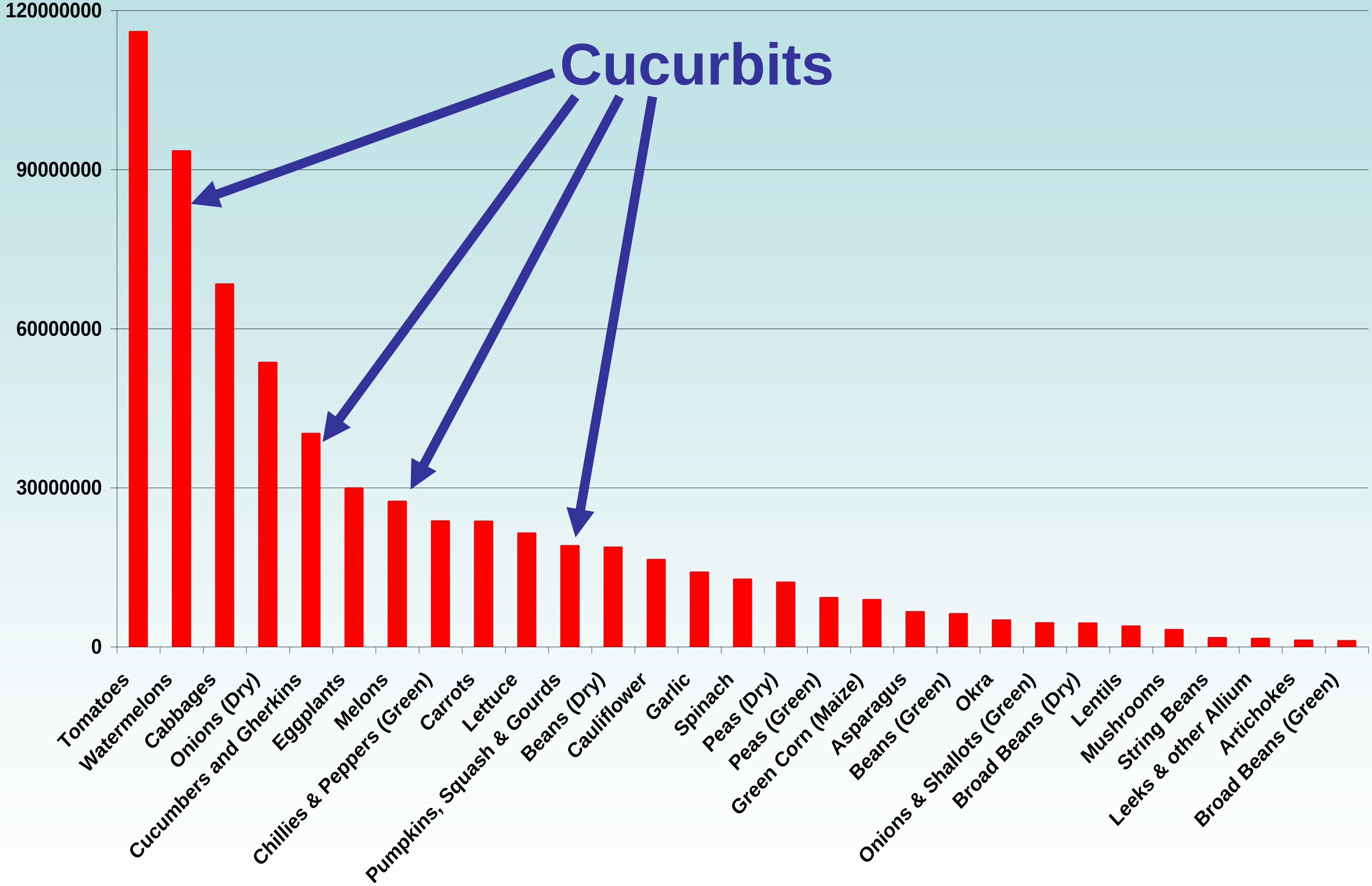
- Especie con mucho polimorfismo
- Transformación factible
- Familia cucurbitáceas



- Colaboración empresarial

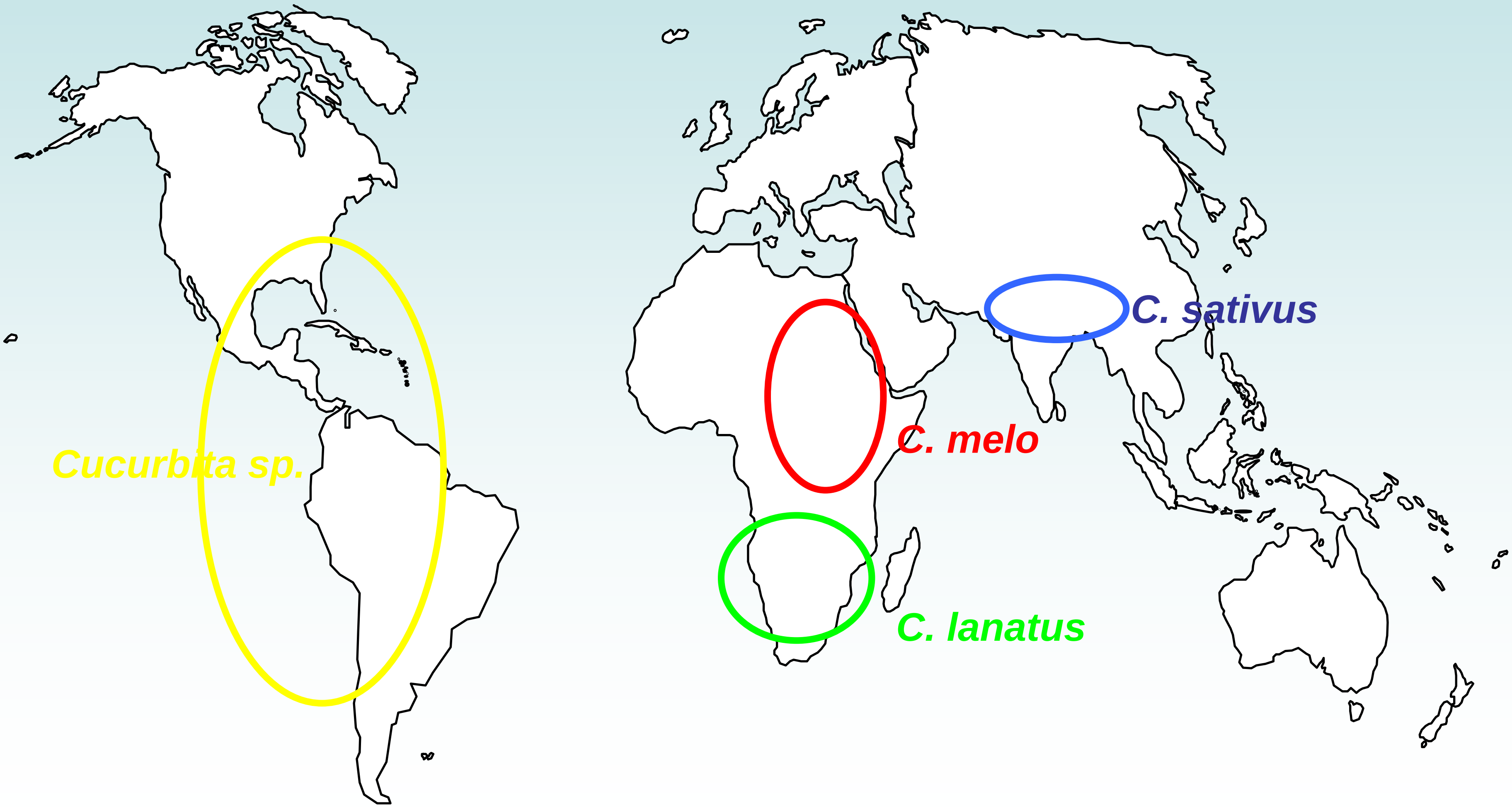
SEMILLAS fitó s.a.

- Modelo de fruto no climatérico



FAO data 2004

Origin



Melon (wild form)

Melon as a vegetable

var *tibish*

var *flexuosus*

var *chate*

Melon for fragrance

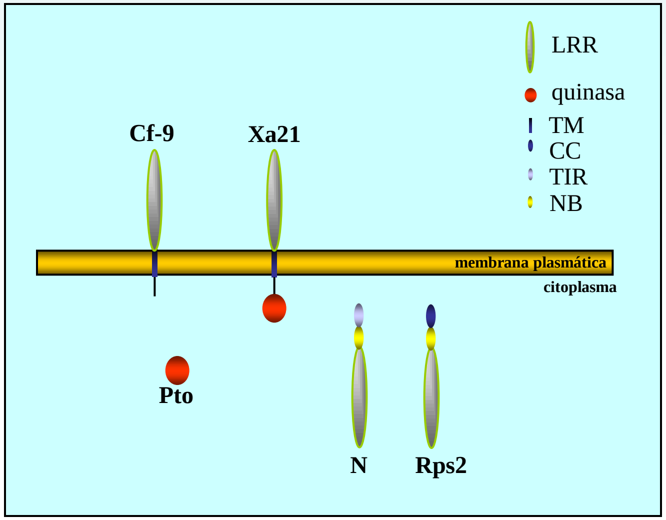
var *dudaim*

Delikatessen en Japón

Objetivos mejora genética melón

1. Resistencia a estrés biótico.

	ORGANISMO	GEN RESISTENCIA
Virus	MNSV	*nsv*
Bacterias	*Erwinia tracheiphila*	
Hongos	*Sphaeroteca fuliginea*	*Pm1*
	Fusarium oxysporum	*Fom-1, Fom-2, Fom-3*
Insectos	*Aphis gossypii*	*Vat*



Qué genes controlan estos caracteres ?

Clonación posicional

Objetivos de la mejora en melón

2. Calidad del fruto. QTLs

Contenido en azúcares
Contenido en beta-carotenos
Maduración y producción de etileno
Firmeza del fruto
Forma
Color

Caracteres cuantitativos
QTLs

Genes candidatos
Análisis de QTL s

Proyecto MCYT 2004-2006

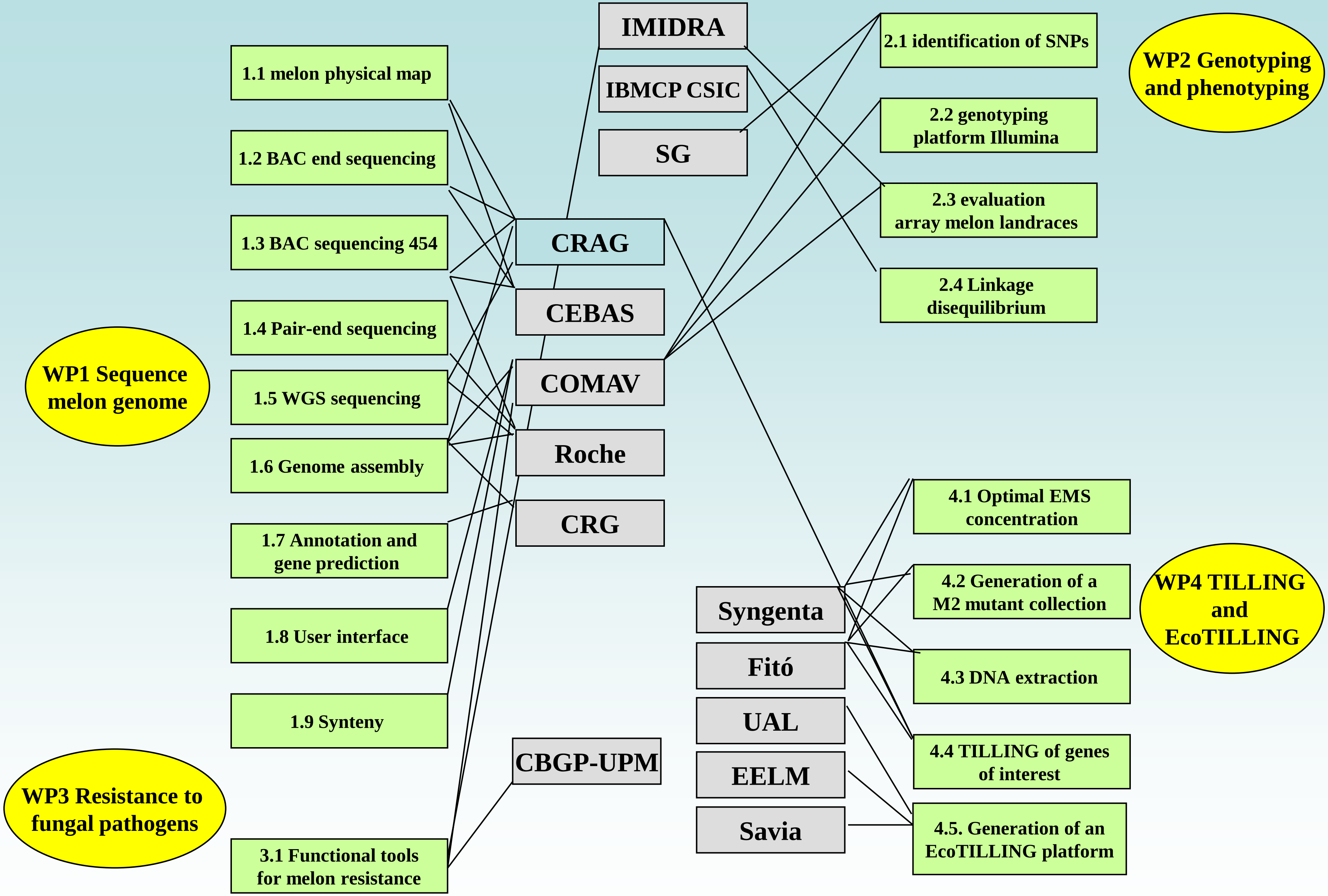
The Genoma España Project

Development of genomic tools in Cucurbits, including the sequencing of the melon genome, and its application for breeding these crop species
MELONOMICS

- 4,1 milion euro project
- Co-financed by Genoma España, 5 private companies and 5 regional governments
- 14 scientific partners
- 3 year project
- 4 workpackages:

High quality BAC-to-BAC sequence of the melon genome

Development of genomic tools for the characterization of Spanish germplasm
Development of functional tools for screening fungal resistance
Exploring natural and induced variation in melon


IMIDRA
IBMCP CSIC
SG
CRAG
CEBAS
COMAV
Roche
CRG
CBGP-UPM
Syngenta
Fitó
UAL
EELM
Savia
WP1 Sequence melon genome
1.1 melon physical map
1.2 BAC end sequencing
1.3 BAC sequencing 454
1.4 Pair-end sequencing
1.5 WGS sequencing
1.6 Genome assembly
1.7 Annotation and gene prediction
1.8 User interface
1.9 Synteny
WP2 Genotyping and phenotyping
2.1 identification of SNPs
2.2 genotyping platform Illumina
2.3 evaluation array melon landraces
2.4 Linkage disequilibrium
WP3 Resistance to fungal pathogens
3.1 Functional tools for melon resistance
WP4 TILLING and EcoTILLING
4.1 Optimal EMS concentration
4.2 Generation of a M2 mutant collection
4.3 DNA extraction
4.4 TILLING of genes of interest
4.5. Generation of an EcoTILLING platform

Variabilidad genètica

- Conservación
- Análisis y aprovechamiento de la variabilidad existente
- Creación de nueva variabilidad por mutagénesis
- Creación de nueva variabilidad por modificación genética

Todo comenzó en 1983

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*.

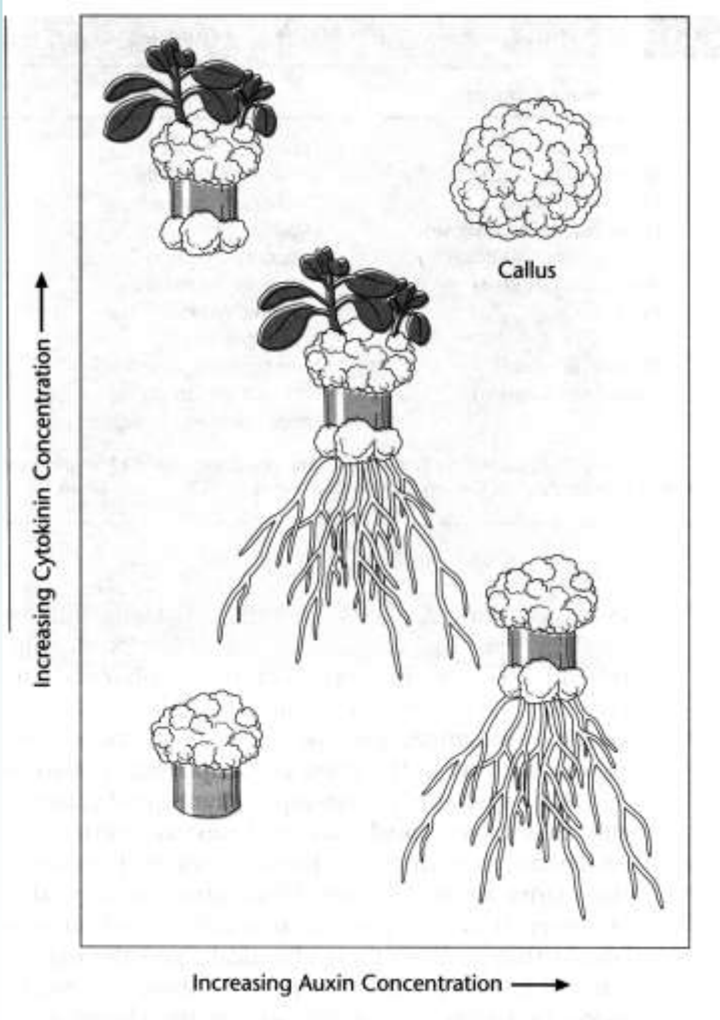
Cell. 1983 Apr;32(4):1033-43. Related Articles, Links

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

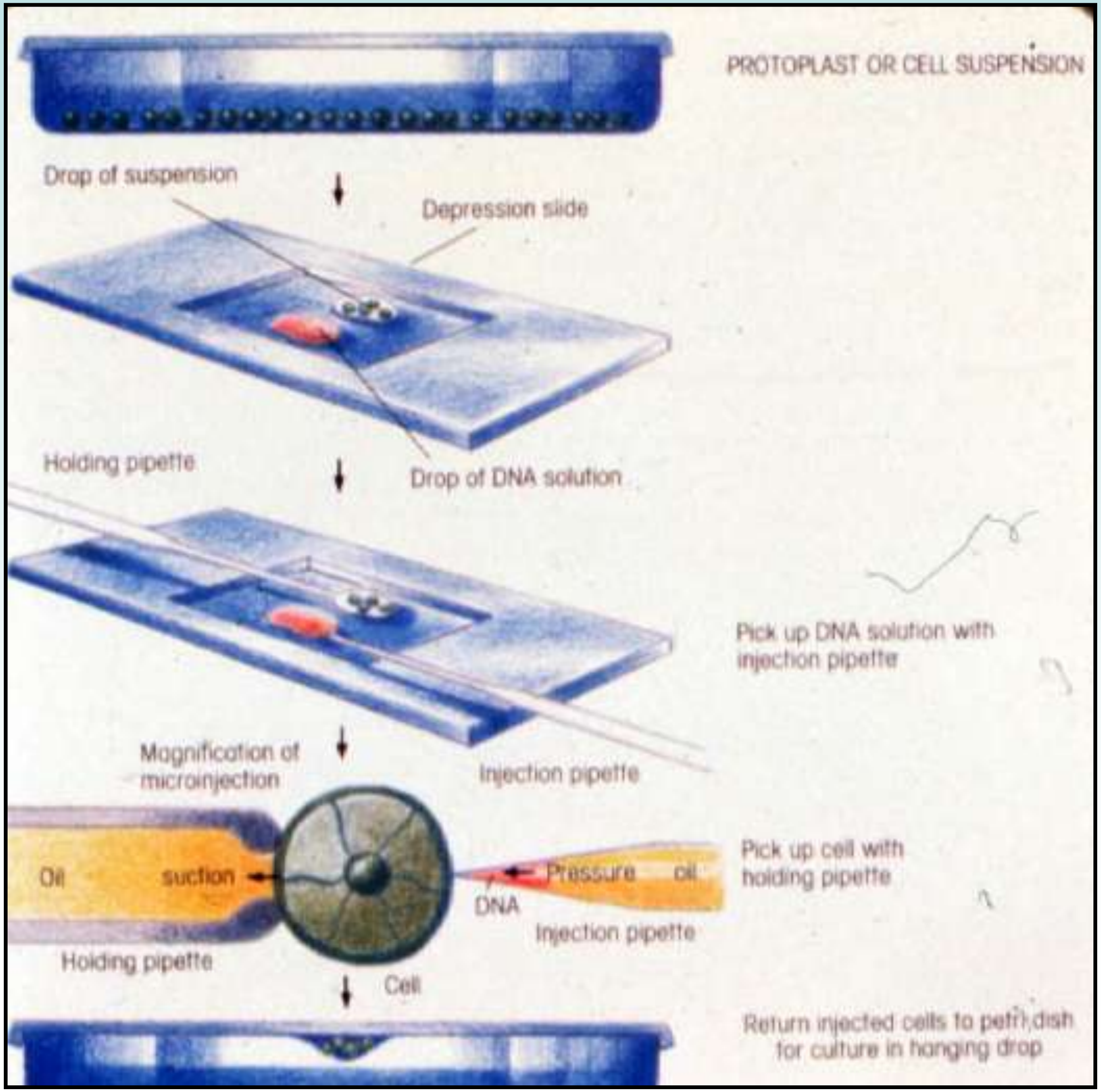
Barton KA, Binns AN, Matzke AJ, Chilton MD.

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.

¿Como se obtiene una planta transgénica? regeneración a partir de callos

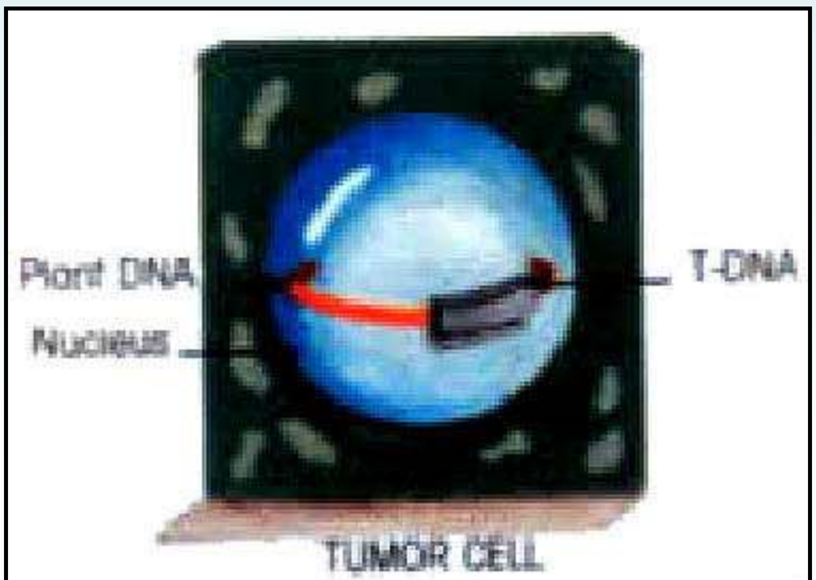


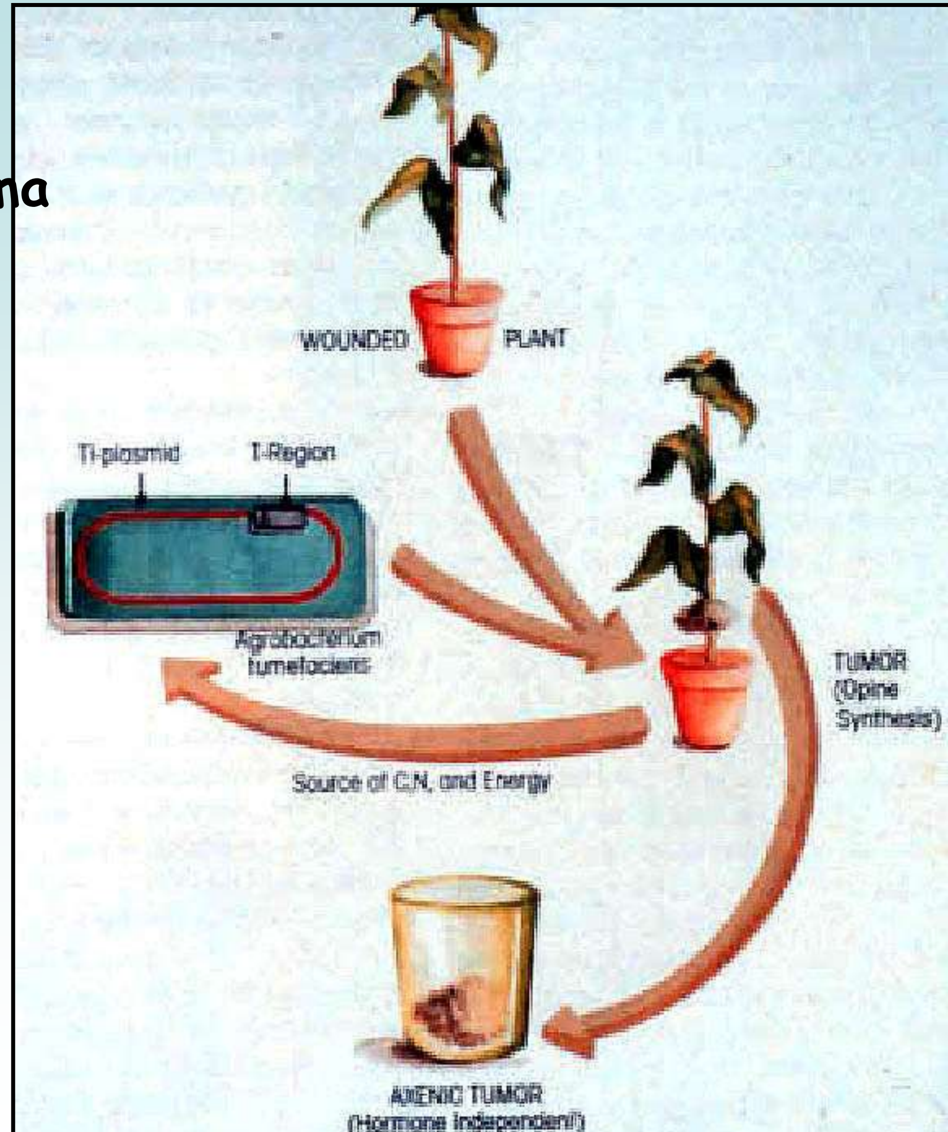
Transformación de protoplastos por microinyección



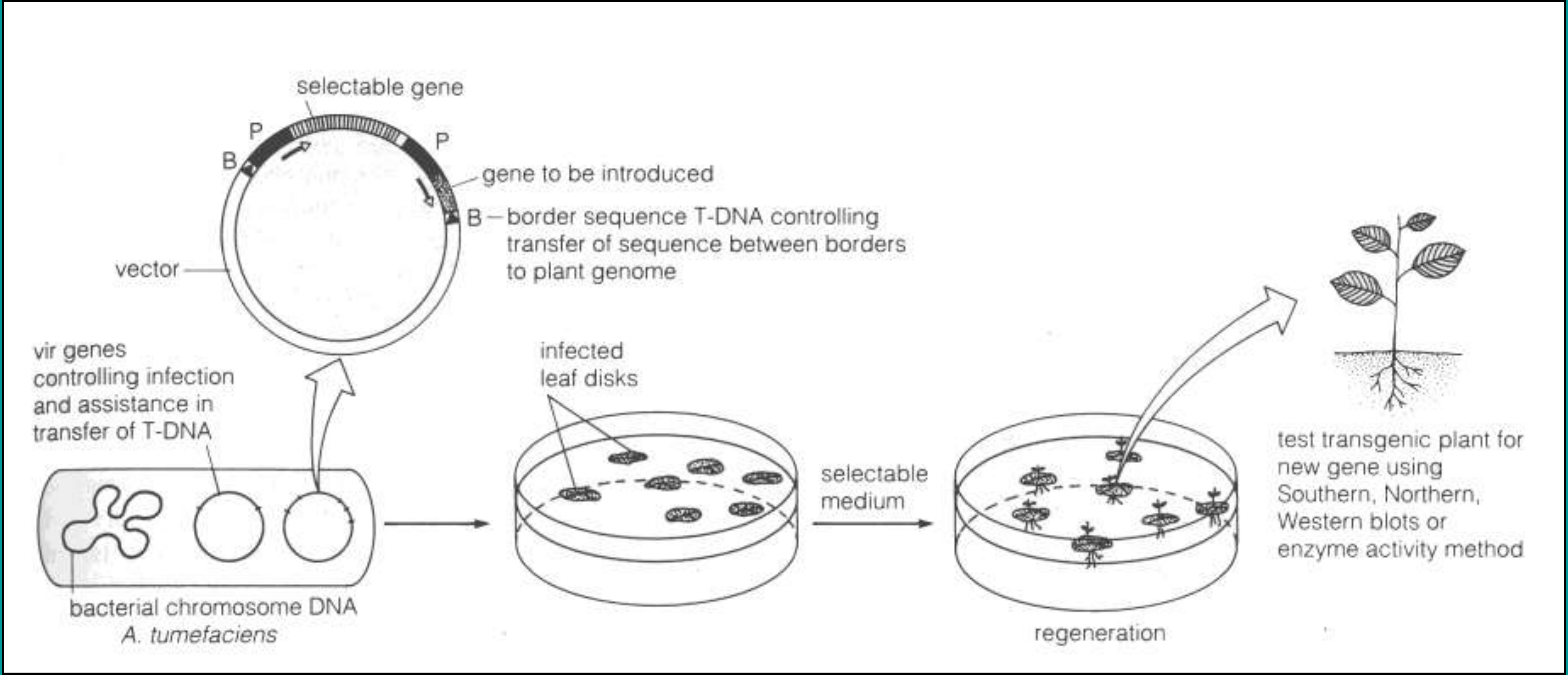
Transformación por *Agrobacterium*

Introducción de un gen en el genoma de la planta (transformación) por *Agrobacterium tumefaciens*



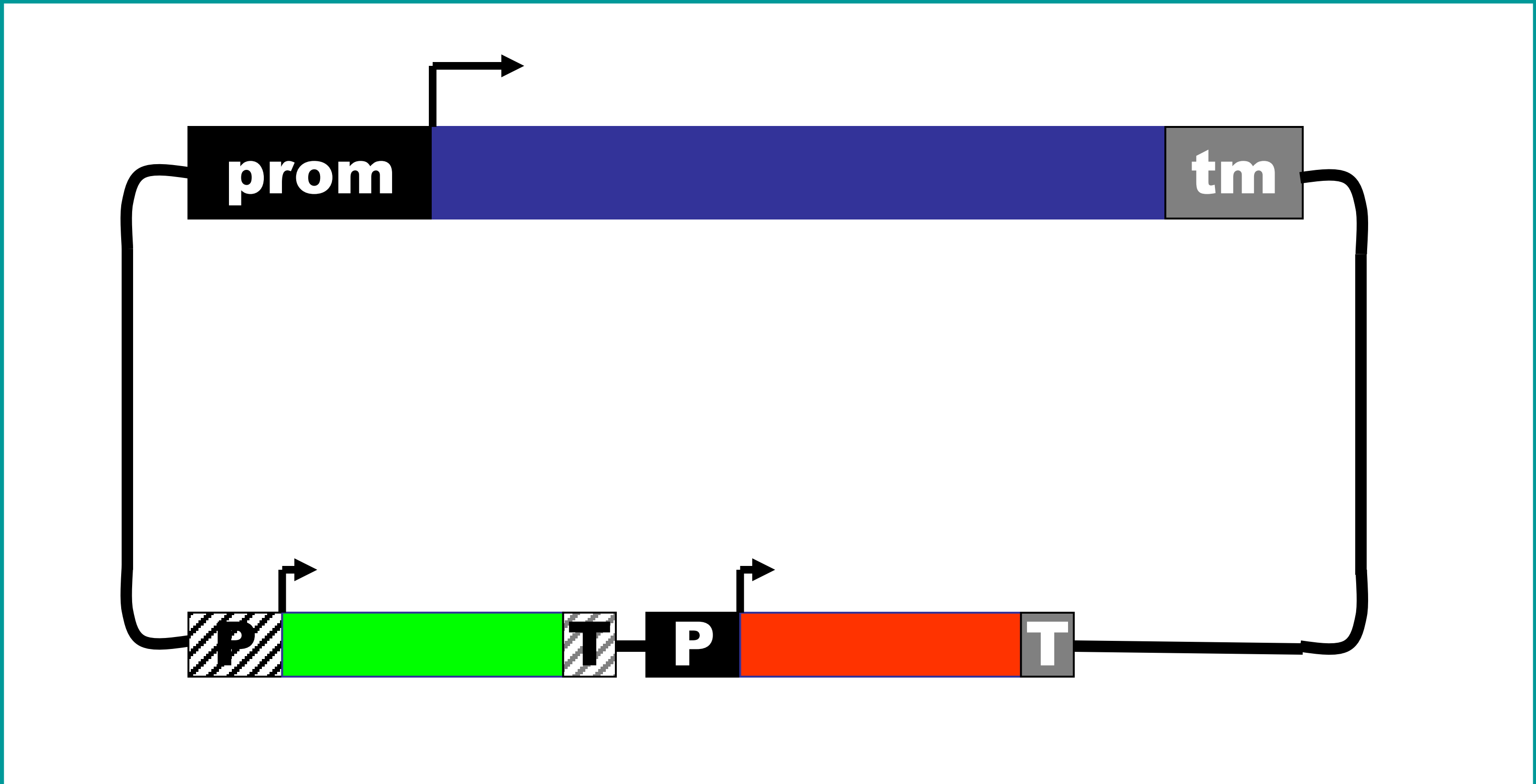


Transformación de discos de hoja mediante infección con *A. tumefaciens*

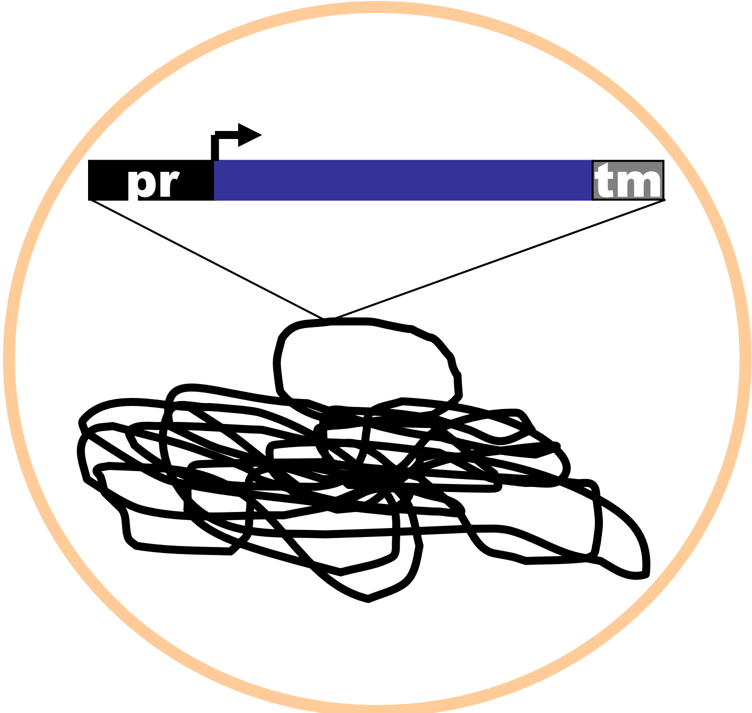


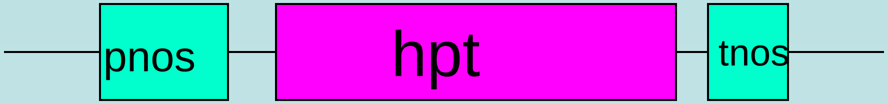
Como se obtiene una planta transgénica?

construcción de un gen quimérico

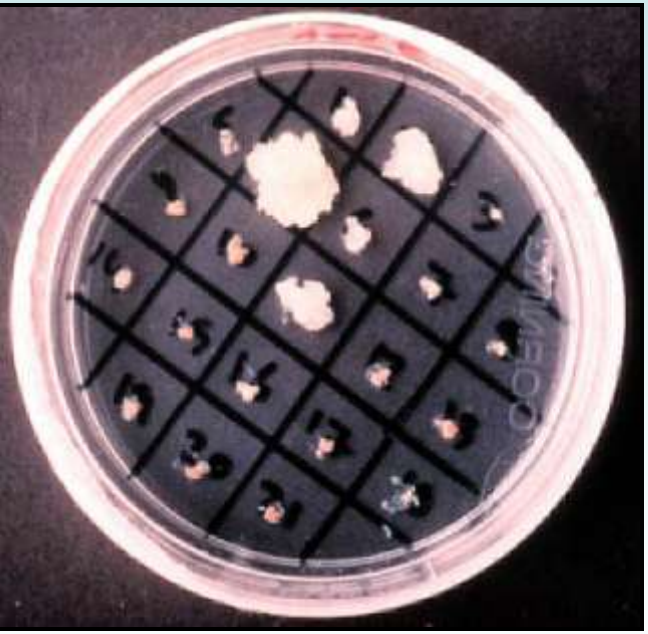


El gen transferido se inserta al azar en el genoma

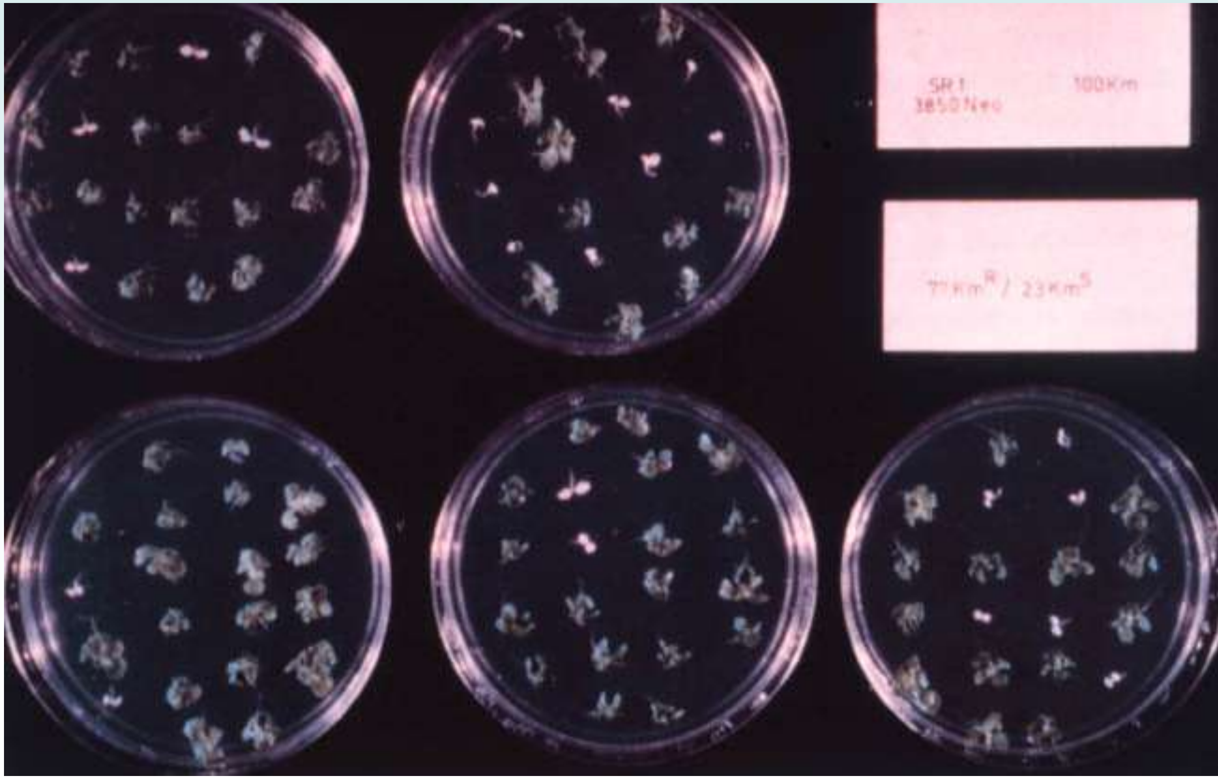




selecció: 100 mg/L kanamicina



$Km^R:Km^S$ 3:1



Genetic Engineering of Plants

Agricultural Research Opportunities and Policy Concerns

Board on Agriculture
National Research Council

NATIONAL ACADEMY PRESS
Washington, D.C. 1984

"Only a handful of serious safety questions remain for RAC to consider," Thornton said. Among those is the release of genetically engineered organisms into the environment. "We're not talking about working with new organisms in the laboratory. We're talking about what recombinant life forms can be put in an oil well."

Other issues may emerge as the genetic engineering of plants nears application. In deciding what, if any, regulatory approach to take, the RAC or any other oversight body will need to draw on the knowledge of agricultural scientists, ecologists, and others. "One of the things that may have gone wrong six or seven years ago, that may have contributed to the public outcry over recombinant DNA research, is that the molecular biologists who were involved did not have the benefit of input from immunologists, epidemiologists, and others who could have helped them to assess the dangers. Because of this lack of knowledge, the restrictions initially applied were perhaps too severe. We have an opportunity to learn from that mistake. By drawing on the expertise of a number of disciplines, we can develop an approach that both satisfies the concerns for safety, yet does not unduly restrict the application of new research methods."

1

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

AGENCY: Executive Office of the President, Office of Science and Technology Policy.

51 FR 23302

June 26, 1986

Coordinated Framework for Regulation of Biotechnology

ACTION: Announcement of policy; notice for public comment.

SUMMARY: This Federal Register notice announces the policy of the federal agencies involved with the review of **biotechnology** research and products. As certain concepts are new to this policy, and will be the subject of rulemaking, the public is invited to comment on these aspects which are specifically identified herein.

DATE: Comments must be received on or before August 25, 1986.

Public Participation: The Domestic Policy Council Working Group on **Biotechnology** through the Office of Science and Technology Policy, is seeking advice on certain refinements published herein to the previously published proposed coordinated framework for regulation of **biotechnology.** These new aspects include the **Biotechnology** Science Coordinating Committee's (BSCC's) definitions for an "integeneric organism (new organism)" and for "pathogen." These definitions are critical to the coordinated framework for the regulation of **biotechnology** because they establish the types of the organisms subject to certain kinds of review.

It is the intention of the Domestic Policy Council Working Group on **Biotechnology, the Biotechnology** Science Coordinating Committee (BSCC), the Department of Agriculture (USDA), the Environmental Protection Agency (EPA), the Food and Drug Administration (FDA), the National Institutes of Health (NIH), the National Science Foundation (NSF), and the Occupational Safety and Health Administration (OSHA) that the policies contained herein be effective immediately. In consideration of comments, modifications, if any, may be published either in a separate notice or as part of proposed rulemaking by the involved agencies.

Directiva Europea 90/220

Council Directive 90/220/EEC of 23 April 1990 on the deliberate release into the environment of genetically modified organisms

(JO No L 117 du 8. 5. 1990, p. 15)

(This Directive was modified by Commission Directive 94/15/EC of 15 April 1994 introducing an adaptation of Annex II for releases of genetically modified higher plants (OJ No L 103, 22. 4. 1994, p. 20)

Whereas living organisms, whether released into the environment in large or small amounts for experimental purposes or as commercial products, may reproduce in the environment and cross national frontiers thereby affecting other Member States; whereas the effects of such releases on the environment may be irreversible;

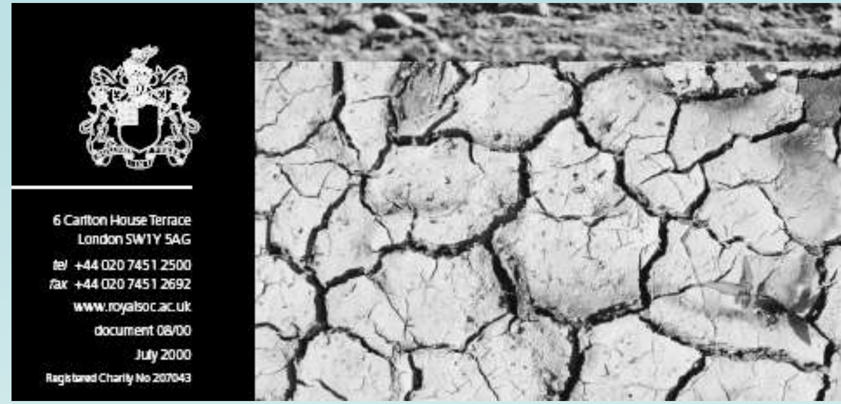
Whereas the protection of human health and the environment requires that due attention be given to controlling risks from the deliberate release of genetically modified organisms (GMOs) into the environment;

Whereas disparity between the rules which are in effect or in preparation in the Member States concerning the deliberate release into the environment of GMOs may create unequal conditions of competition or barriers to trade in products containing such organisms, thus affecting the functioning of the common market; whereas it is therefore necessary to approximate the laws of the Member States in this respect;

Whereas measures for the approximation of the provisions of the Member States which have as their object the establishment and functioning of the internal market should, inasmuch as they concern health, safety, environmental and consumer protection, be based on a high level of protection throughout the Community;

Whereas it is necessary to establish harmonized procedures and criteria for the case-by-case evaluation of the potential risks arising from the deliberate release of GMOs into the environment;

Whereas a case-by-case environmental risk assessment should always be carried out prior to a release;



2 Summary

2.1 It is essential that we improve food production and distribution in order to feed and free from hunger a growing world population, while reducing environmental impacts and providing productive employment in low-income areas. This will require a proper and responsible utilisation of scientific discoveries and new technologies. The developers and overseers of GM technology applied to plants and micro-organisms should make sure that their efforts address such needs.

2.2 Foods can be produced through the use of GM technology that are more nutritious, stable in storage and in principle, health promoting - bringing benefits to consumers in both industrialised and developing nations.

2.3 New public sector efforts are required for creating transgenic crops that benefit poor farmers in developing nations and improve their access to food through employment-intensive production of staples such as maize, rice, wheat, cassava, yams, sorghum, plantains and sweet potatoes. Cooperative efforts between the private and public sectors are needed to develop new transgenic crops that benefit consumers, especially in the developing world.

2.4 Concerted, organised efforts must be undertaken to investigate the potential environmental effects, both positive and negative, of GM technologies in their specific applications. These must be assessed against the background of effects from conventional agricultural technologies that are currently in use.

2.5 Public health regulatory systems need to be put in place in every country to identify and monitor any potential adverse human health effects of transgenic plants, as for any other new variety.

2.6 Private corporations and research institutions should make arrangements to share GM technology, now held under strict patents and licensing agreements, with responsible scientists for use for hunger alleviation and to enhance food security in developing countries. In addition, special exemptions should be given to the world's poor farmers to protect them from inappropriate restrictions in propagating their crops.

Aspectos relativos a la inocuidad de los alimentos de origen vegetal genéticamente modificados

Informe de una Consulta Mixta FAO/OMS de Expertos sobre Alimentos Obtenidos por Medios Biotecnológicos

Sede de la Organización Mundial de la Salud
Ginebra, Suiza
29 de mayo a 2 de junio de 2000

7. Conclusiones

1. La Consulta acordó que la evaluación de la inocuidad de los alimentos genéticamente modificados exige un método integrado y gradual, caso por caso, que puede ser apoyado por una serie estructurada de preguntas. El criterio comparativo centrado en la determinación de similitudes y diferencias entre el alimento genéticamente modificado y su homólogo convencional contribuye a definir cuestiones potenciales en materia nutricional y de inocuidad y se considera la estrategia más apropiada para la evaluación nutricional y de la inocuidad de los alimentos genéticamente modificados.

Aplicación de la directiva 2001/18

Safeguard clause

1. Where a Member State, as a result of new or additional information made available since the date of the consent and affecting the environmental risk assessment or reassessment of existing information on the basis of new or additional scientific knowledge, has detailed grounds for considering that a GMO as or in a product which has been properly notified and has received written consent under this Directive constitutes a risk to human health or the environment, that Member State may provisionally restrict or prohibit the use and/or sale of that GMO as or in a product on its territory.

The Member State shall ensure that in the event of a severe risk, emergency measures, such as suspension or termination of the placing on the market, shall be applied, including information to the public.

The Member State shall immediately inform the Commission and the other Member States of actions taken under this Article and give reasons for its decision, supplying its review of the environmental risk assessment, indicating whether and how the conditions of the consent should be amended or the consent should be terminated, and, where appropriate, the new or additional information on which its decision is based.

Article 28

Consultation of Scientific Committee(s)

1. In cases where an objection as regards the risks of GMOs to human health or to the environment is raised by a competent authority or the Commission and maintained in accordance with Article 15(1), 17(4), 20(3) or 23, or where the assessment report referred to in Article 14 indicates that the GMO should not be placed on the market, the relevant Scientific Committee(s) shall be consulted by the Commission, on its own initiative or at the request of a Member State, on the objection.

2. The relevant Scientific Committee(s) may also be consulted by the Commission, on its own initiative or at the request of a Member State, on any matter under this Directive that may have an adverse effect on human health and the environment.

Article 29

Consultation of Committee(s) on Ethics

1. Without prejudice to the competence of Member States as regards ethical issues, the Commission shall, on its own initiative or at the request of the European Parliament or the Council, consult any committee it has created with a view to obtaining its advice on the ethical implications of biotechnology, such as the European Group on Ethics in Science and New Technologies, on ethical issues of a general nature.

This consultation may also take place at the request of a Member State.

2. This consultation is conducted under clear rules of openness, transparency and public accessibility. Its outcome shall be accessible to the public.

3. The administrative procedures provided for in this Directive shall not be affected by paragraph 1.

EFSA European Food Safety Authority

Home Page
About EFSA
Road map to EFSA
EFSA Structure
Interim Scientific Advisory Forum
Publications
Speeches
Press
Procurement
Recruitment
Links

About the European Food Safety Authority

The primary responsibility of the Authority will be to provide independent scientific advice on all matters with a direct or indirect impact on food safety.

The Authority has been given a wide brief, so that it can cover all stages of food production and supply, from primary production to the safety of animal feed, right through to the supply of food to consumers. It will gather information from all parts of the globe, keeping an eye on new developments in science.

It will share its findings and listen to the views of others through a vast network that will be developed over time, as well as interacting with experts and decision-makers on many levels. A key task of the Authority will be to communicate directly with the public on its areas of responsibility.

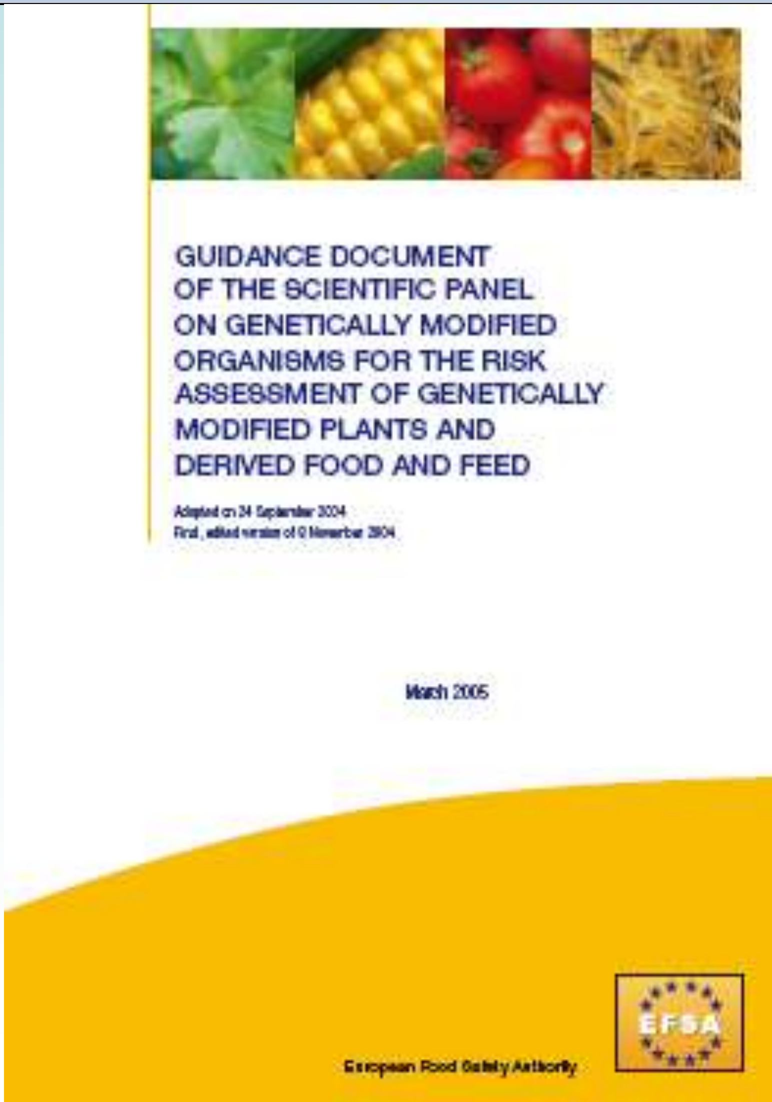
Although the Authority's main "customer" will be the Commission, it will be open to respond to scientific questions from the European Parliament and the Member States and it can also initiate risk assessments on its own behalf.

The Authority will carry out assessments of risks to the food chain and indeed can carry out scientific assessment on any matter that may have a direct or indirect effect on the safety of the food supply, including matters relating to animal health, animal welfare and plant health.

The Authority will also give scientific advice on non-food and feed GMOs, and on nutrition in relation to Community legislation.

→Legal basis for the European Food Safety Authority

Guía de EFSA para el análisis del riesgo asociado a las plantas transgénicas y productos derivados para consumo animal o humano



- Adoptada el 24 de septiembre de 2004,
- Revisada el deciembre 2005 (PMEM)
- Nueva revisión en curso (2008)
- Completada
  - Diciembre 2006 (Renovaciones)
  - Marzo 2007 (Eventos combinados)

Elementos principales del análisis de riesgo

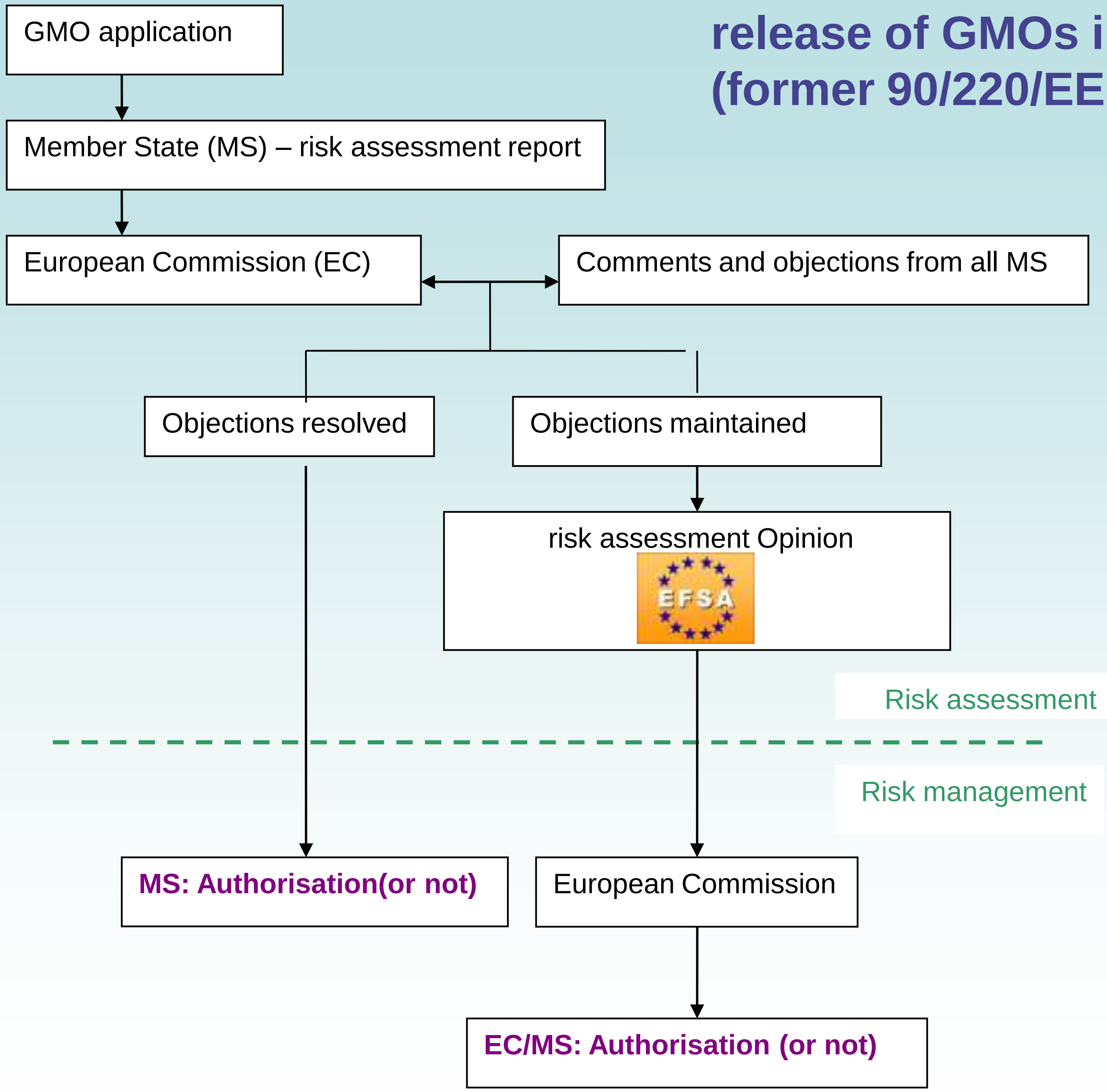
- Caracterización Molecular :
  - Análisis del DNA introducido, expresión de proteínas y sus consecuencias

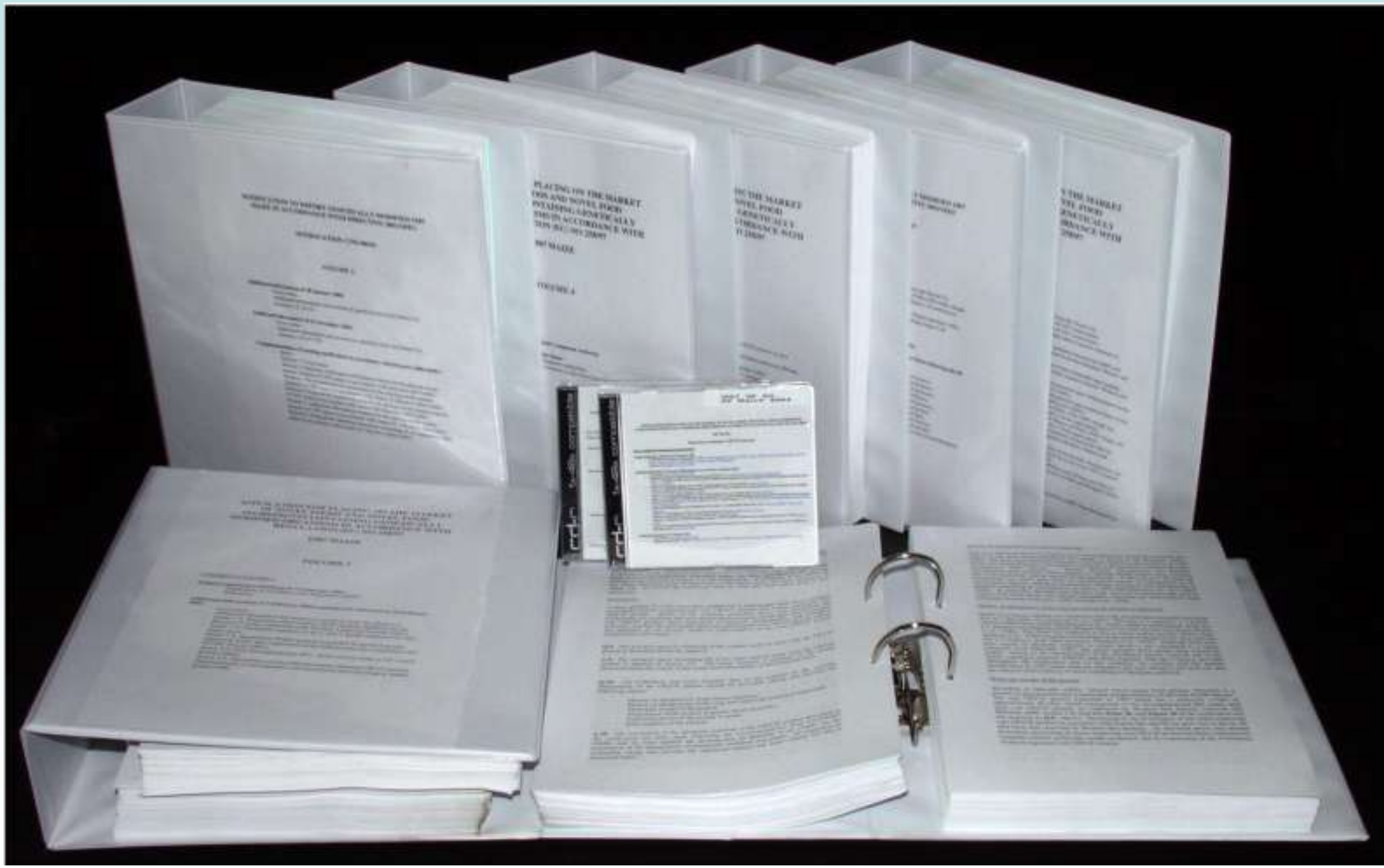
- Alimentación humana y animal
  - Atención especial sobre Toxicidad, Alergenicidad y Nutrición

  (análisis de la composición, rendimiento agronómico, tests de alimentación animal,…)

- Análisis ambiental
  - Incluyendo la evaluación del impacto potencial sobre la fauna y la flora presente en los campos o los espacios naturales

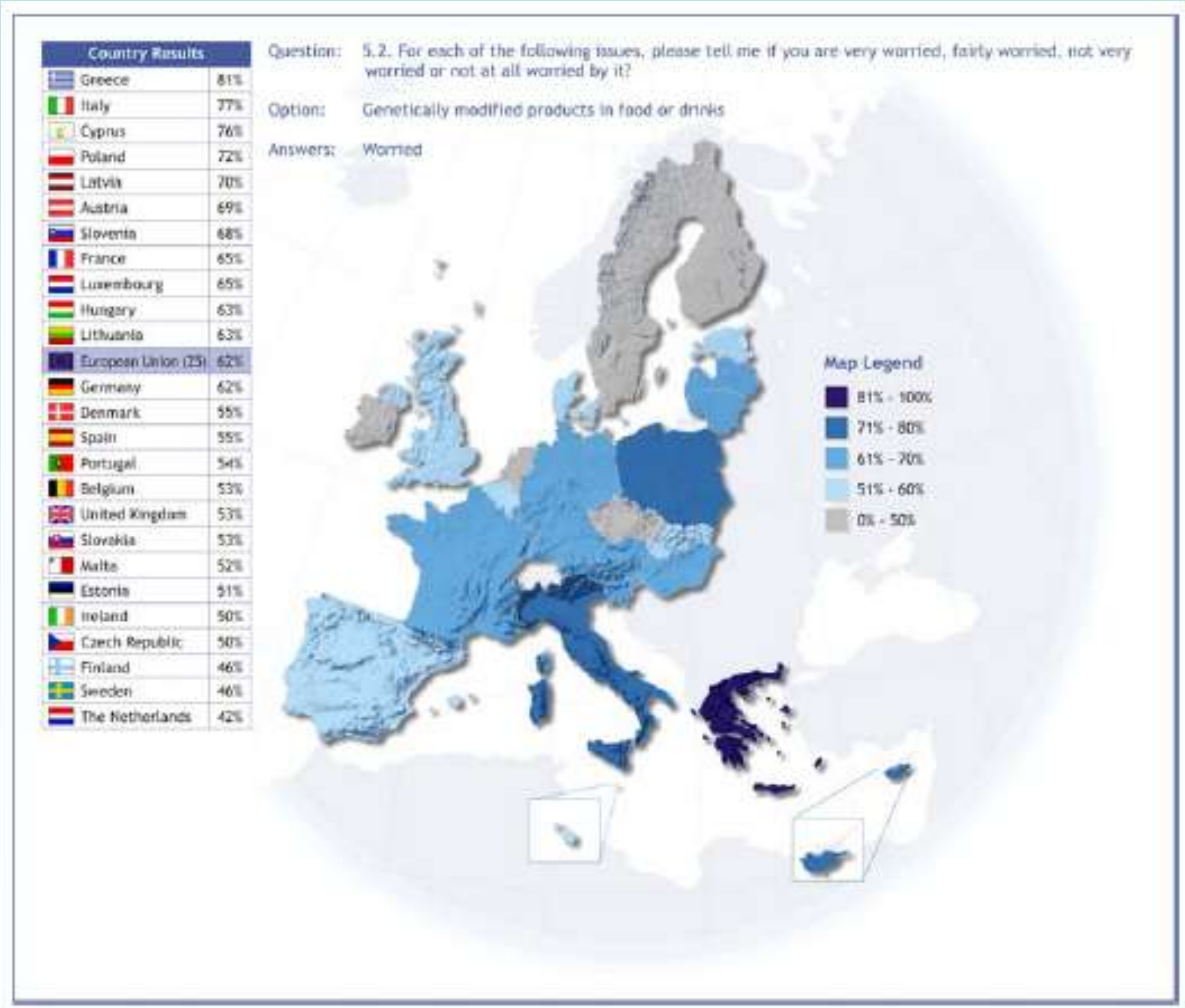
Directive 2001/18/EC – deliberate release of GMOs into environment (former 90/220/EEC)



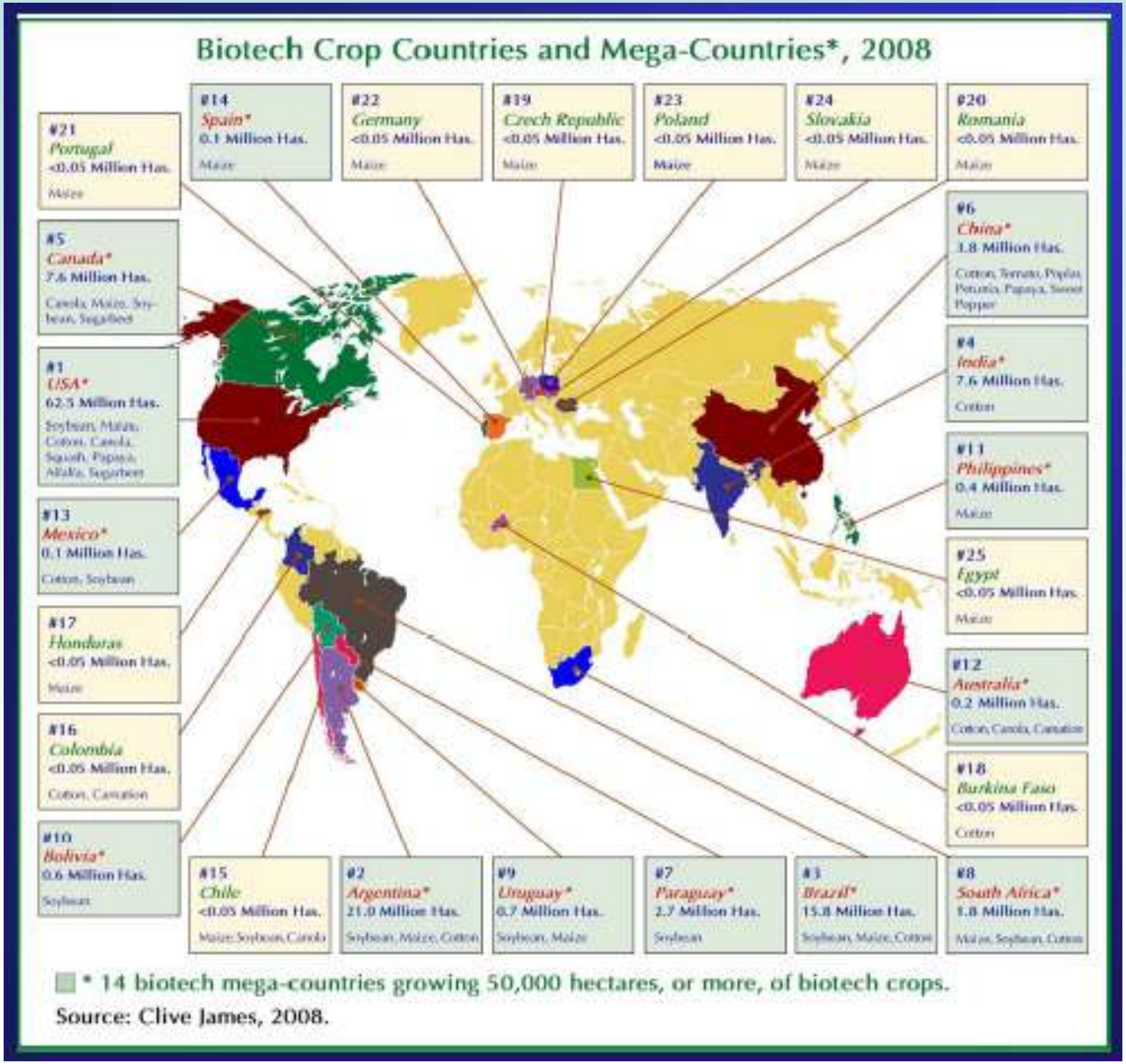


A pesar de ello…

Eurobarómetro 2006



Situación en 2008



Plantas resistentes a herbicidas

maiz (GA21), soja (GTS40-3-2), colza (GT73), algodón (MON14451698)

Shikimato

EPSPS

bacterias
levaduras
plantas

Aminoacidos aromáticos

Source: Monsanto

Shikimato

EPSPS

Agrobacterium CP4
Zea mays modif.

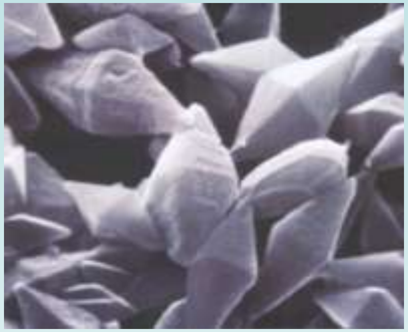
Aminoácidos aromáticos

Glifosato (Roundup®)

EPSPS: 5-enolpyruvylshikimate-3-phosphate synthase

Resistentes a insectos

maize Bt176, Bt11, YieldGard ® and cotton Bollgard ®



Bt protein crystals
Bacillus thuringiensis

Caterpillar-like insect larvae
Ostrinia nubilalis y *Sesamia nonagrioides*

cry IA(b)

↓

Bt protein
(δ-endotoxin)

↓

Binding to specific insect receptors causes paralysis of the digestive system

Table 1: Global Biotech Crop Area: Leading Countries

Five leading counties	Area in biotech crop production	Share of world biotech area	biotech crop varieties:
	67.5 million hectares	**98%**	
United States	42.8 million hectares	63%	maize, cotton, soy, canola
Argentina	13.9 million hectares	21%	soy, maize, cotton
Canada	4.4 million hectares	6%	canola, maize, soy
Brazil	3.0 million hectares	4%	soy
China	2.8 million hectares	4%	cotton

Source: James, 2003.

Table 2: Global Biotech Crop Value: Leading Countries

2003/04	Biotech-related crop value*		2003/04	Biotech-related crop value*
Five countries:	**$43.9 billion**		**Four crops:**	**$43.9 billion**
United States	$27.5 billion		Soybean	$23.5 billion
Argentina	$8.9 billion		Maize	$11.2 billion
China	$3.9 billion		Cotton	$7.8 billion
Canada	$2.0 billion		Canola	$1.4 billion
Brazil	$1.6 billion			

* Market value of crop production associated with biotech plant varieties

Source: USDA (2004a,b); FAO (2004); FAPRI (2004); James (2003).

¿Qué hacemos nosotros?

- Introducir en el debate la ciencia más rigurosa posible
- Ayudar a mantener credibilidad en la ciencia
- Participar en la reflexión política, económica e intelectual
- Buscar alternativas en la Genómica

Examples of samples analyzed

Productos en los que se ha detectado DNA del inserto

Maiz

Grano de maíz
Harina de maíz
Harinas mezcladas (con trigo y arroz)
Maíz dulce en grano
Sémola
Polenta
Papilla infantil
Carne picada
Crema de champiñones
Cacao en polvo
Cereales extrudados
Maíz frito
Fritos
Palomitas
Barquillo
Aceite crudo

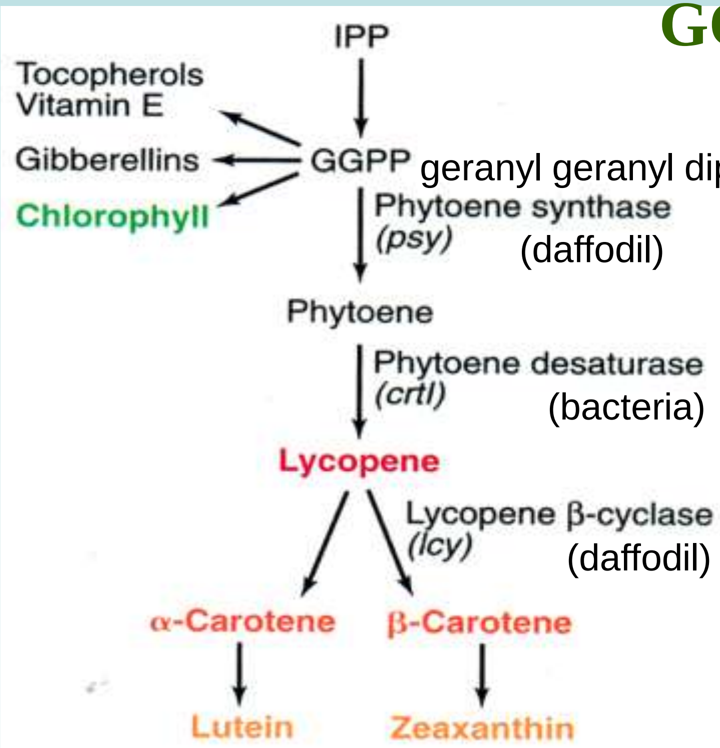
Galletas
Pan rallado
Magdalenas
Cobertura
Crema de licor
Almidones
Fécula de maíz
Sorbitol
Gluten
Glucosa atomizada
Dextrosa
Extracto de malta
Fructosa
Colorante (especia con harina de maíz)
Cervezas
Tomate tipo “ketchup”

Soja

Habas de soja
Aislado de soja
Lecitina
Concentrados proteicos
Proteína texturizada
Complementos dietéticos
Papilla infantil

Embutidos
Carne picada
Galletas
Paté
Extractos enriquecidos en vitaminas o esteroides
Aceite crudo

GOLDEN RICE



Ferritin, rich iron storage protein

Phytase, breaks down phytate to make iron available

cystein-rich metallothionein like protein, facilitates iron resorption

Ye *et al*., Science 287, 303-305 (2000)

- Polished rice lacks provitamin A
- Some 124 million children estimated to be vitamin A deficient
- Engineered to produce pro-vitamin A in the endosperm, and to increase iron uptake and resorption

La Fundació Melinda i Bill Gates finança el projecte

Grand Challenges in Global Health

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Home > 4 Improve Nutrition > Challenges > 9 Nutrient-Rich Plants > Improving Rice for High Beta-Carotene, Vitamin E, and Enh

PRIMARY INVESTIGATOR:

Dr. Peter Beyer, Albert-Ludwigs-Universität Freiburg, Germany - DE

Engineering Rice for High Beta Carotene, Vitamin E and Enhanced Fe and Zn Bioavailability

Research Objectives

Collaborators

Project Progress & Milestones

Poor nutrition is a major global health problem, contributing to half of the nearly 10 million deaths that occur each year in children younger than 5. Although rice is a primary source of food for much of the world's population, it is a poor source of many essential micronutrients, as well as protein. As a result, widespread reliance on rice is the primary cause of micronutrient malnutrition throughout much of the developing world. A promising long-term solution to this problem is to genetically modify crops, including rice, so that they have high levels of essential nutrients.

Dr. Beyer is leading an international, collaborative effort called the ProVitaMinRice Consortium. The consortium's members are developing new varieties of rice with increased levels or bioavailability of pro-vitamin A, vitamin E, iron, and zinc as well improved protein quality and content. As their platform, the consortium's researchers are using Golden Rice, which has been genetically engineered to produce and accumulate pro-vitamin A in the grain, and are working with novel transgene-based technologies to enhance the availability of the target nutrients. The project plans to incorporate the new rice lines as well as Golden Rice into ongoing breeding and seed delivery programs for developing countries, and to make the products freely available to low-income farmers in the developing world.

Research Objectives:

- Stack multiple micronutrient and bioavailability traits into Golden Rice
- Identify the genetic and biochemical basis of mineral bioavailability in plant-based foods
- Assess the bioavailability of iron in human subjects, using pro-vitamin A- improved rice lines
- Improve protein quality and content, particularly with regard to lysine
- Introduce novel traits from transgenic lines into regional rice cultivars through conventional breeding

Tomates azules (Octubre 2008)

nature biotechnology

Enrichment of tomato fruit with health-promoting anthocyanins by expression of select transcription factors

Eugenio Butelli[1], Lucilla Titta[2], Marco Giorgio[2], Hans-Peter Mock[3], Andrea Matros[3], Silke Peterek[3], Elio G W M Schijlen[4], Robert D Hall[5], Arnaud G Bovy[4], Jie Luo[1] & Cathie Martin[1]

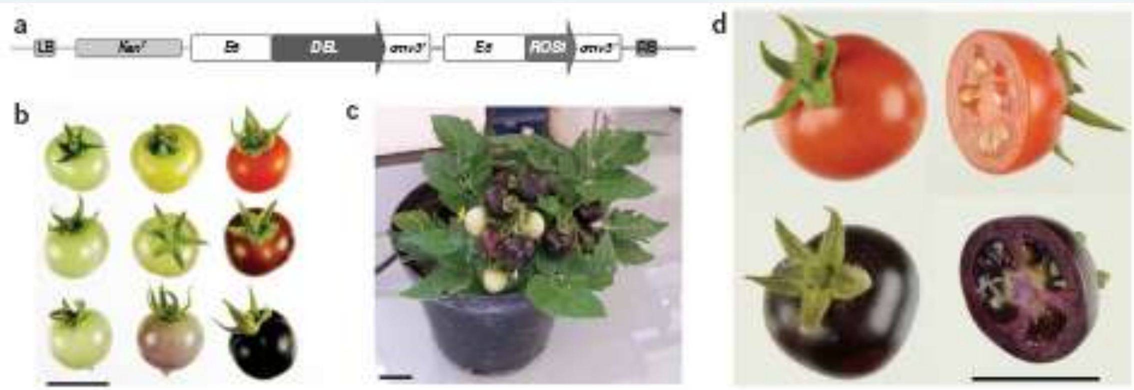

Figure 1 Fruit-specific phenotypes of T1 generation tomatoes (cv. MicroTom) expressing both *Del* and *Ros1* under the control of the *E8* promoter. (a) Map of T-DNA region of the binary vector used for transformation. LB, left T-DNA border region; RB, right T-DNA border region; Kan^r, *nptII* gene conferring kanamycin resistance under the control of the *nos* promoter; *camv3'*, terminator region of cauliflower mosaic virus. (b) Phenotypic analysis of wild-type (upper row), *Del/Ros1C* (middle) and *Del/Ros1N* (lower) tomato fruit harvested at the green (left column), breaker (middle) and red (right) ripening stages. (c) *Del/Ros1N* tomato plant showing fruit at different stages of ripening. (d) Whole and cross-section of ripe wild-type and *Del/Ros1N* tomato fruit. All scale bars, 2 cm.

SemBioSys

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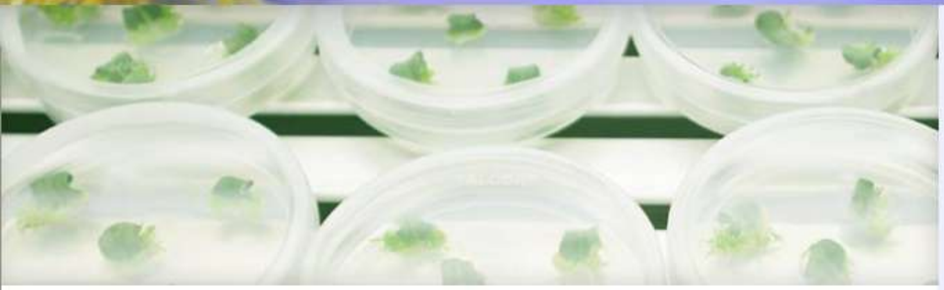


Creating Biotechnology Solutions

Who is SemBioSys

SemBioSys Genetics Inc. is a plant biotechnology company with a powerful technology that enables production of high-value pharmaceutical and non-pharmaceutical products in an affordable and sustainable manner.

Why Safflower?

- Safflower is a highly productive oilseed crop whose seed can be stored for extended periods of time
- Safflower is a low acreage crop, so it can be easily separated from other safflower production
- Safflower is predominantly self-pollinating and has no weedy relatives
- SemBioSys has secured significant patent protection for the use of safflower in protein production

Our Solution

To answer this need, SemBioSys is producing human insulin from genetically engineered safflower. We believe our plant-made insulin will offer dramatic reductions in capital and operating costs and provide an accessible source of insulin to meet this exploding demand. In fact, SemBioSys could meet this increased demand with just three commercial farms.

What We Have Accomplished

We have achieved commercial levels of insulin production in safflower and demonstrated that our insulin is physically, structurally and functionally identical to pharmaceutical-grade human insulin. Discussions with the US Food and Drug Administration (FDA) have confirmed that safflower-produced insulin is eligible to follow a shortened drug approval process and we have filed an Investigational New Drug (IND) application to the FDA.

What We Are Working On

We have submitted a Clinical Trial Application (CTA) to the appropriate European authorities and, pending feedback, will initiate a Phase I/II clinical trial in the UK this year.

Se aprueba un fármaco producido en cabras transgénicas

FDA News

FOR IMMEDIATE RELEASE
February 6, 2009

Media Inquiries:
Siobhan DeLancey, 301-796-4668
Consumer Inquiries:
888-INFO-FDA

FDA Approves Orphan Drug ATryn to Treat Rare Clotting Disorder

The U.S. Food and Drug Administration today issued its first approval for a biological product produced by genetically engineered (GE) animals.

The approval is for ATryn, an anticoagulant used for the prevention of blood clots in patients with a rare disease known as hereditary antithrombin (AT) deficiency. These patients are at high risk of blood clots during medical interventions, such as surgery, and before, during and after childbirth.

ATryn is a therapeutic protein derived from the milk of goats that have been genetically engineered by introducing a segment of DNA into their genes (called a recombinant DNA or rDNA construct) with instructions for the goat to produce human antithrombin in its milk. Antithrombin is a protein that naturally occurs in healthy individual and helps to keep blood from clotting in the veins and arteries.

GTC Biotherapeutics, Inc., the manufacturer of ATryn, received approvals from two FDA centers. The Center for Biologics Evaluation and Research (CBER) approved the human biologic based on its safety and efficacy, and the Center for Veterinary Medicine (CVM) approved the rDNA construct in the goats that produce ATryn.

Concentración de compañías de semillas

La discusión sobre las patentes

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.

Inversiones en China!

Big funding for GM research

26 March 2008

Hepeng Jia/**Beijing, China**

China is to launch a huge research programme on genetically modified (GM) crops by the end of the year, according to top agricultural biotechnology advisors.

Huang Dafang, former director of the Chinese Academy of Agricultural Sciences' (CAAS) Institute of Biotechnologies, says the programme could receive as much as 10 billion yuan (US$1.4 billion) over the next five years - five times more than the country spent on GM research in the preceding five years.

A member of the Chinese People's Political Consultative Conference (CPPCC), China's upper house, and a key government advisor on biotechnology policies, Huang revealed the news at a briefing on the annual report of the International Service for the Acquisition of Agri-Biotech Applications (ISAAA), a non-profit organisation promoting agricultural biotechnology.

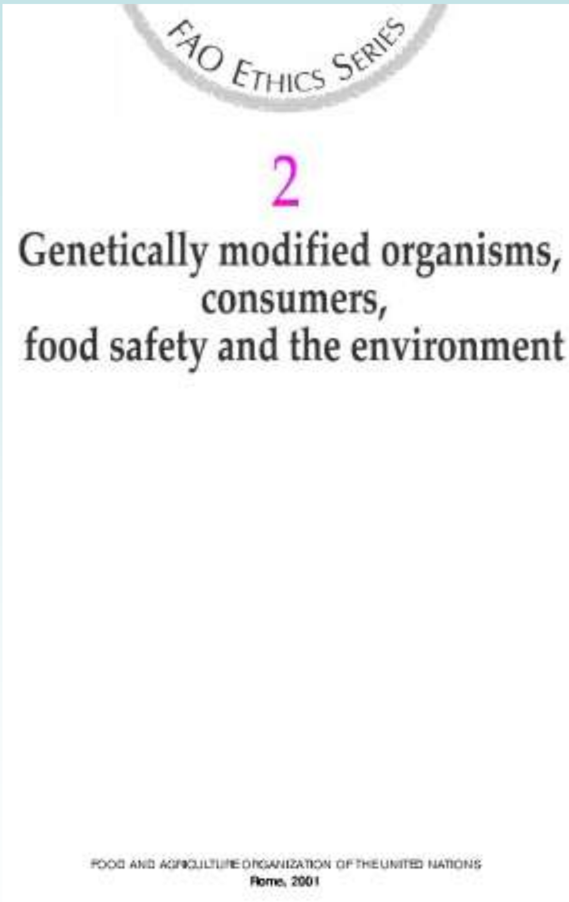
The ISAAA report indicates in 2007 a total of 114.3 million hectares of GM crops were cultivated worldwide - an increase of 18.3 per cent from 2006.

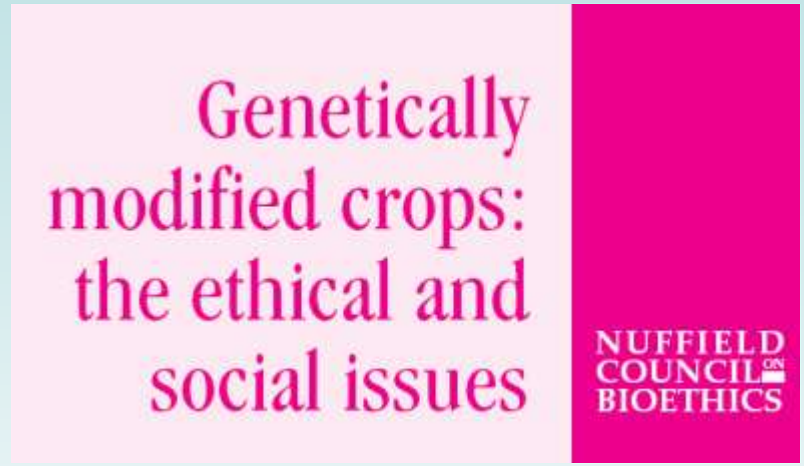
The most widely adopted GM crop is Bt cotton, engineered to produce a toxin from Bacillus thuringiensis (Bt) to fight bollworm. China has developed GM petunias, tomatoes, sweet peppers, poplar and papaya, and several varieties of rice but to date policymakers have only allowed GM cotton to be marketed.

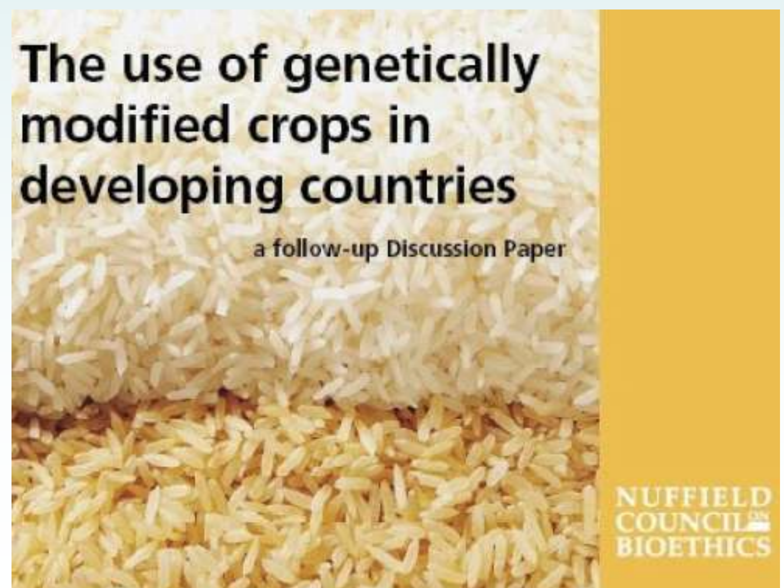
Huang says that yield, quality, nutritional value and drought resistance will be major targets of the new research programme. As well as rice and cotton - which have been the focus of GM technology research in the past - corn and wheat will also now be priority crops for research.

Receptive farmers

Discusiones éticas



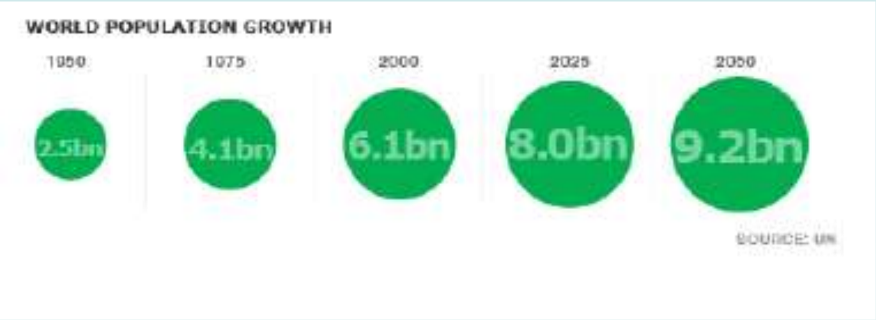


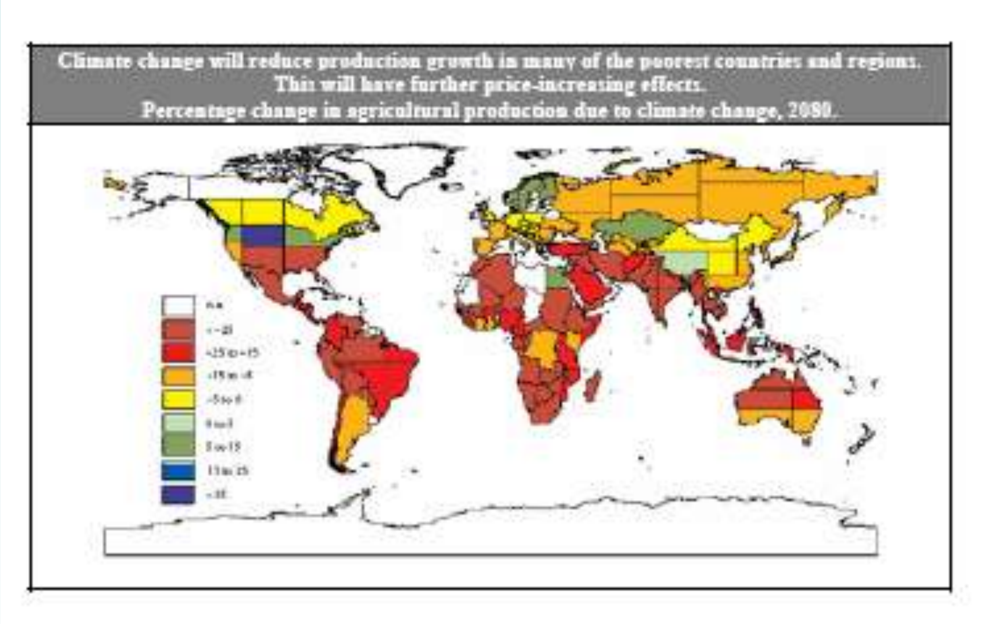


Preocupaciones al inicio del siglo XXI

- Preocupaciones relacionadas con la producción de alimentos: Problemas de hambre, alimentos seguros y sanos
- Preocupaciones relacionadas con los efectos de la agricultura sobre el medio ambiente: Pérdida de biodiversidad. Degradación del medio ambiente, deforestación, uso y contaminación del agua, contribución al cambio climático

Una ecuación compleja



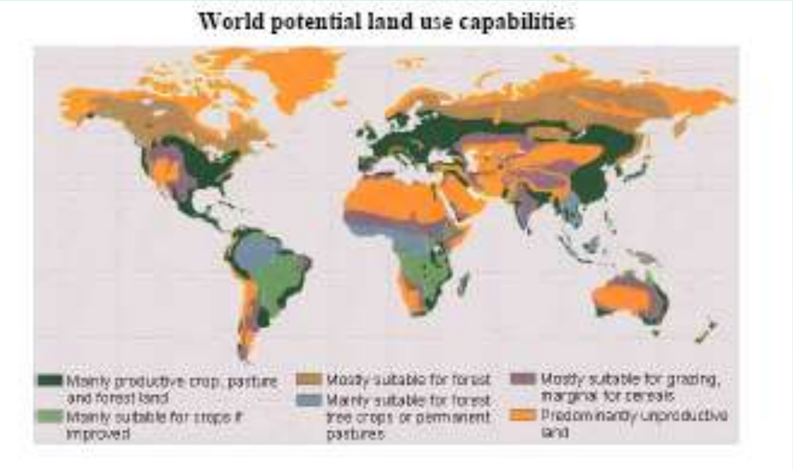


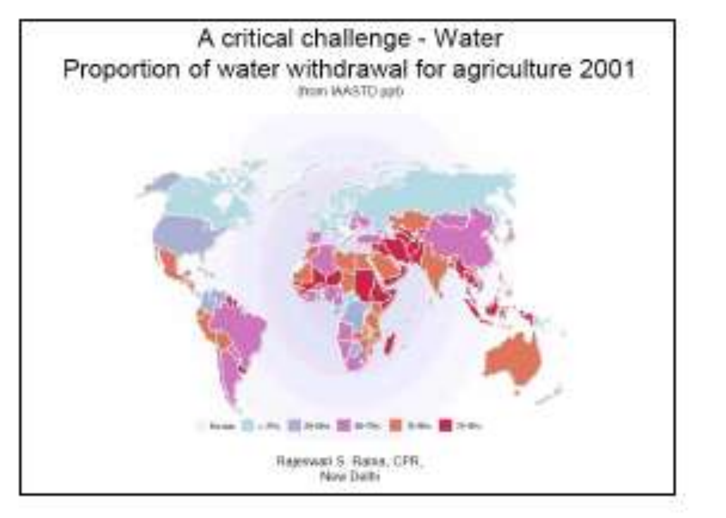
1990/2005 ratios of per capita consumption (FAO)	India	China	Brazil	Nigeria
Cereals	1.0	0.8	1.2	1.0
Meat	1.2	2.4	1.7	1.0
Milk	1.2	3.0	1.2	1.3
Fish	1.2	2.3	0.9	0.8
Fruit	1.3	3.5	0.8	1.1
Vegetables	1.3	2.9	1.3	1.3

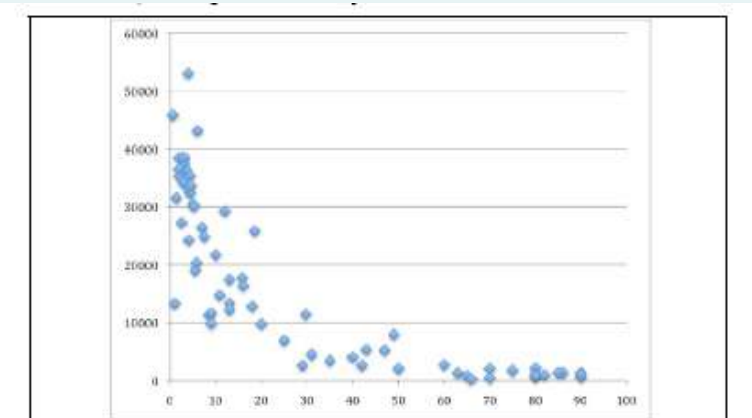
Preocupaciones al inicio del siglo XXI

- Preocupaciones relacionadas con las condiciones sociales y políticas: Inestabilidad política. Disrupción de estructuras sociales y la urbanización masiva. Control sobre el control de los alimentos. Conflictos en el comercio internacional
- Preocupaciones relacionadas con la situación global cambiante: Crecimiento de la población, globalización de amenazas (pestes, etc.), cambio climático, reducción de las reservas de petróleo

Una ecuación compleja







Plot of GDP per capita against proportion of the population involved in agriculture. The graph demonstrates that the proportion of people involved in agriculture is much greater in poorer countries than in the richer countries. Data derived from the CIA World Factbook (July 2008), ISSN 1553-8133.

Urbanization and industrialization in emerging world economies. The balance of global population is shifting to urban areas, with rapid growth of major cities in developing nations, in particular. By 2015, experts project that there will be at least 550 cities around the world with populations of at least one million. By 2050, there could be more than 400 "megacities" with populations of more than 10 million, up from 18 today. Cities have absorbed nearly two thirds of the global population explosion since 1950 and are currently growing by a million inhabitants each week.[3]

The European Group on Ethics

in Science and New Technologies to the European Commission

The group is an independent, pluralist and multidisciplinary body which advises the European Commission on ethical aspects of science and new technologies.

EGE 2005-2009

- For its third mandate, the EGE has grown in size from 12 to 15 members. The President of the European Commission José Manuel Barroso decided to re-appoint six members of the previous group: Göran Hermerén, Linda Nielsen, Rafael Capurro, Inez de Beaufort, Pere Puigdomenèch Rosell and Günter Virt, and invited the following nine new members join the group: Emmanuel Agius, Diana Bánáti, Anne Cambon-Thomsen, Carlo Casini, Jozef Glaza, Hille Haker , Julian Kinderlerer, Krzysztof Marczewski and Paula Martinho da Silva.

Questions addressed to the Group (2005-2009)

- Ethical aspects of Nanomedicine (December 2006)
- Ethical criteria for the approval of european research projects using embryo stem cells of human origin (June 2007)
- Ethical aspects of consumption of meat from cloned animals (January 2008)
- Ethical aspects of new developments in agriculture (January 2009)
- Synthetic Biology (October 2009?)

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 -

Resumen de la opinión

10.2.1 The right to food

The starting point of any ethical agricultural policy must be the obligation of States and of the international community to secure all human beings' right to food. Agricultural policies at national, EU and international levels must therefore aim, first and foremost, to secure access to food at regional, national and international levels, so that everyone has sufficient access to safe and healthy food corresponding to their particular cultural background and available scientific data.

10.2.3 Food safety

The Group considers food safety a prerequisite for production and marketing of food products from arable agriculture, including imports of agricultural commodities and products from third countries, and calls on the competent authorities to monitor enforcement of food safety provisions. The Group supports the work done by the EU, Member States and relevant bodies (EFSA in particular) on enforcement of food safety standards and considers it necessary that:

- EU food safety standards have to be based on scientific data only;
- If EU food safety standards for food products from arable agriculture differ from international standards, they must be scientifically justified.

- Importancia de crear tradiciones adecuadas con una comida segura y sana

10.5.3 Food waste

The concept of food waste concerns different levels (production, storage, transport, distribution and consumption) and has strong ethical implications for social and distributive justice. As indicated in section 4.8 of this Opinion, it seems probable that the phenomenon of food waste has taken on very high proportions, The Group is aware that waste is a key issue in the context of food security, safety and sustainability. Appropriate technologies should be developed and applied in modern agriculture to reduce and/or recycle food waste. The EGE also proposes quantitative and qualitative analysis of waste dynamics at national and supranational levels, along with research into optimisation of waste recycling.

- Importancia de promover comportamientos responsables ante la comida

The Group is aware of the need to promote innovation in agriculture but it is equally aware that technologies alone cannot provide final solutions to the challenges modern agriculture is facing in the EU and worldwide. However, the Group supports all technologies in agriculture, insofar as they are conducive to the goals and priorities indicated in this Opinion. The Group also emphasises the need for an integrated view and an integrated approach on agricultural technologies, so that the production, storage and distribution processes are considered together when the ethical implications of any new technology are assessed.

10.2 The EGE's ethical approach to agriculture

The Group considers the goals of (1) food security, (2) food safety and (3) sustainability as first priorities and guiding principles to which any technology in agriculture must adhere. Therefore the Group recommends an integrated approach to agriculture, based on a system where its constituent units are balanced, not just at technical level (where there is continuous assessment of the balance between the input required, e.g. resources, energy, etc., and the outcomes expected to achieve its goals) but also at ethical level (where members of society act and interact on the basis of commonly held values).

The EGE calls for explicit embedding of ethical principles in agricultural policy (whether traditional or innovative) and argues that respect for human dignity and justice, two fundamental ethical principles, have to apply to production and distribution of food products too (see section 8.1). In addition, the EGE calls for impact assessment of agricultural technologies, as described in section 10.2.4 of this Opinion.

Posición sobre OGMs

10.3.4 GM crops

While agricultural scientists are debating the role of GM crops for food security (to increase production yields and the nutritional capacity of food products), the Group acknowledges that use of GM crops is controversial in the EU. In this debate, concerns have been expressed about possible risks of economic monopoly and to biosafety. The Group recognises that EU legislation and international treaties place an obligation on the EU to undertake a scientific risk assessment. The Group urges that the precautionary principle should be taken into account to make sure that all technologies avoid the risk of "serious or irreversible damage", as provided for in Principle 15 of the Rio Declaration on the Environment[245], and also of unwanted pleiotropic effects. The Group recommends that risk management procedures should be revised to take full account of the need for an impact assessment of all new technologies (see section 10.2.4). Food safety and environmental assessment should therefore be prerequisites for approval. In general, the Group takes the view that all agricultural technologies[246] should be sustained in the EU only if they are conducive to the goals of this Opinion and if they meet the ethical criteria indicated in it.

Prospective document. 2005-2025. June 2004

Journal of Experimental Botany, Vol. 56, No. 417, pp. 1699–1709, July 2005
doi:10.1093/jxb/eri212 Advance Access publication 6 June, 2005

European plant science: a field of opportunities

European Plant Science Organization (EPSO)*
European Plant Science Organization, Technologiepark 927, 9052 Gent, Belgium

Received 27 April 2005

Plants are the key to life on earth

Without plants, most life on earth would cease. Plants use energy from sunlight to convert carbon dioxide and inorganic nutrients into carbohydrates, proteins, fats, nucleic acids, and tens of thousands of other organic compounds. These are required by almost all other aquatic and terrestrial organisms as a source of energy, and as raw material for growth. In addition to being the driving force for most ecosystems, plants are a major determinant of water and nutrient circulation and play a key role in stabilizing the soil and establishing the microclimate. At a global scale, the assimilation of carbon dioxide and recycling of oxygen play a key role in establishing and maintaining the atmospheric composition, with far-reaching implications for climate. The landscapes formed by plants are important for our recreation, and play a dominant role in our cultural appreciation of nature. Plants are the ultimate source of all our food, and produce natural fibres and innumerable compounds that are pivotal for industrial and medical purposes.

(i) Advances from basic science can now be used to support plant breeding
(ii) New technology developments and discoveries in basic research will lay the grounds for further major undertakings
(iii) Profiling of composition will integrate plant breeding and agronomic practice with emerging knowledge about nutrition and health
(iv) Improved and novel crops will contribute to the creation of new economies based on plant products
(v) Advances in knowledge will provide strategies to stabilize agricultural yield in a fluctuating environment
(vi) Changes in crops and management systems will help us to carry out agriculture in concert with the environment
(vii) Knowledge about plants is needed to monitor, understand, and cope with climate change and its impact on agriculture and ecosystems
(viii) A global perspective dictates strong and open support for the developing world

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.

Moltes gràcies!

CENTRE DE RECERCA EN AGRIGENÒMICA

CSIC IRTA UAB