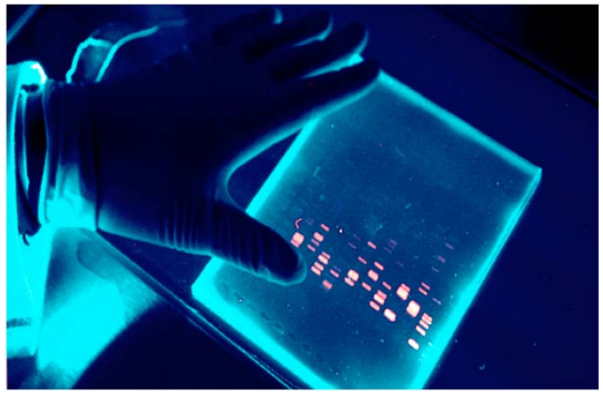


Plantes transgèniques: solucions o problemes?

Albert Boronat

Departament de Bioquímica i Biologia Molecular
Facultat de Biologia
Universitat de Barcelona

L’agricultura en la societat actual

Alimentació humana

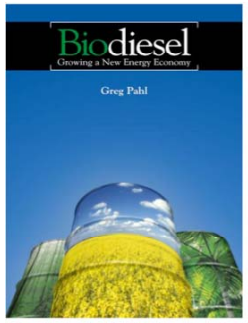
Arròs, blat de moro, patates, blat, fruites, hortalisses
oli, vi, cervesa, té, cafè, refrescos

Alimentació animal

Pinsos, farratge

Matèries primeres

Cel.lulosa, cotó, olis industrials, cautxú, biocombustibles



Altres

Medicaments, colorants, aromes, cosmètics

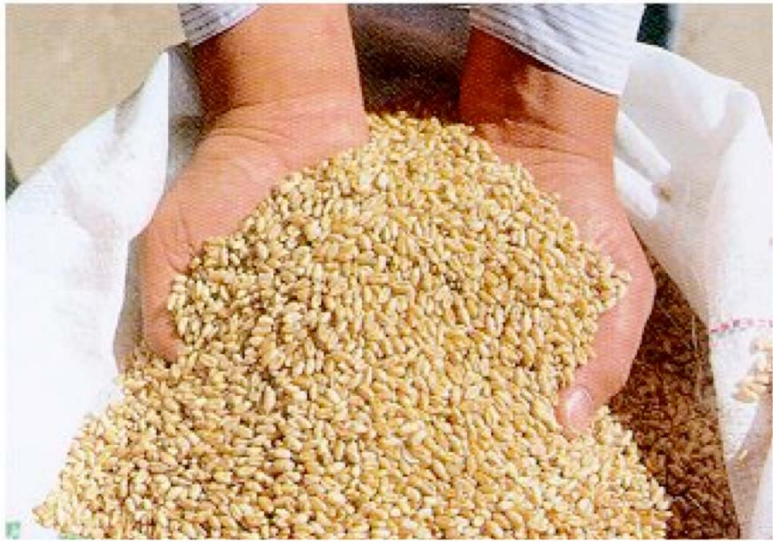
Agricultura i millora genètica

870 B.C.

2010

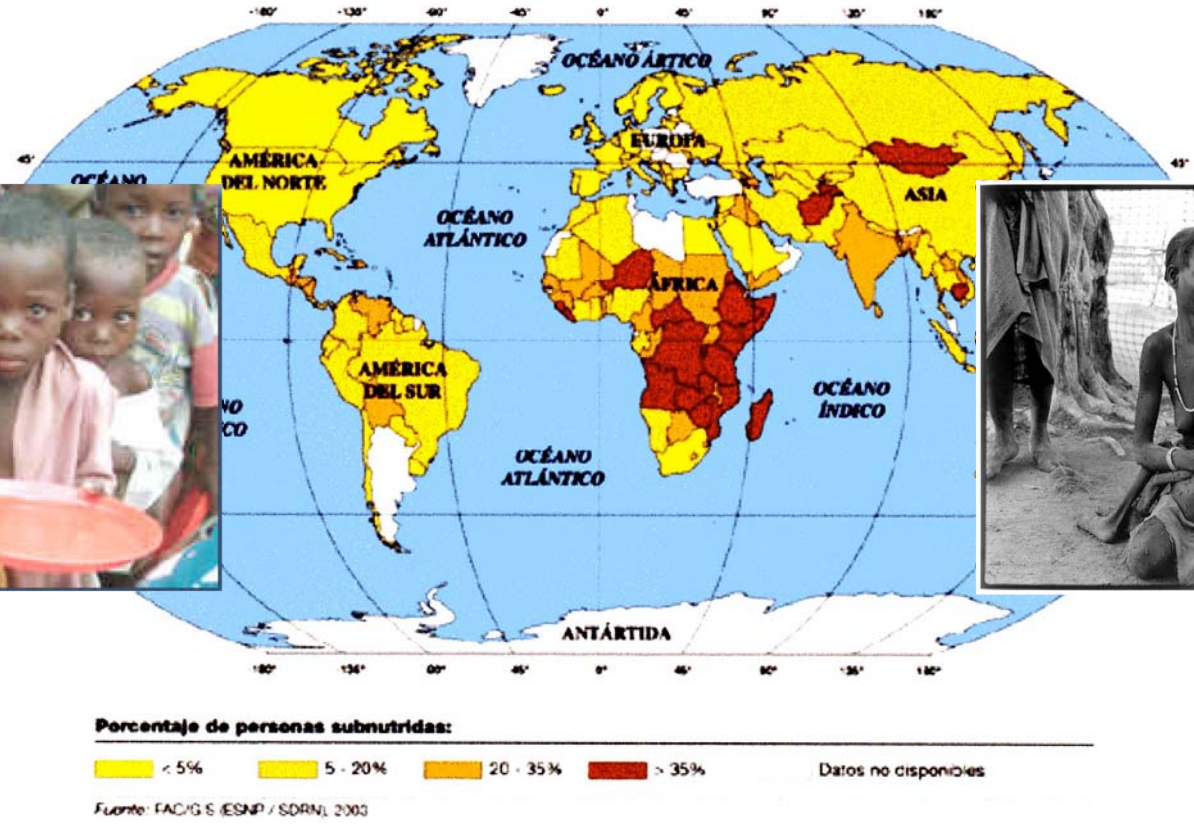
Del teosinte al blat de moro

Pràctiques agrícoles en els països desenvolupats



Agricultura de subsistència als països subdesenvolupats

Mapa del hambre en el mundo
Proporción de personas subnutridas (1998-2000)



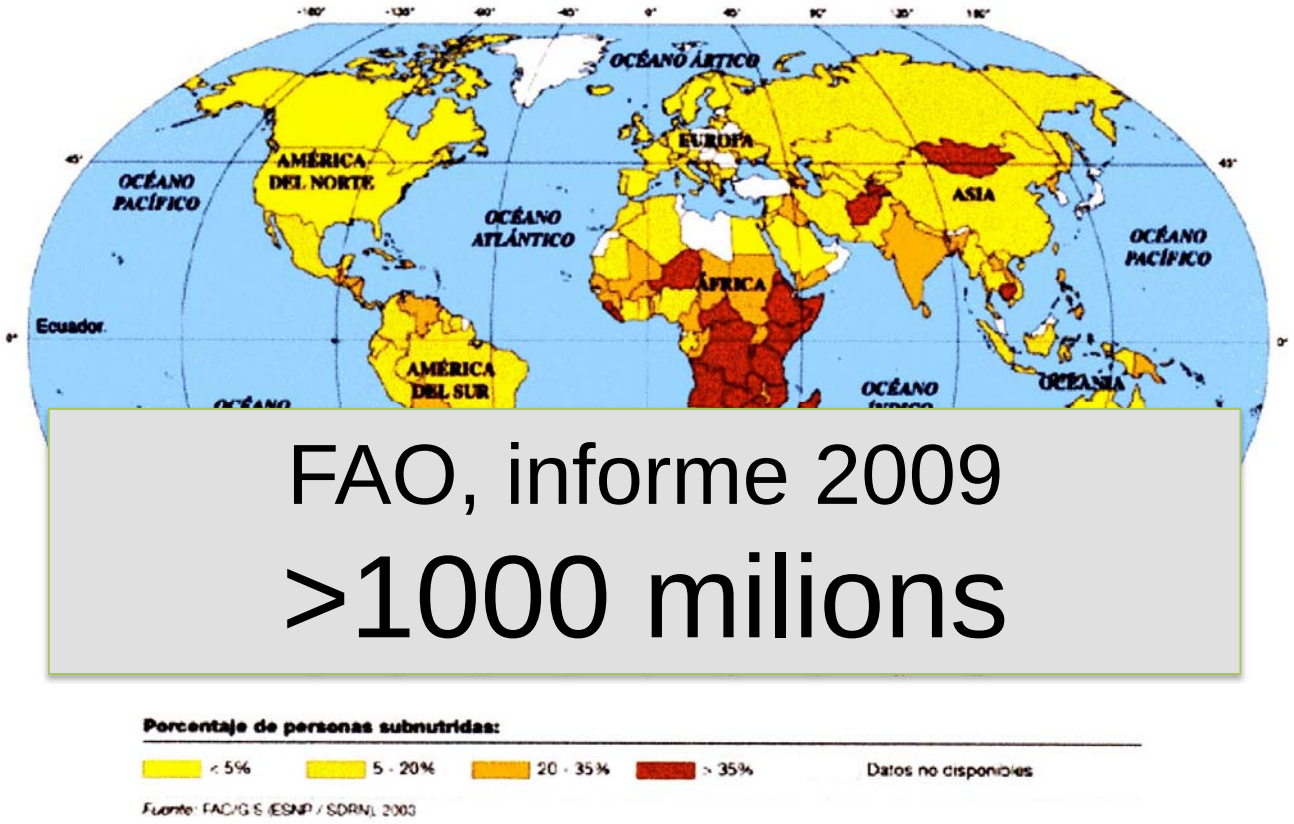
Informe FAO 2005

852 millones de personas pasan hambre en el mundo (54% en India y África)

5 millones de niños mueren cada año por desnutrición

2.5 millones de niños más por enfermedades derivadas de la malnutrición

Mapa del hambre en el mundo
Proporción de personas subnutridas (1998-2000)



FAO, informe 2009

>1000 milions

Informe FAO 2005

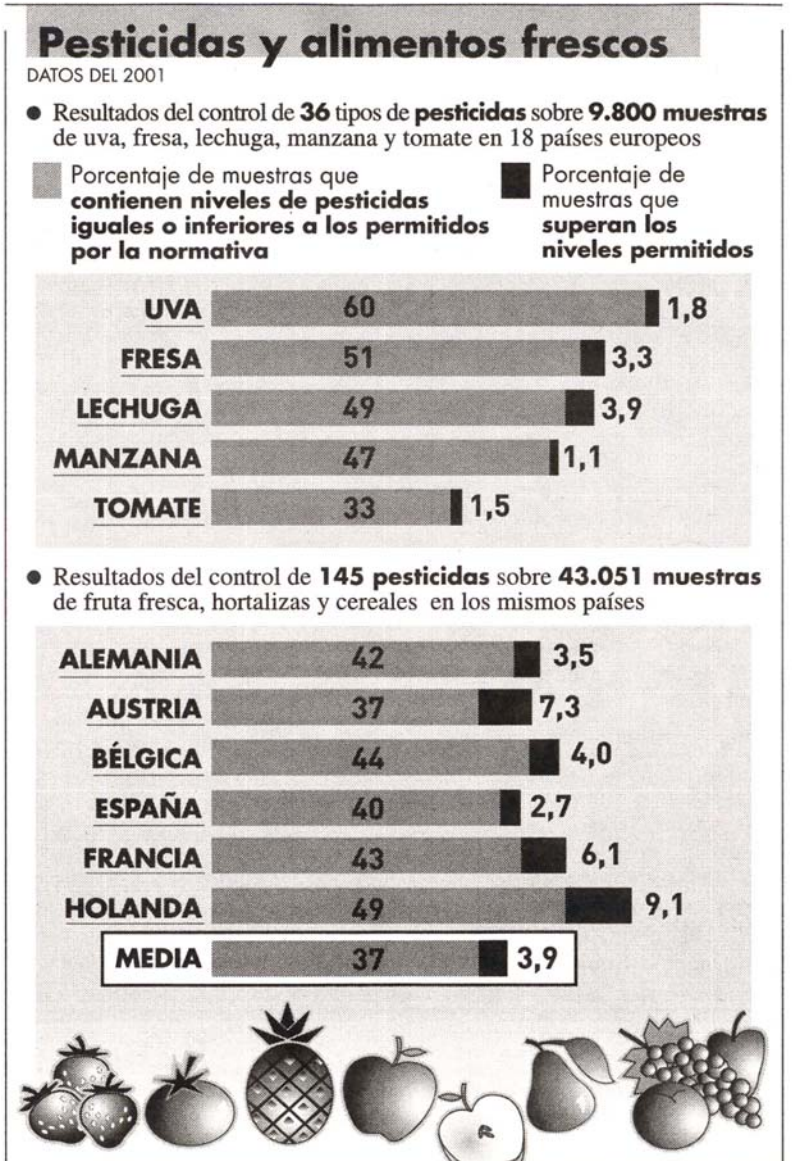
852 millones de personas pasan hambre en el mundo (54% en India y África)

5 millones de niños mueren cada año por desnutrición

2.5 millones de niños más por enfermedades derivadas de la malnutrición

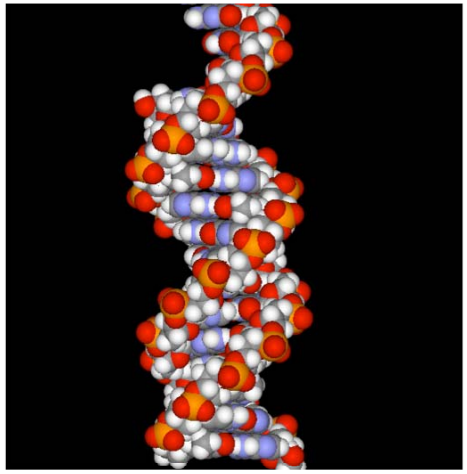
Agricultura intensiva

El 43% de las frutas y verduras frescas presentan residuos de pesticidas



Agricultura ecològica: una alternativa

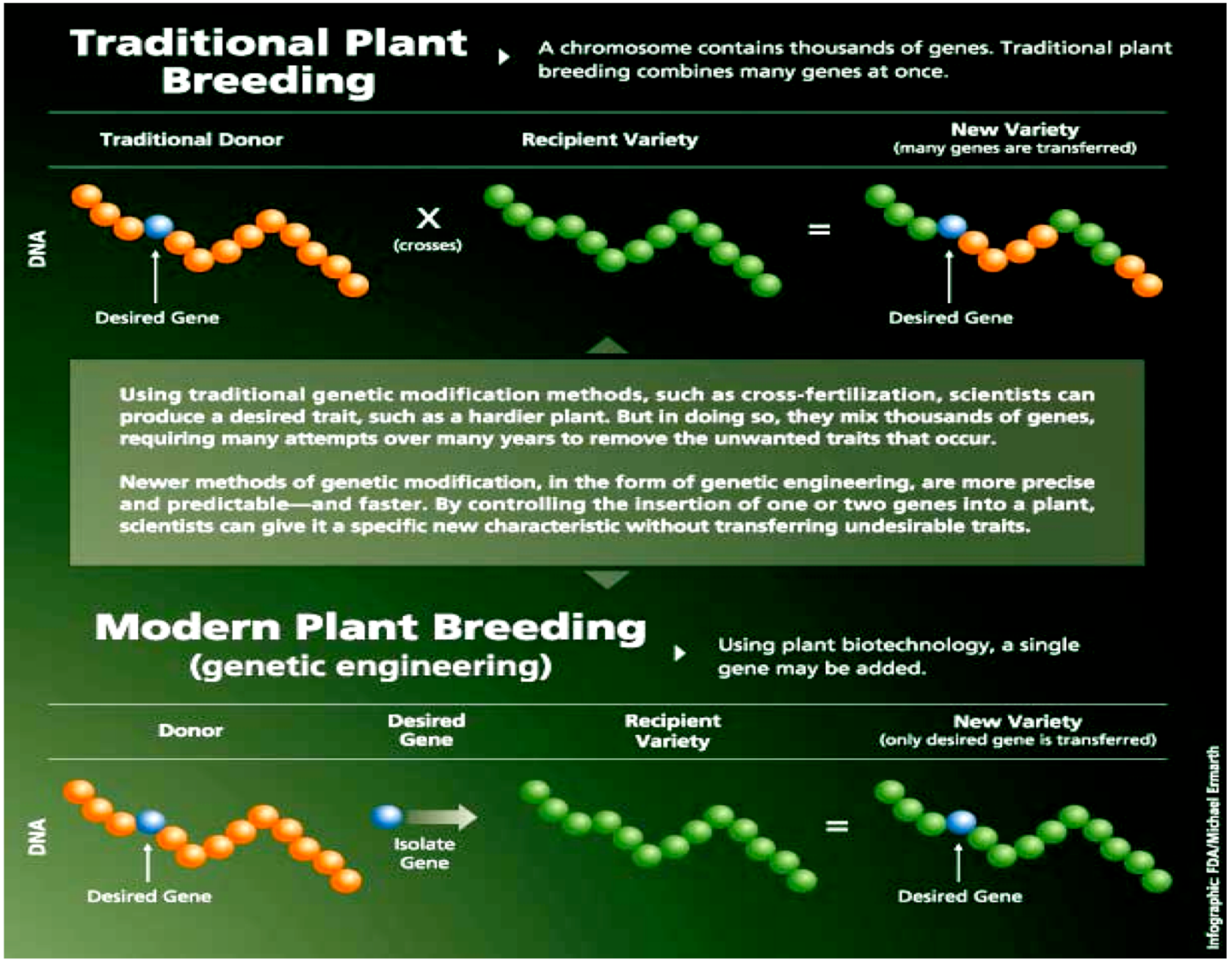
Agricultura ecològica: millor qualitat (?) a un preu més elevat



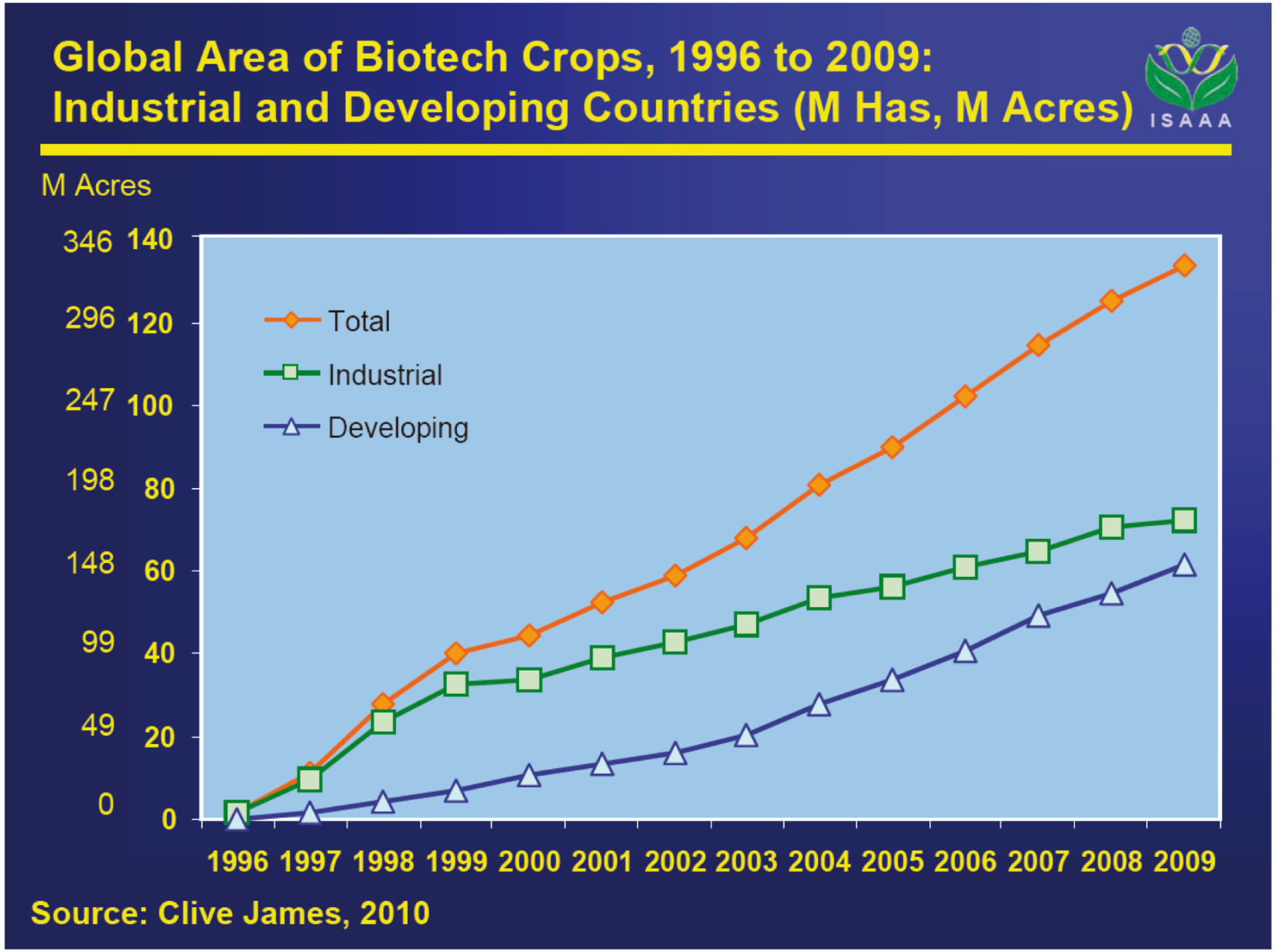
Agricultura transgènica

Plantes millorades mitjançant l'ús de tècniques d'enginyeria genètica

Millora genètica tradicional vs. millora gènetica basada en l'enginyeria genètica



L'agricultura transgènica: una activitat en constant expansió des de 1996

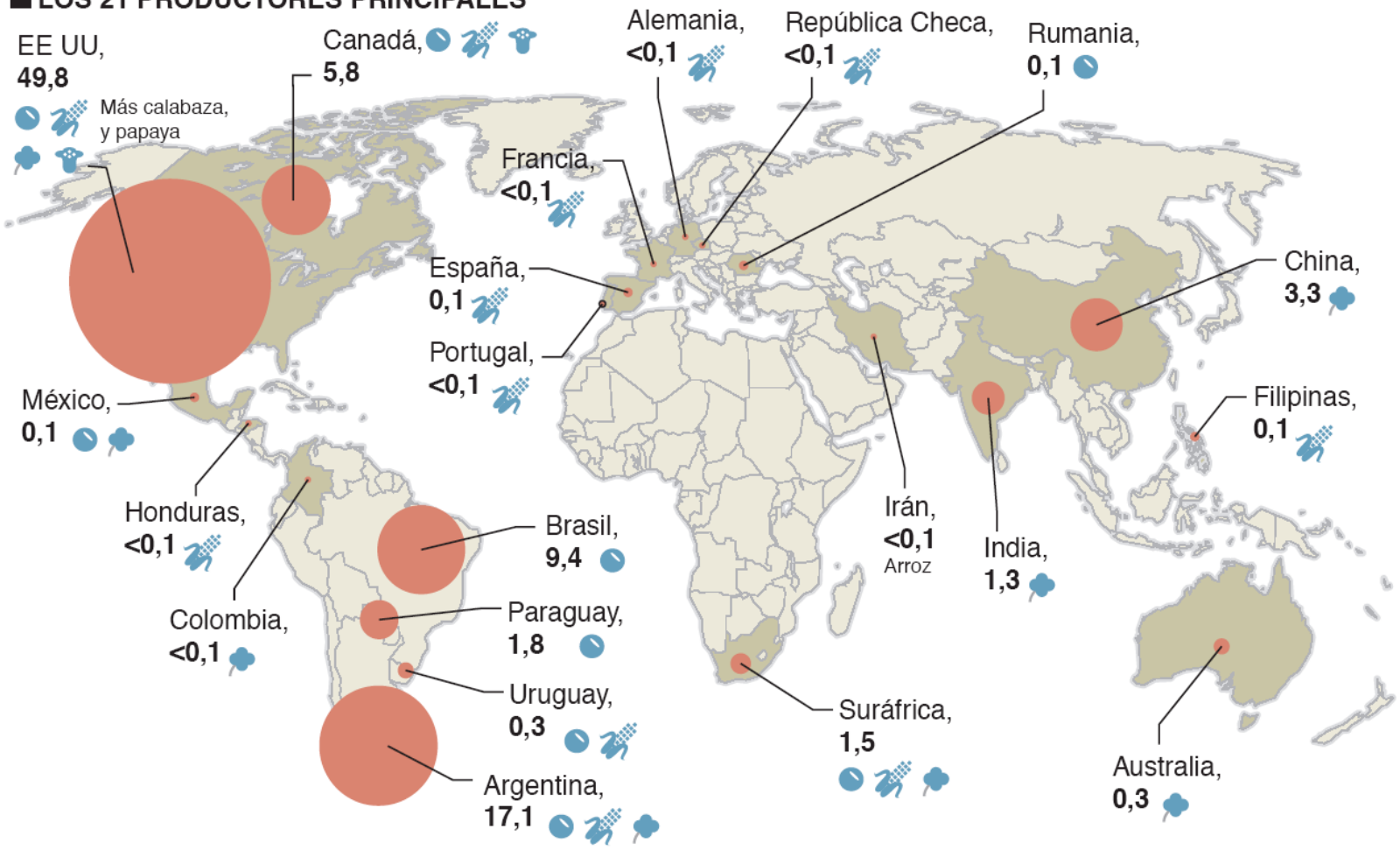


Cultivos de especies vegetales tratadas genéticamente

Cifras en millones de hectáreas

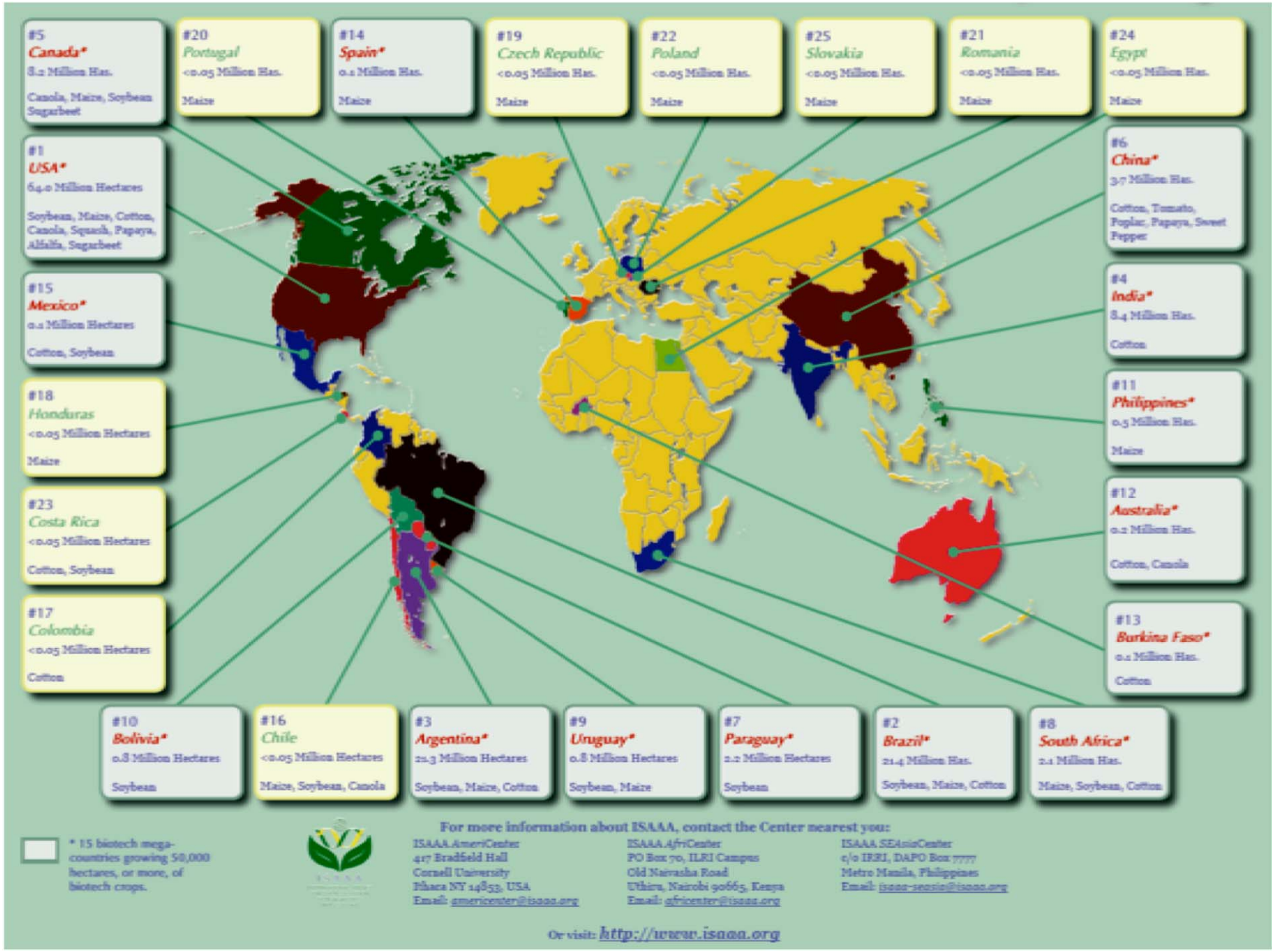
Soja · Maíz · Algodón · Colza

LOS 21 PRODUCTORES PRINCIPALES



Fuente: ISAAA (Servicio Internacional para la Adquisición de Programas Agro-biotecnológicos, en sus siglas en inglés) / Clive James, 2005.

Cultiu de varietats transgèniqes a nivell mundial (2009)



Global Area of Biotech Crops in 2009: by Country (Million Hectares)

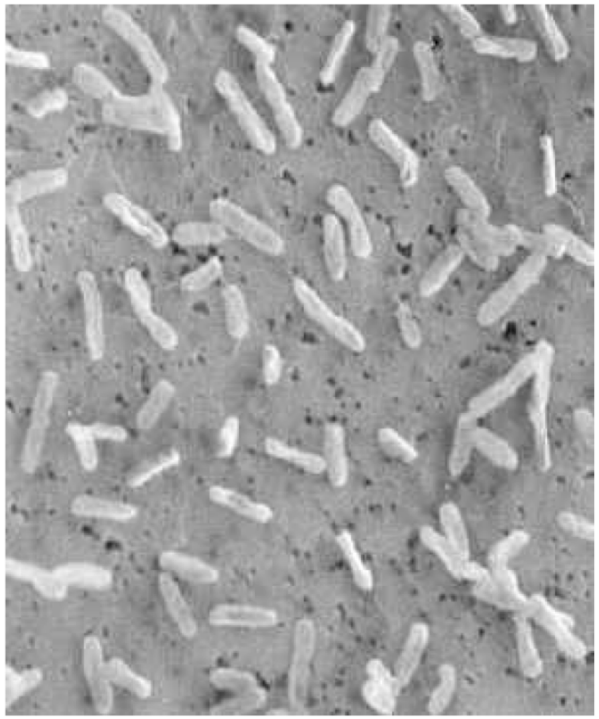
Country	Area	Biotech crops
USA*	64.0	Soybean, maize, cotton, canola, squash, papaya, alfalfa, sugarbeet
*Brazil**	21.4	Soybean, maize, cotton
*Argentina**	21.3	Soybean, maize, cotton
*India**	8.4	Cotton
Canada*	8.2	Canola, maize, soybean, sugarbeet
*China**	3.7	Cotton, tomato, poplar, papaya, sweet pepper
*Paraguay**	2.2	Soybean
*South Africa**	2.1	Maize, soybean, cotton
*Uruguay**	0.8	Soybean, maize
*Bolivia**	0.8	Soybean
*Philippines**	0.5	Maize
Australia*	0.2	Cotton, canola
*Burkina Faso**	0.1	Cotton
Spain*	0.1	Maize
*Mexico**	0.1	Cotton, soybean
Chile	<0.1	Maize, soybean, canola
Colombia	<0.1	Cotton
Honduras	<0.1	Maize
Czech Republic	<0.1	Maize
Portugal	<0.1	Maize
Romania	<0.1	Maize
Poland	<0.1	Maize
Costa Rica	<0.1	Cotton, soybean
Egypt	<0.1	Maize
Slovakia	<0.1	Maize

* 15 biotech mega-countries growing 50,000 hectares, or more, of biotech crops. (Developing countries in italics.)

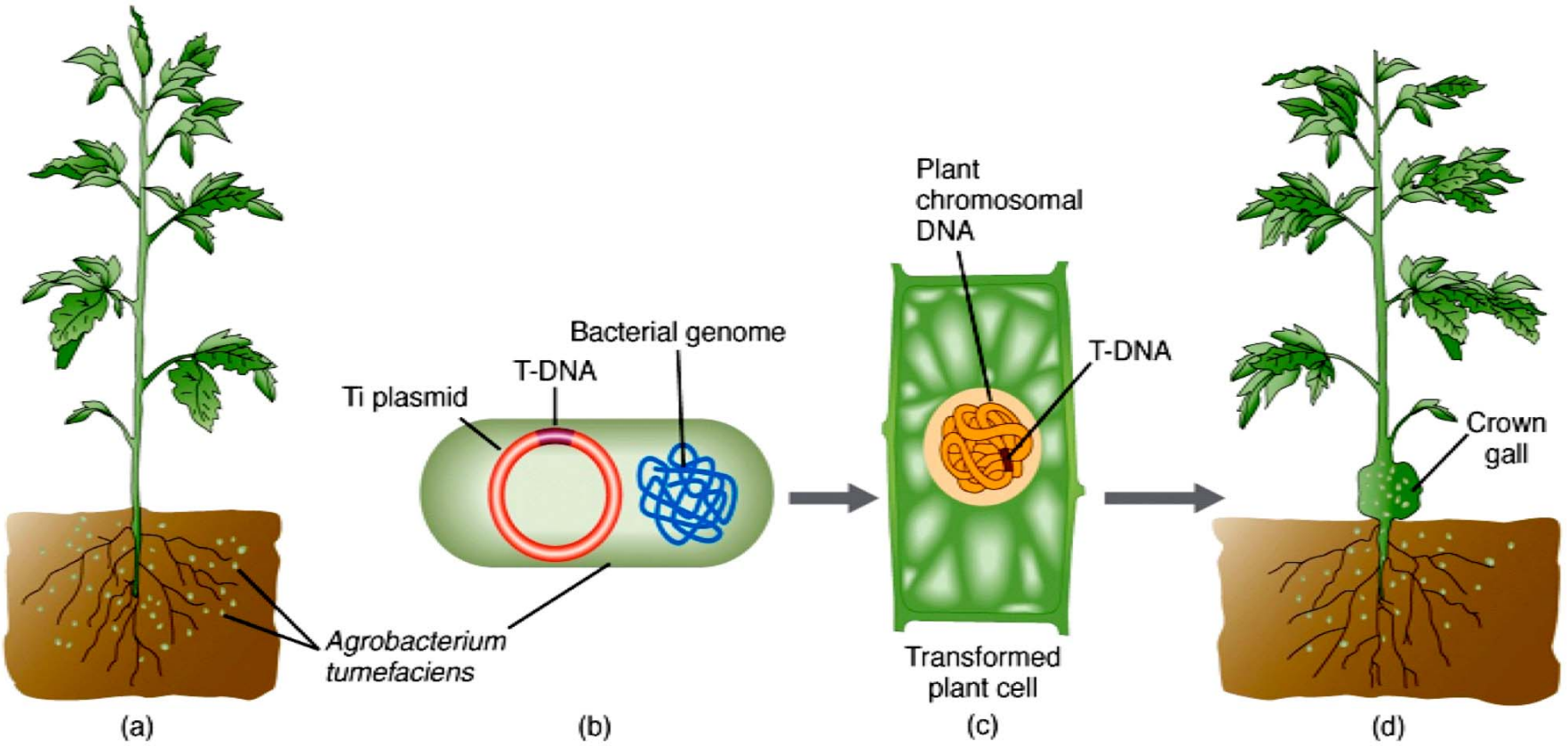
Source: Clive James, 2009. Global Status of Commercialized Biotech/GM Crops: 2009. ISAAA Briefs No. 41-2009.

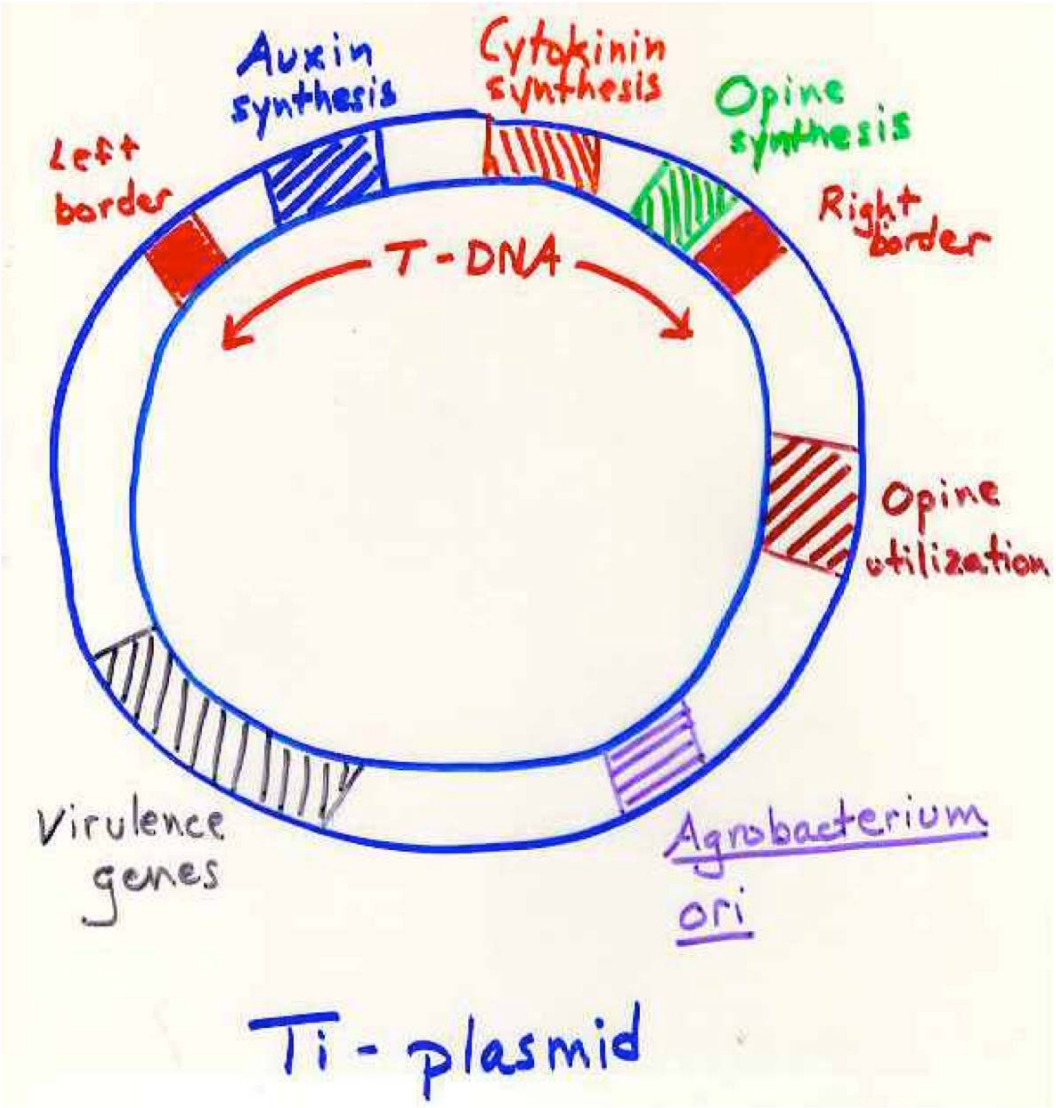
"Agalla de la corona", una patologia que afecta a moltes plantes

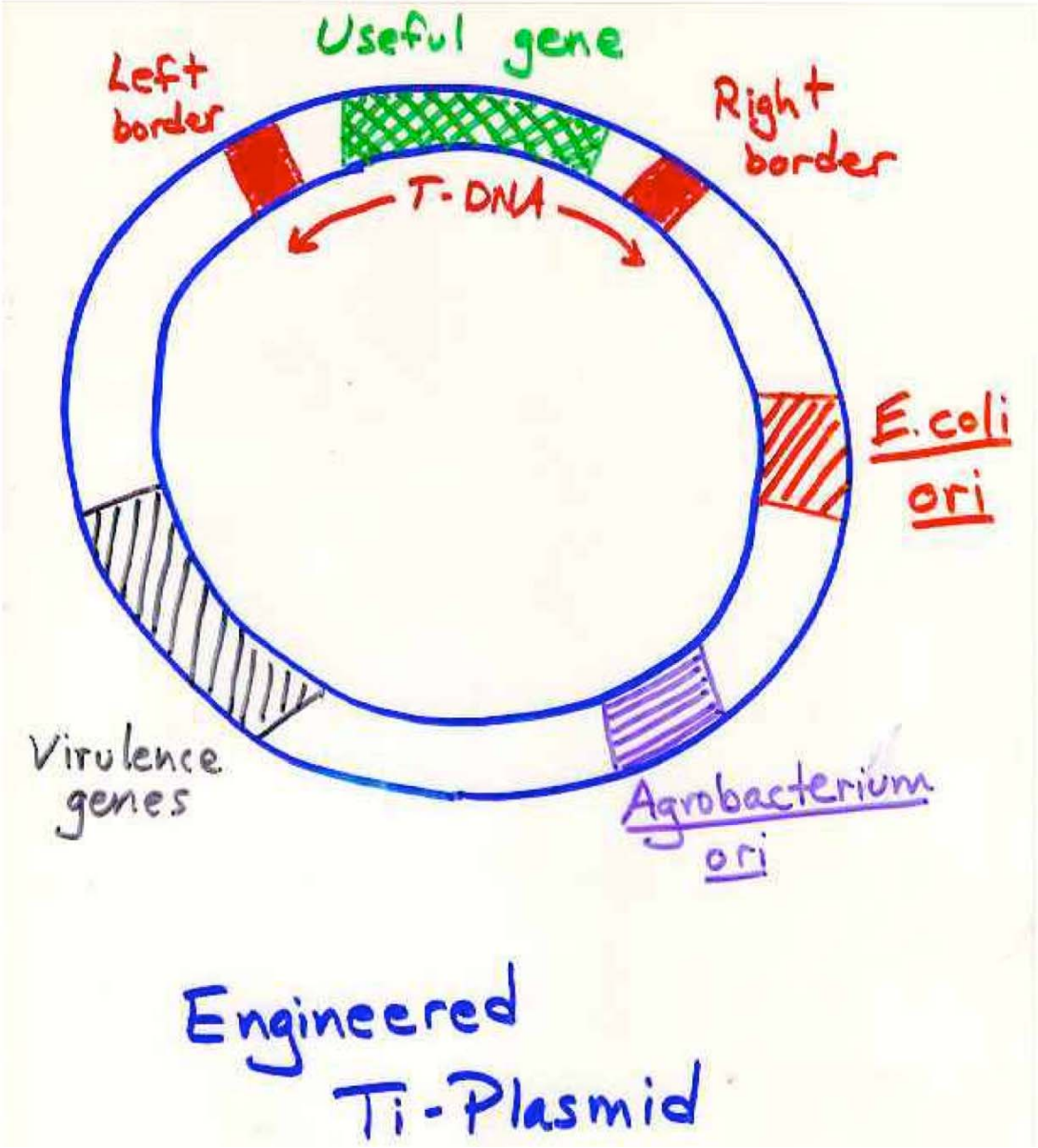
Agrobacterium tumefaciens, el bacteri responsable de l'agalla de la corona



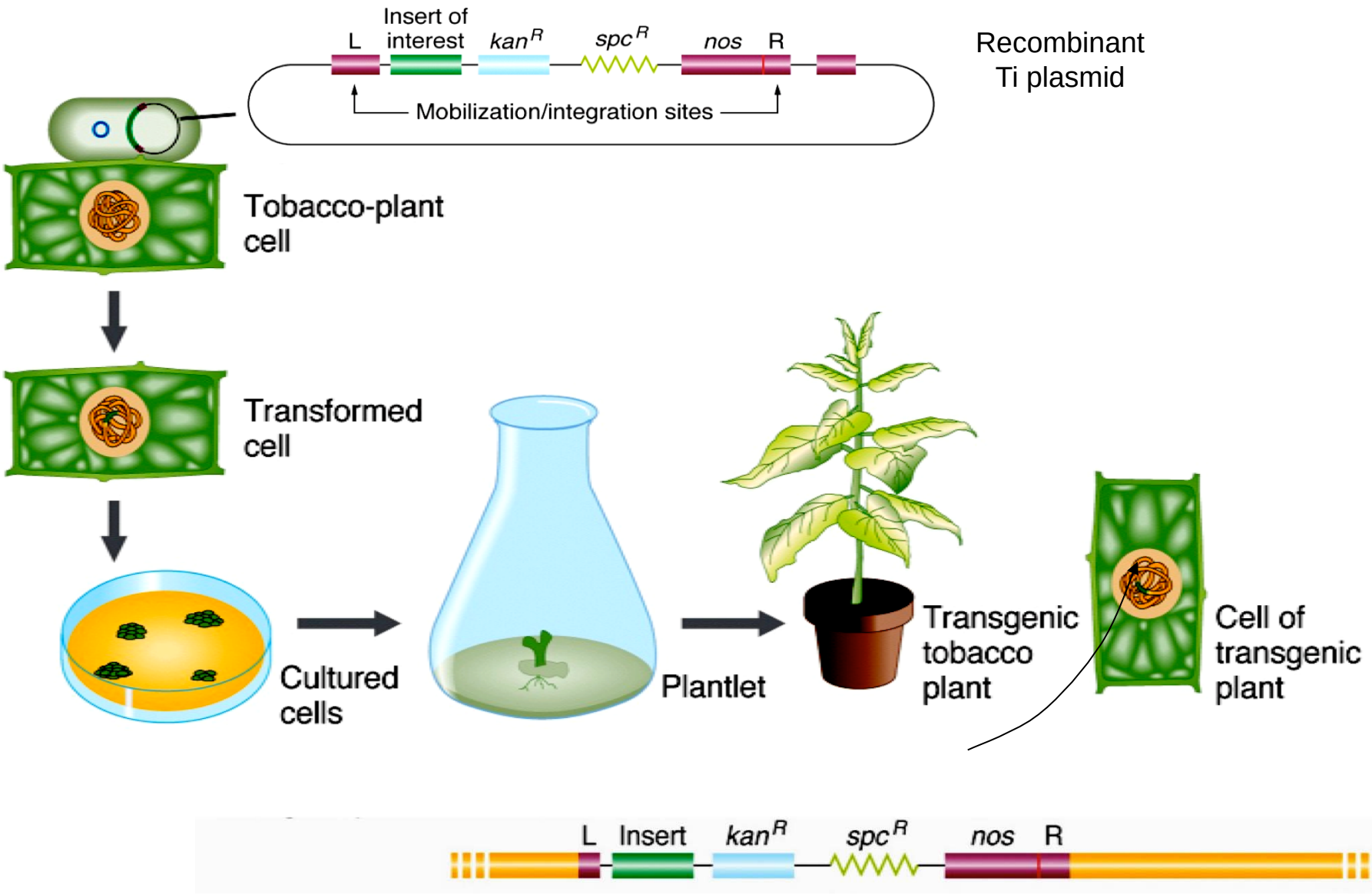
Bases moleculars del mecanisme pel qual *Agrobacterium tumefaciens* indueix els tumors: paper del plàsmid Ti i del T-DNA



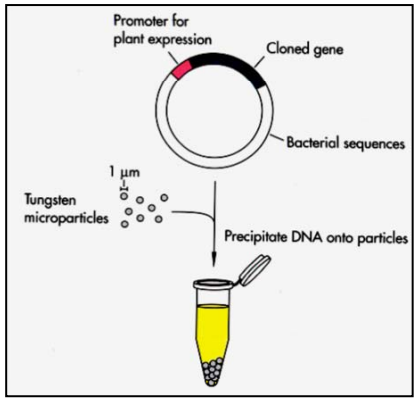

Auxin synthesis
Cytokinin synthesis
Opine synthesis
Left border
Right border
T-DNA
Opine utilization
Virulence genes
Agrobacterium ori
Ti-plasmid

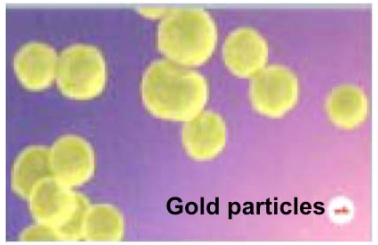

Useful gene
Left border
Right border
T-DNA
E.coli ori
Virulence genes
Agrobacterium ori
Engineered Ti-Plasmid

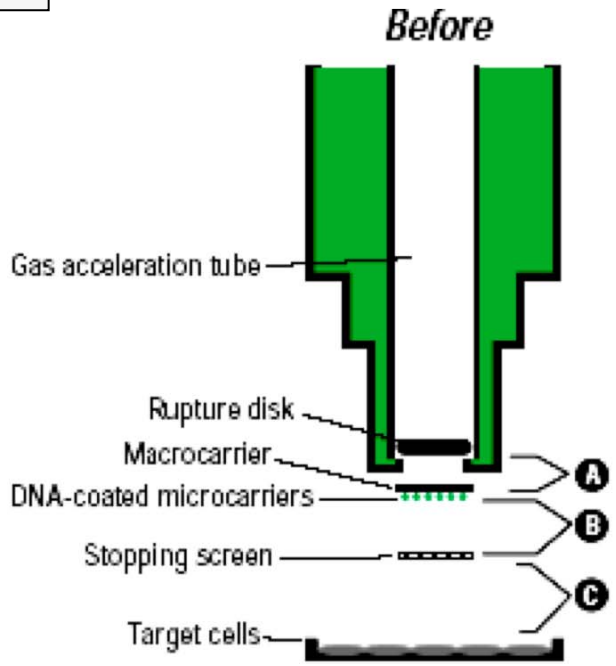
Generació de plantes transgèniques mitjançant Agrobacterium tumefaciens

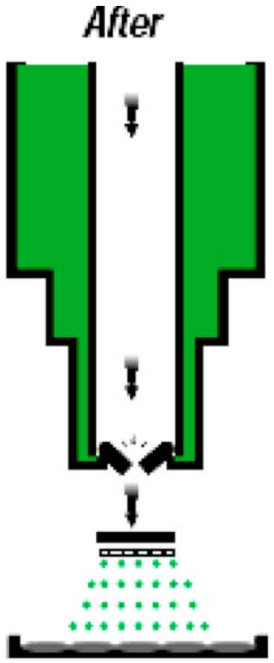


Transformació mitjançant micro-bombardeig: una alternativa a *Agrobacterium tumefaciens*

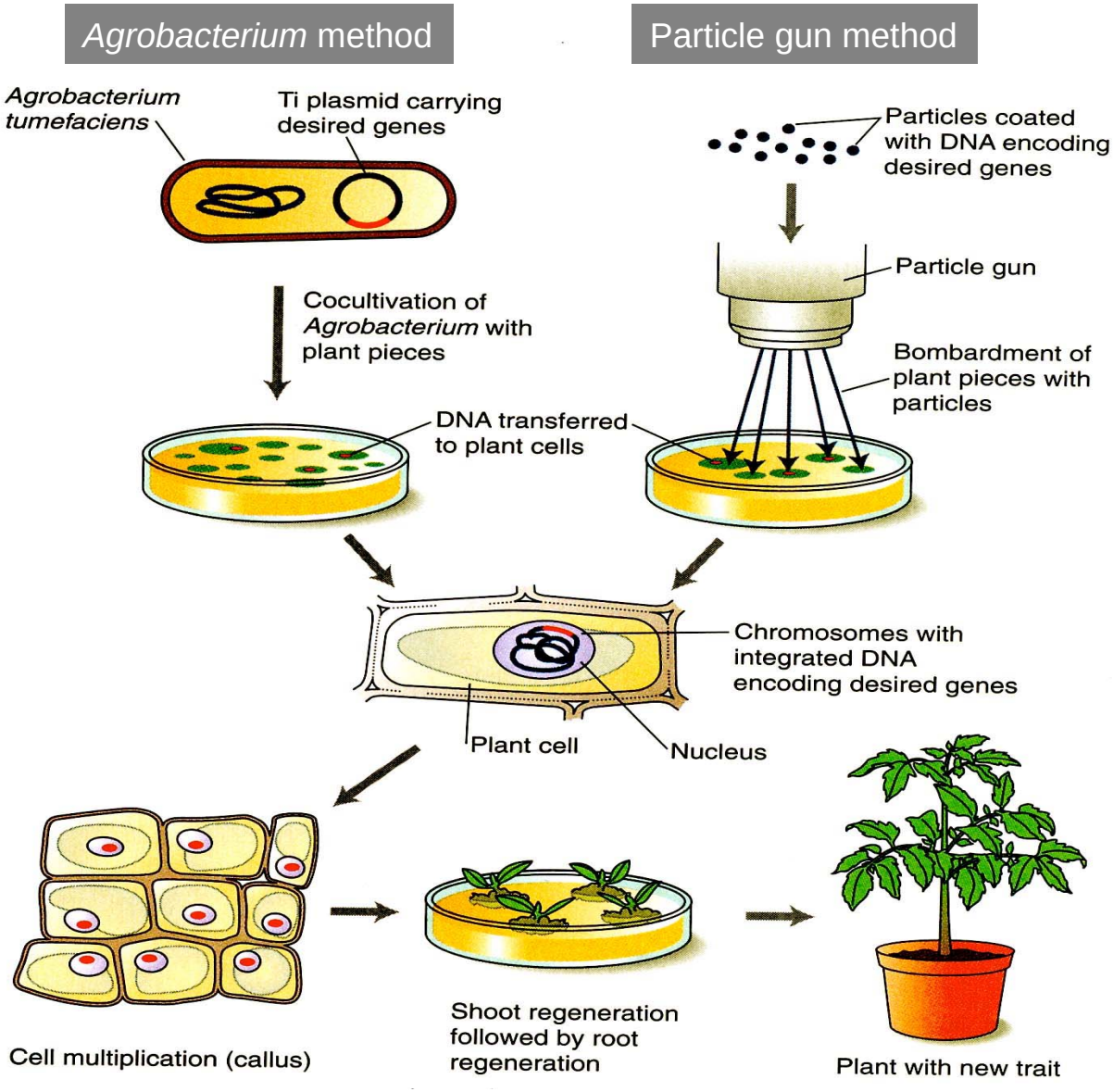




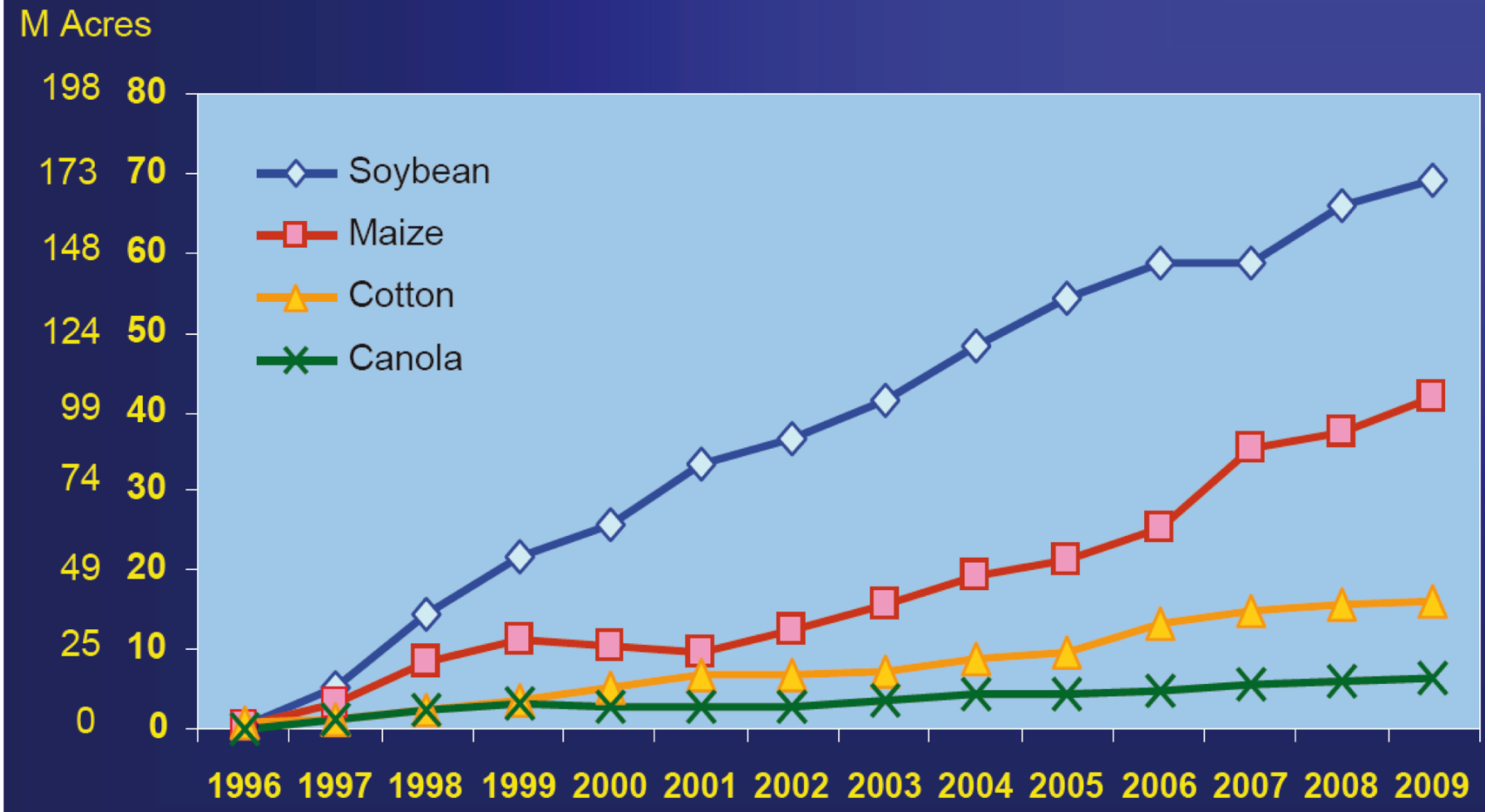




Generació de plantes transgèniques

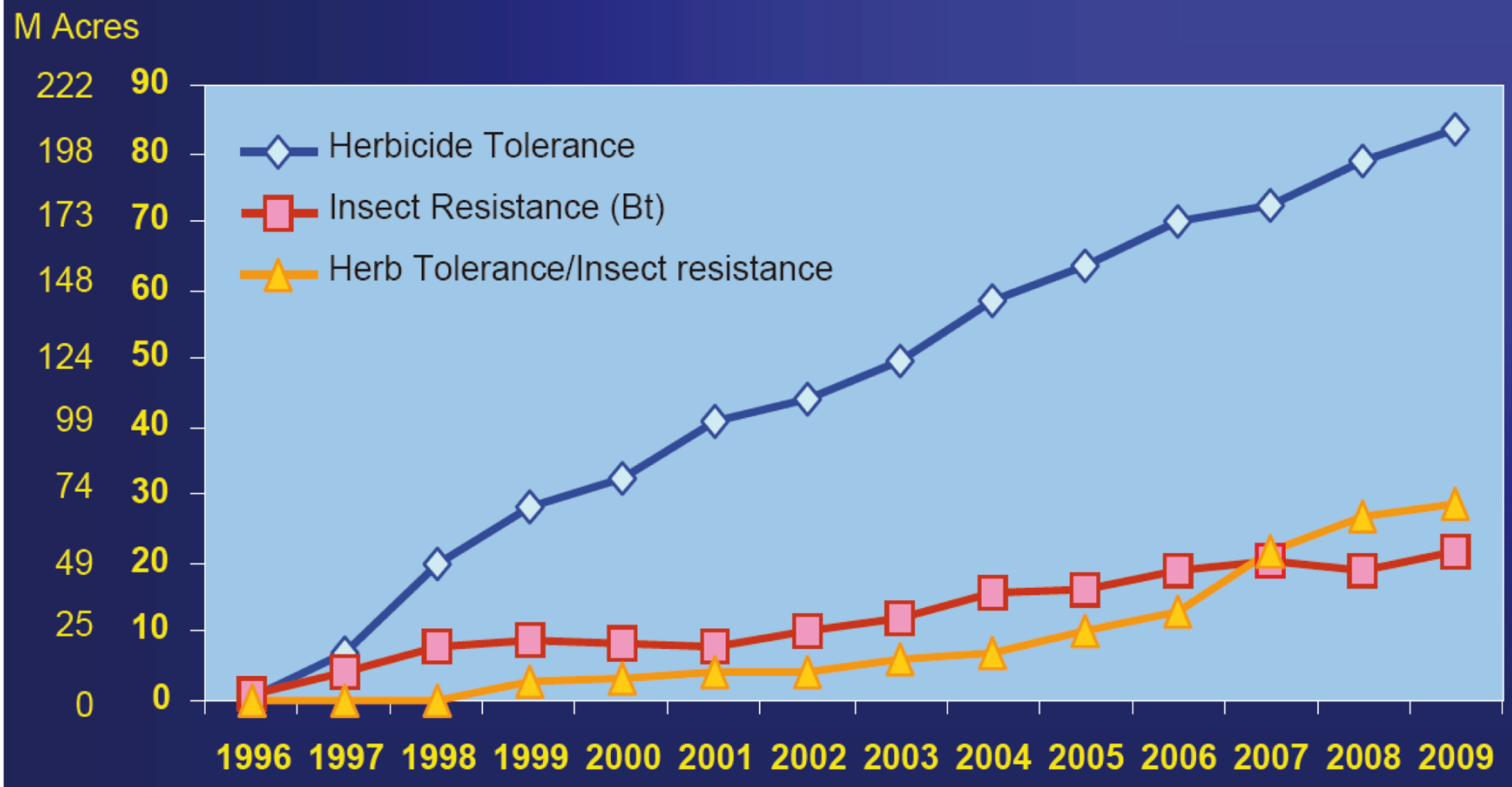


Global Area of Biotech Crops, 1996 to 2009: By Crop (Million Hectares, Million Acres)



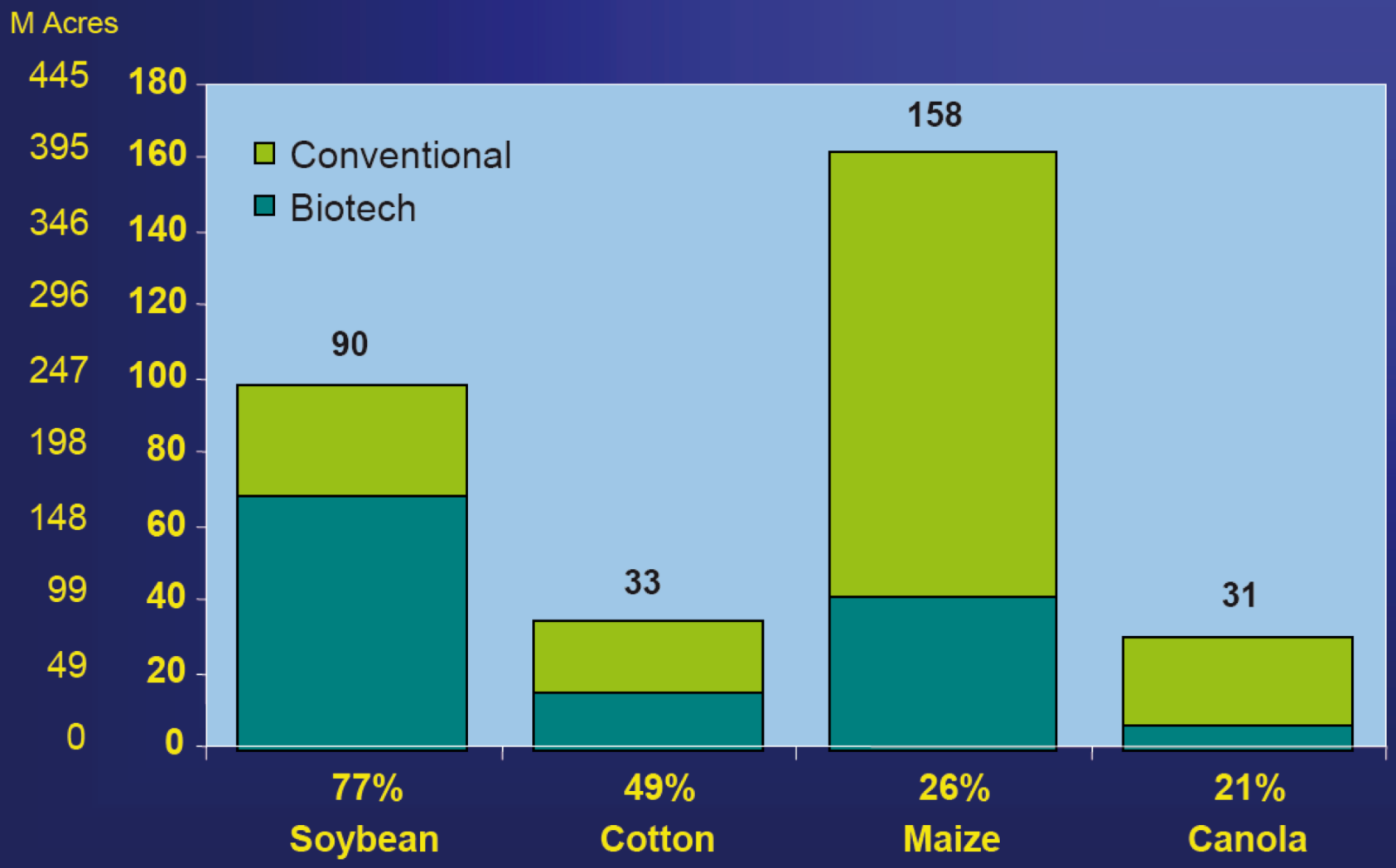
Source: Clive James, 2010

Global Area of Biotech Crops, 1996 to 2009: By Trait (Million Hectares, Million Acres)



Source: Clive James, 2010

Global Adoption Rates (%) for Principal Biotech Crops (Million Hectares, Million Acres), 2009



Source: Clive James, 2010

Espècies amb varietats transgèniques comercials

Blat de moro

Cotó

Colza

Soja

Alfals

Arròs

Patata

Remolatxa

Carbassó

Pruna

Llí

Tomàquet

Papaya

Radiccio

Blat

What traits have been engineered?

Herbicide Resistance

Several crop varieties have been engineered to be resistant to the application of an herbicide, simplifying weed management.

Bt-based Insect Resistance

Several crop species have been engineered to produce their own insecticide, *Bt-toxin*, making them resistant to certain insects.

Delayed Fruit Ripening

Several varieties of tomatoes have been engineered to ripen more slowly, making them last longer in shipment and on consumers' shelves. None are currently marketed.

Virus Resistance

Commercial varieties of three crop species have been genetically engineered to be resistant to plant viral diseases: squash, papaya, and potato.

Altered Oil Content

Varieties of both canola and soybean have been genetically engineered to produce oils with improved nutritional or cooking properties.

Pollen Control for Hybrid Production

Two crops have been genetically engineered with a trait that makes hybrid- production easier.

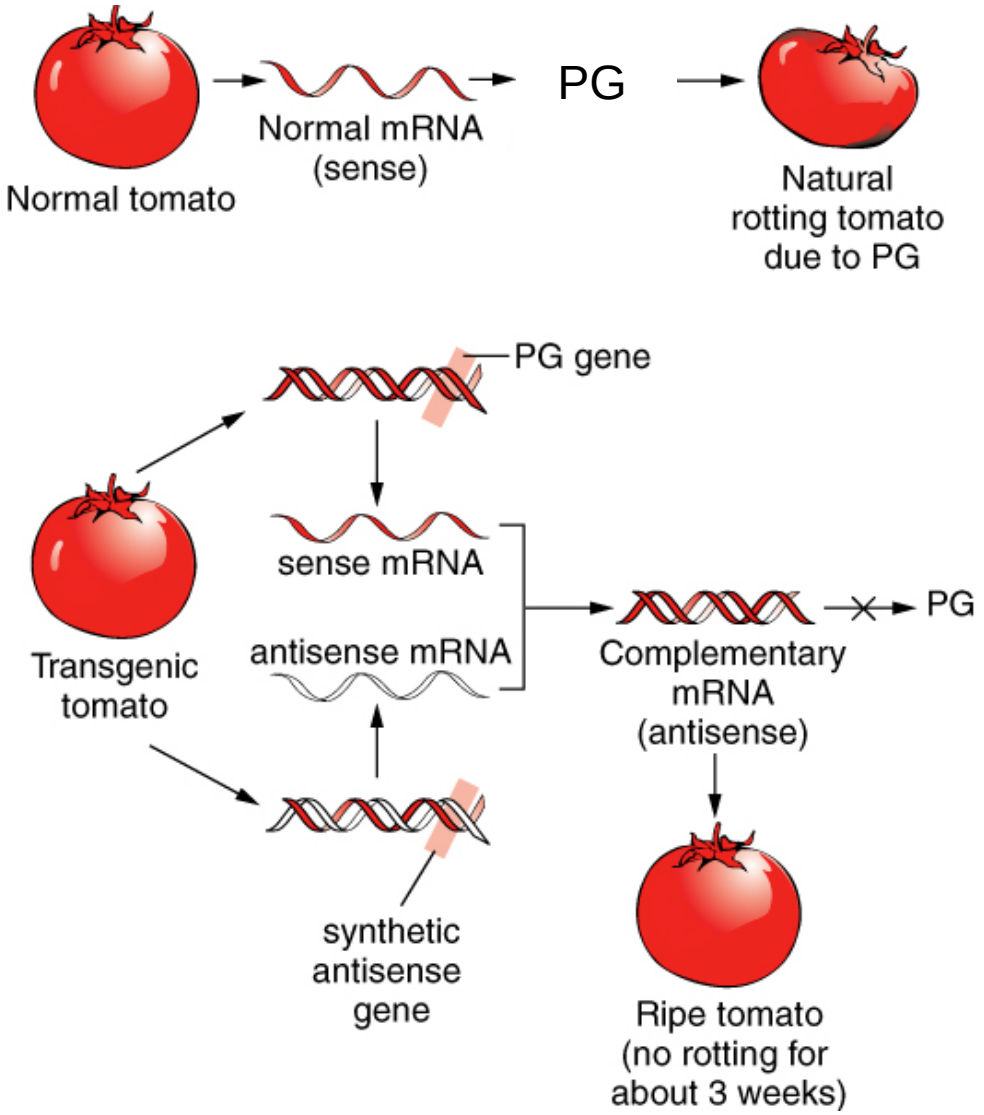
Tomàquets FlavRSavR®, el primer aliment transgènic comercialitzat (any 1994)

Fruits amb maduració retardada

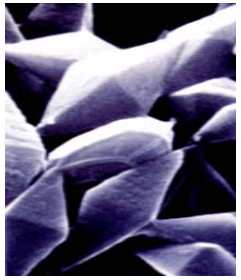
Inhibició de l'enzim poligalacturonasa utilitzant la tecnologia de l'RNA antisentit

El tomàquet Flavr Savr™

Inhibició antisentit de la poligalacturonasa (PG)



Blat de moro transgènic BT resistent a l'atac d'insectes

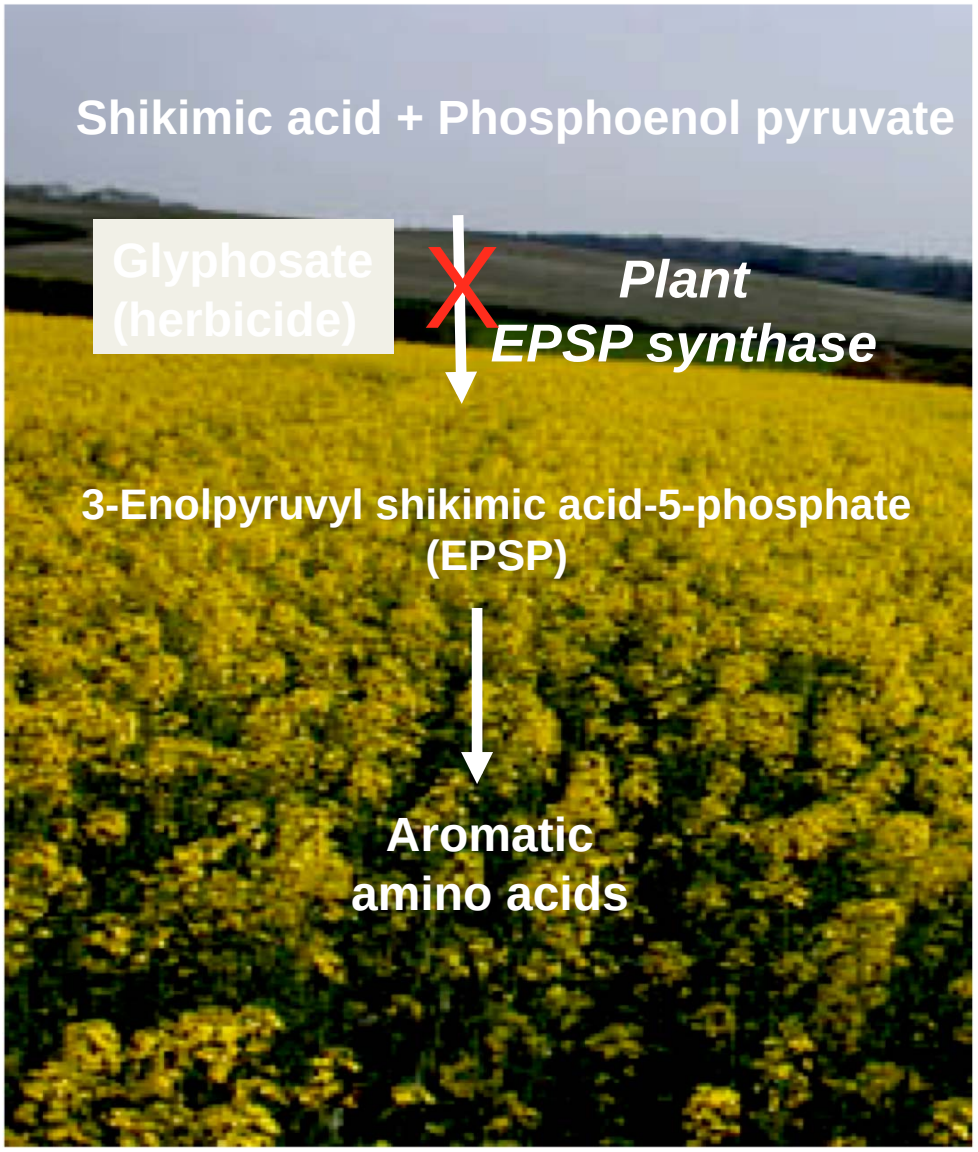


Bt crystals

El bacteri *Bacillus thuringiensis* produeix proteïnes amb activitat insecticida

Resistència a herbicides

Glyphosate, the active ingredient in Roundup Reday, is a broad-spectrum herbicide



Plantes resistents al Roundup (Glyphosate)

Shikimic acid + Phosphoenol pyruvate

+ Glyphosate

Bacterial EPSP synthase

RoundUp has no effect;
EPSP synthase enzyme is resistant to the herbicide

3-enolpyruvyl shikimic acid-5-phosphate (EPSP)

Aromatic amino acids

Non-transgenics

Transgenics

Plantes transgèniques de segona generació

Arròs daurat (Golden Rice):
acumula b-caroté (provitamina A)

transgen = tres gens de la biosíntesi de carotenoides (plantes i microroganismes)

Una insuficiència en (pro)vitamina A resulta en símptomes clínics severs

5 milions de nens desenvolupen xeroftalmia cada any, dels quals uns 250.000 acaben cecs.

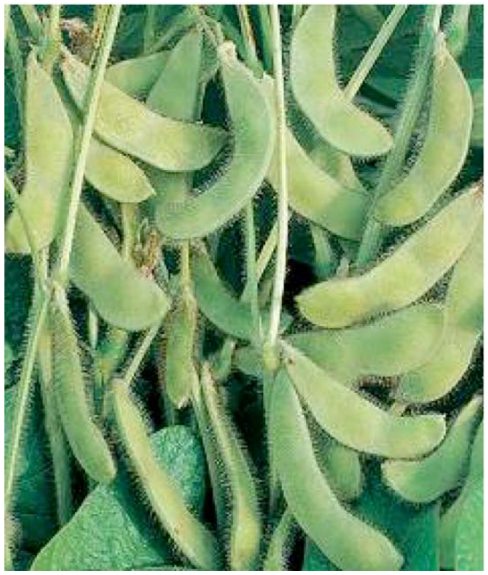
La deficiència en vitamina A incrementa la susceptibilitat d'altres malalties greus (diarrees, malalties respiratòries, etc.)

Una nutrició millorada en provitamina A podria prevenir de 1-2 milions de mort infantils (nens d'entre 1 i 4 anys)

En els humans, els carotenoides (b-caroté) actuen com a provitamina A

El b-caroté és més efectiu i segur que la vitamina A

Llavors, fruits i hortalisses amb propietats nutricionals millorades

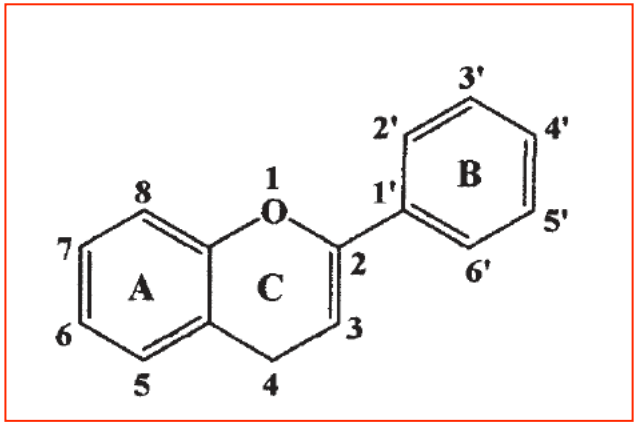




Aminoàcids essencials, vitamines, carotenoides, flavonols, fitoesterols, àcids grassos ω3

Efectes dels flavonoides en la salut

Prevenció de:

Malalties cardiovasculars
Malalties cerbrovasculars
Càncer
Malalties cròniques



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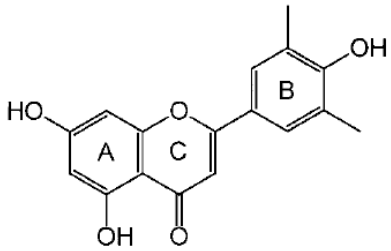
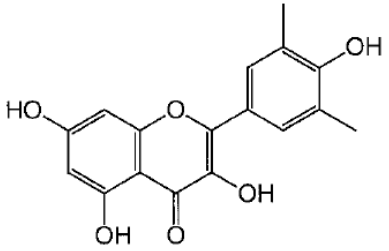
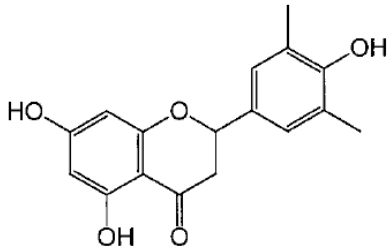


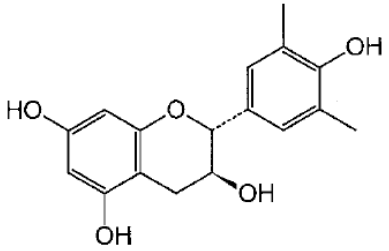
Flavones



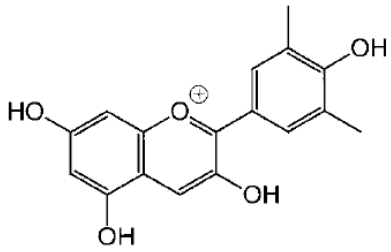
Flavonols



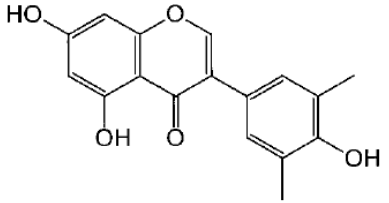
Flavanones



Catechins



Anthocyanidins

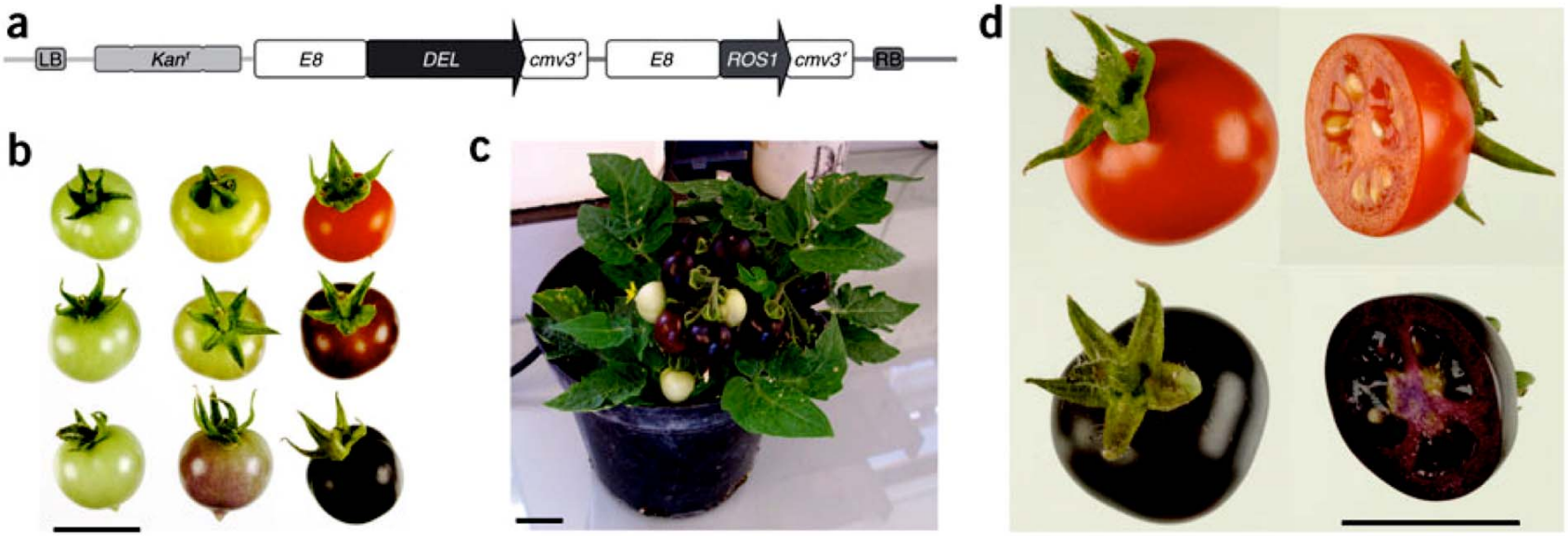


Isoflavones

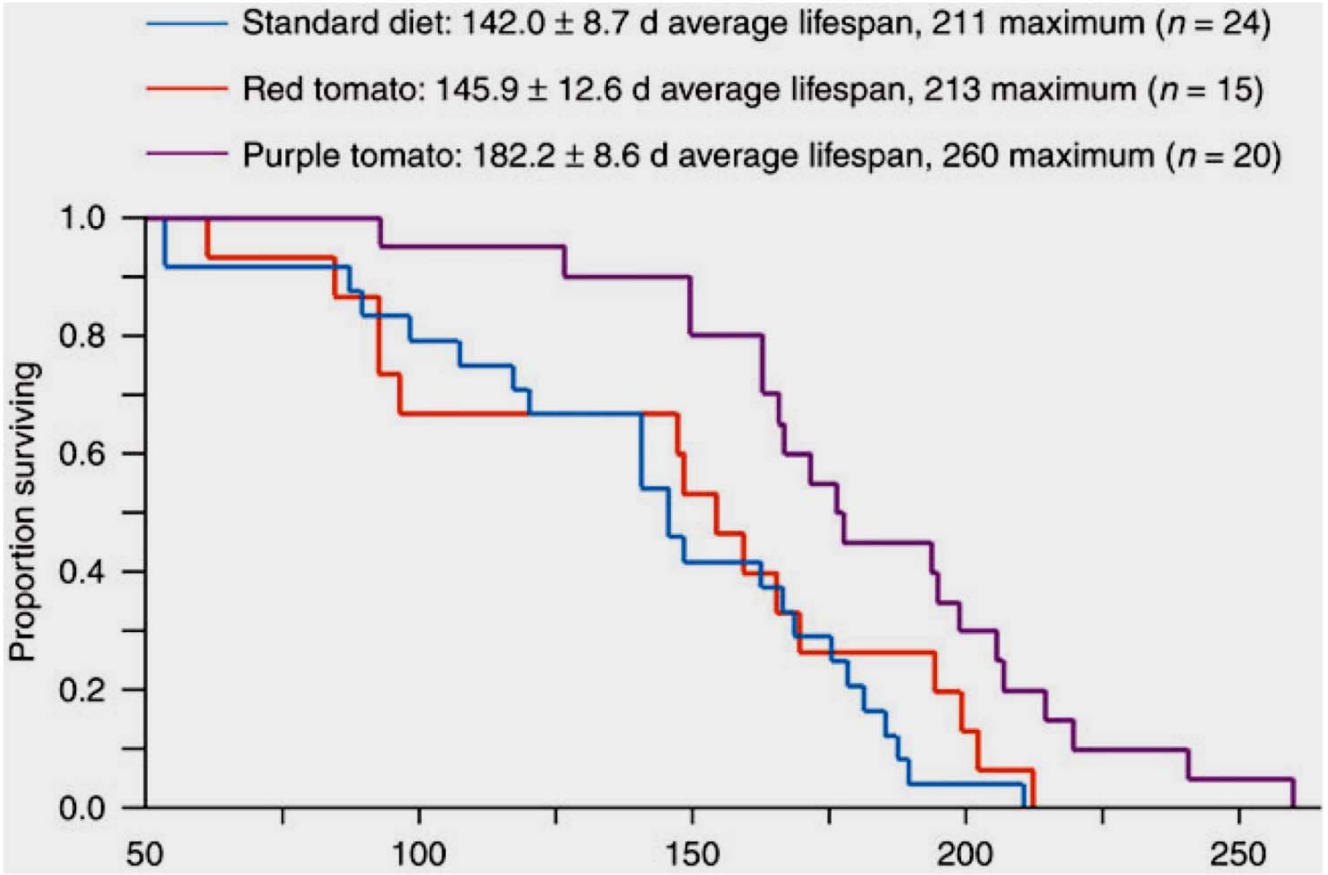
Nature Biotechnology
Published online: 26 October 2008 | doi:10.1038/nbt.1506

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

Butelli *et al.*



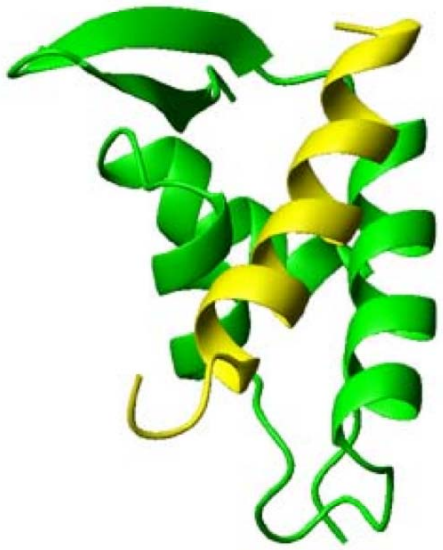
Viabilitat de ratolins Trp53–/– alimentats amb dieta estàndard o amb dietes suplementades amb extracte sec (10%) de tomàquets vermells o púrpures



Butelli *et al. Nature Biotechnology*
Published online: 26 October 2008 |
doi:10.1038/nbt.1506

“Molecular farming”

Utilització de plantes transgèniques com a factories per a la producció de proteïnes recombinants d’interès industrial o farmacèutic.

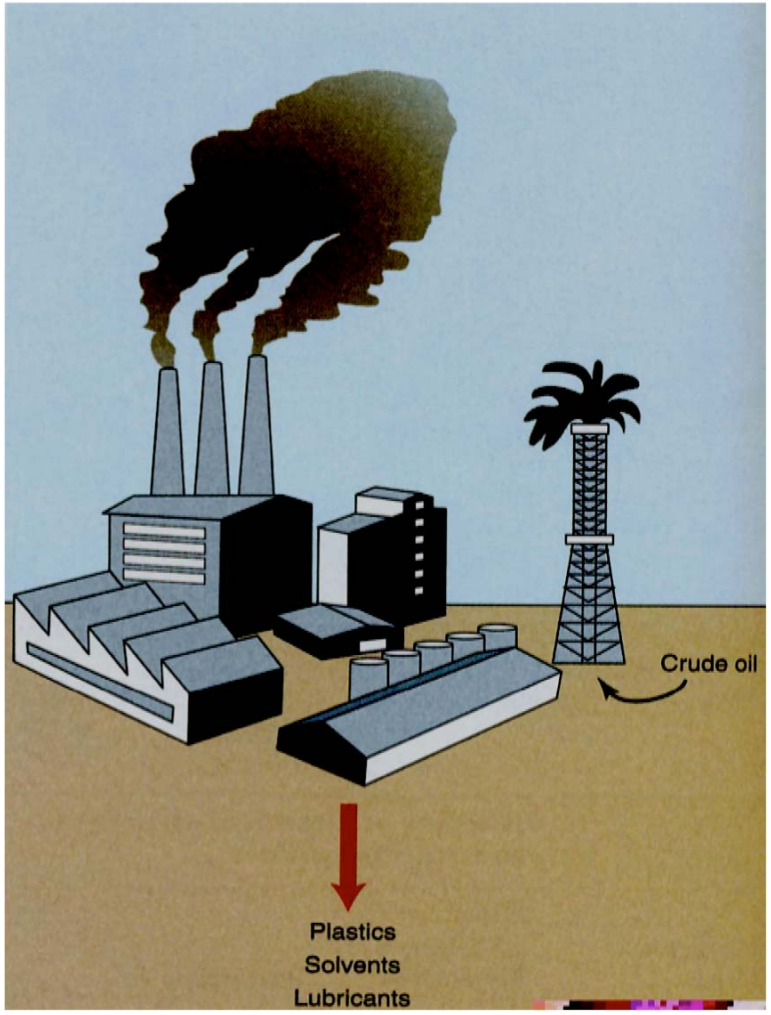


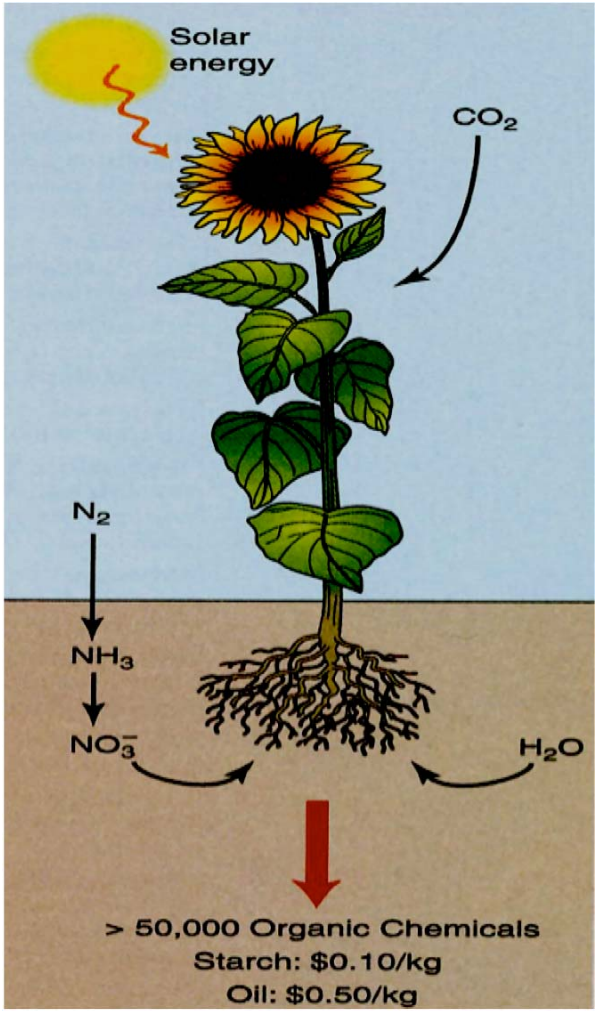
Vacunes orals

Expressió de proteïnes recombinants antigèniques en parts comestibles de la planta (llavor, fruit)

- Works like any vaccine
- A transgenic plant with a pathogen protein gene is developed
- Potato, banana, and tomato are targets
- Humans eat the plant
- The body produces antibodies against pathogen protein
- Humans are ***"immunized"*** against the pathogen
- Examples:
  - ✓Diarrhea
  - ✓Hepatitis B
  - ✓Measles

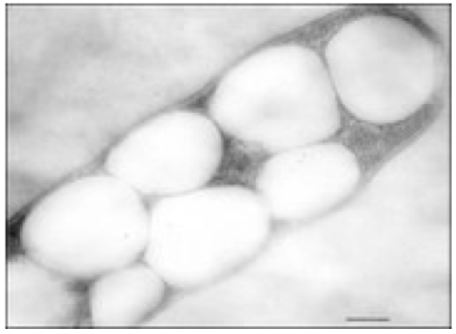
Poden les plantes reemplaçar les plantes químiques?



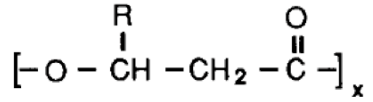


Biocombustibles, plàstics, olis industrials, etc.

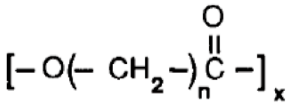
Producció de plàstics biodegradables en plantes



Polihidroxialcanoats



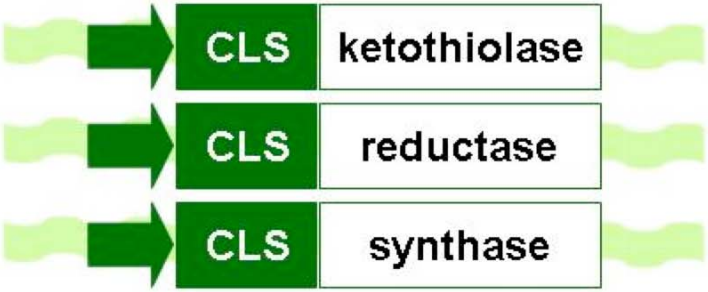
R = hydrogen	3-hydroxypropionate	(3HP)
R = methyl	3-hydroxybutyrate	(3HB)
R = ethyl	3-hydroxyvalerate	(3HV)
R = propyl	3-hydroxycaproate	(3HC)
R = butyl	3-hydroxyheptanoate	(3HH)
R = pentyl	3-hydroxyoctanoate	(3HO)
R = hexyl	3-hydroxynonanoate	(3HN)
R = heptyl	3-hydroxydecanoate	(3HD)
R = octyl	3-hydroxyundecanoate	(3HUD)
R = nonyl	3-hydroxydodecanoate	(3HDD)

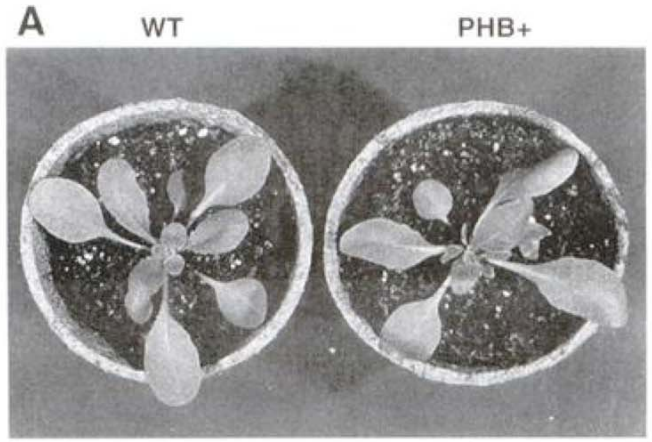


n = 3	4-hydroxybutyrate	(4HB)
n = 4	5-hydroxyvalerate	(5HV)

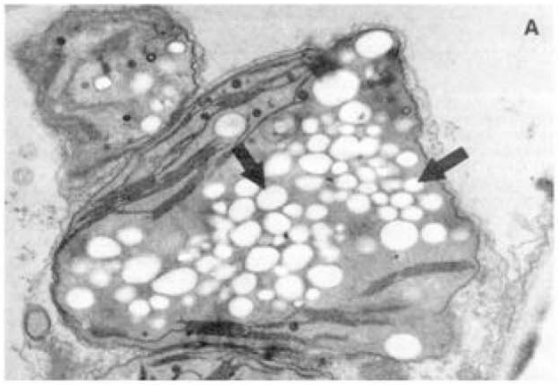
Producció de plàstics biodegradable en plantes: síntesis de PHB in els cloroplastes

Chloroplast Localisation Signal (CLS) added to target each enzyme to chloroplasts





normal vigour



PHB = 14% (dry wt)

Instantánea Archivo Edición Captura Ventana Ayuda lun 12:13

GMO COMPASS – Information on genetically modified organisms

http://www.gmo-compass.org/eng/home/

GMO COMPAS...organisms | Ministerio d... Innovación | PubMed Home | InfoMet | Universitat ...a – EspaiPDI | Universitat de Barcelona

GMO Compass

News/Current Affairs | Grocery Shopping | Agri-Biotechnology | GMO Database | Safety | Regulation | Service

Jul 6, 2009 | 12:05 pm

Site Search

Enter search term ...

Searches all of GMO-Compass in an instant

Glossary

New on GMO-Compass

New database entries

Imprint

GMO Compass

The setting-up of this website was financially supported by the European Union within the European Commission's Sixth Framework Programme from 1 January 2005 until 28 February 2007.

The European Commission and other EU agencies are not responsible for the content.

See what's what.

The GMO Food Database.

You want to know for which food products or plants gene technology plays a role?

Then enter here the name of a plant, foodstuff, ingredient or

Latest News

- **USA: Further high degree of cultivation of GM plants in 2009**
  01 July 2009
- **Renewed approval of GM maize MON810: EFSA has no reservations**
  01 July 2009
- **EU countries should be able to ban genetically modified plants**
  25 June 2009
- **Wheat field trial destruction: GM opponents must pay**
  12 June 2009
- **New EFSA Opinion: BASF now calls for approval the Amflora potato**
  11 June 2009

all messages

Stories

An overview of European consumer polls on attitudes to GMOs

In the field and on the plate, gene technology is seen as controversial, particularly in Europe. The European Commission, as well as national institutes and agencies, regularly conduct polls in order to assay the general tendencies of consumers.

Online Discourse Co-existence

What lies in the future for GM crops in Europe?

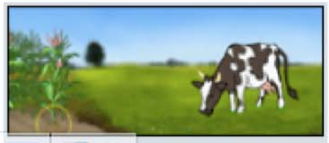
Take a look at the open discussion carried out with co-operation of experts from the field last autumn.

More details here

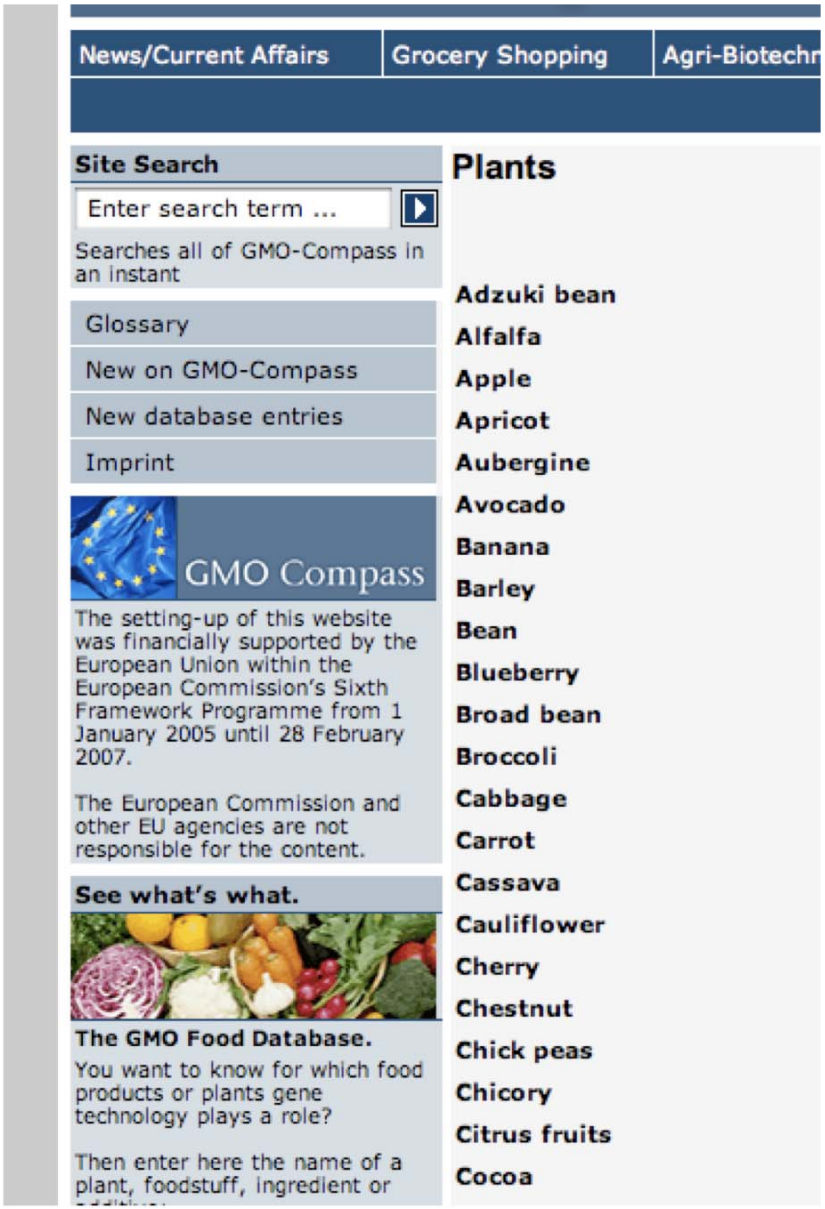
Animation: The Authorisation Process in Motion!

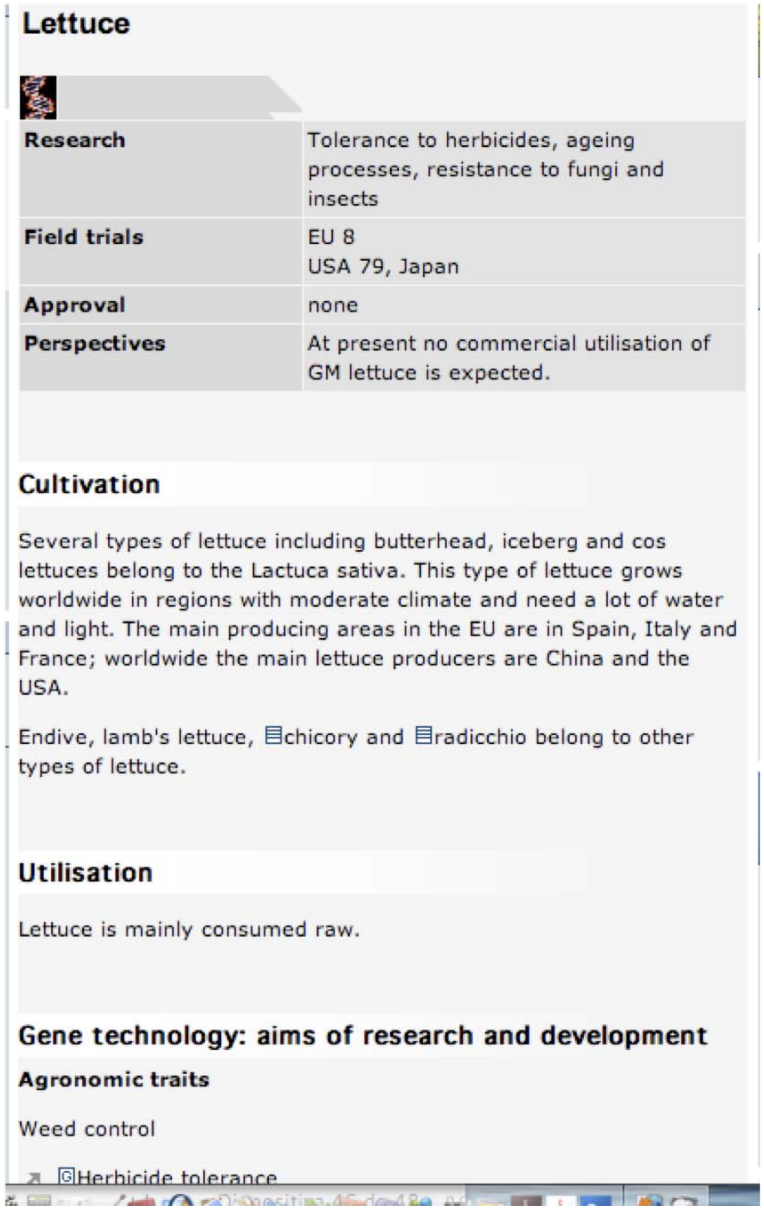
Applying, consulting, and making a decision: The long and winding road to GMO authorisation in the EU

start animation



http://www.gmo-compass.org/eng/home/





Risks and concerns

Impact of Bt-corn on monarch butterflies

A milkweed plant (foreground, left)-- the sole food source of monarch butterfly larvae-- grows in a ditch next to a corn field.

GE and Food Allergies

Genetic engineering usually introduces a new protein into a plant. Could the new protein cause allergic reactions?

Photo: USDA

Peanuts, one of the more common food allergens, can cause many people to have severe allergic reactions.

GE and Pesticide Use

Proponents of genetic engineering argue that GE plants could reduce pesticide use. Do they?

GE and Antibiotic resistance

The rise of antibiotic resistant bacteria is a serious human health problem. Could genetic engineering make it worse?

Horizontal Gene Transfer

The tassel atop a corn plant sheds gene-carrying pollen into the wind.

Photo: USDA

In the plant world, genes don't "stay put." Genes from GE plants could move to other non-GE varieties of the same crop or to other wild relatives.

Plant Toxins and Antinutrients

Most plants-- including food plants we eat-- contain low levels of natural plant toxins. Could genetic engineering inadvertently elevate the levels of these toxins?

Photo: USDA ARS

A chemist measures the levels of toxins in plant tissues to evaluate their safety for animal feed.

Increased Weediness

A researcher inspects a cypress forest that has been swamped by an invasive climbing fern.

Photo: USDA ARS

If genetic engineering significantly alters how a plant grows and reproduces, could normal crop plants become more "weedy" or invasive?

Experimental Corn Contaminates Soybeans

A biotech company is currently being investigated by federal authorities after a soybean field was found to be contaminated with one of the company's experimental corn varieties. None of the contaminated soybeans entered the food supply.

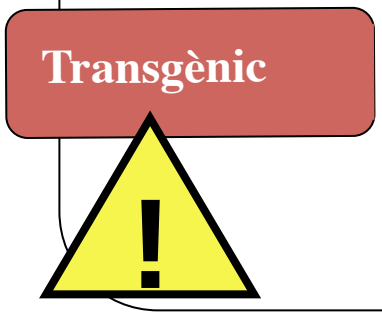
ProdiGene Inc. of College Station, TX, is developing several varieties of genetically engineered corn that produce pharmaceutical and industrial-related compounds. Among them are corn plants that produce trypsin (a protein used in the processing of insulin and in other research applications), oral vaccines, antibodies, and other enzymes for industrial uses. Most of these crops are experimental and not yet grown commercially, but ProdiGene does have trial fields of some of these crops in several states.

Normativa europea sobre l'etiquetat de productes transgènics (Març de 2004)

S'han d'etiquetar

1) tots els OMG agraris i ramaders de consum humà

2) Els productes elaborats que continguin algún ingredient derivat d'OMG > 0,9% (encara que no sigui detectable en una anàlisi final d'ADN)



Exemples:

Aliments elaborats amb additius transgènics (farines, dextroses, olis, midons)

Productes a granel (fruites i verdures)

Pinsos fets de cereals transgènics

No s'ha d'etiquetar

1) Carn, llet o greix d'animals alimentats amb pinsos transgènics

2) Ous d'aus alimentats amb pinsos transgènics

Informació visible i sense termes confusos