

Gurteen Agricultural College
Environmental and Sustainable
Farming

Level 6 Certification

In association with

Susliving

Module 6

Sustainable Farming and Environmental
Protection Schemes, Biotechnologies

6.6 & 6.7 Biotechnology

GURTEEN

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Biotechnology....applying technology to alter or modify products or processes for specific use

A genetically modified organism (GMO) is an organism whose genetic material has been altered

Plant and animal DNA can be changed /altered by genetic engineering techniques ---

In the 'old days':

(a) Mutation breeding - the process of exposing seeds to chemicals or radiation in order to randomly generate lots of mutants some of which, it was hoped, would lead to plants with desirable traits (e.g., had higher yield, were disease or cold-resistant or just had unusual colors. From 1930–2007 thousands of mutagenic plant varieties were released. However, it is unclear how many of these varieties are currently used in agricultural production around the world, as these seeds are seldom identified or labeled as being mutagenic.

Nowadays:

(b) Genetic modification (GM) - using the techniques of “modern biotechnology”* (as opposed to traditional breeding or mutation by chemicals / radiation) to alter the genetic makeup of the organism concerned.

Link to excellent 1 page summary here: <http://www.isaaa.org/resources/publications/pocketk/1/default.asp>

Area of Genetically Engineered Crops, 1996 to 2006: By Crop (million hectares)								
Crop	Soybean	Maize	Cotton	Canola	Squash	Papaya	Potato	Total
1996	0.5	0.3	0.8	0.1	--	--	<0.1	1.7
1997	5.1	3.2	1.4	1.2	--	--	<0.1	11.0
1998	14.5	8.3	2.5	2.4	0.0	0.0	<0.1	27.8
1999	21.6	11.1	3.7	3.4	<0.1	<0.1	<0.1	39.9
2000	25.8	10.3	5.3	2.8	<0.1	<0.1	<0.1	44.2
2001	33.3	9.8	6.8	2.7	<0.1	<0.1	<0.1	52.6
2002	36.5	12.4	6.8	3.0	<0.1	<0.1	--	58.7
2003	41.4	15.5	7.2	3.6	<0.1	<0.1	--	67.7
2004	48.4	19.3	9.0	4.3	<0.1	<0.1	--	81.0
2005	54.4	21.2	9.8	4.6	<0.1	<0.1	--	90.0
2006	58.6	25.2	13.4	4.8	--	--	--	102.0

ISAAA, Clive James, 2006.

Graph above shows the increasing number of plant genomes being sequenced (i.e., genetic makeup worked out).

“Modern” biotechnology involves knowing the genetic makeup of the organism (i.e. its genome – see below), so that particular genes, known to be responsible for certain traits, can be selected for

modification. This is (potentially) a more efficient way to acquire new traits than by traditional breeding methods (e.g., making lots of crosses and hoping for the best, without really knowing what genes are involved).

Having the genome sequence is only a first step to figuring out what all the genes actually do and then (further in the future) being able to use that knowledge to make GM versions with the traits you want.

So far there are only a few GM crops that are widely grown, and these have been modified in relatively simple ways (e.g. for herbicide tolerance or insect resistance) . See the figures in this link http://knowledge.allianz.com/environment/food_water/?500/gm-crops-facts-and-figures

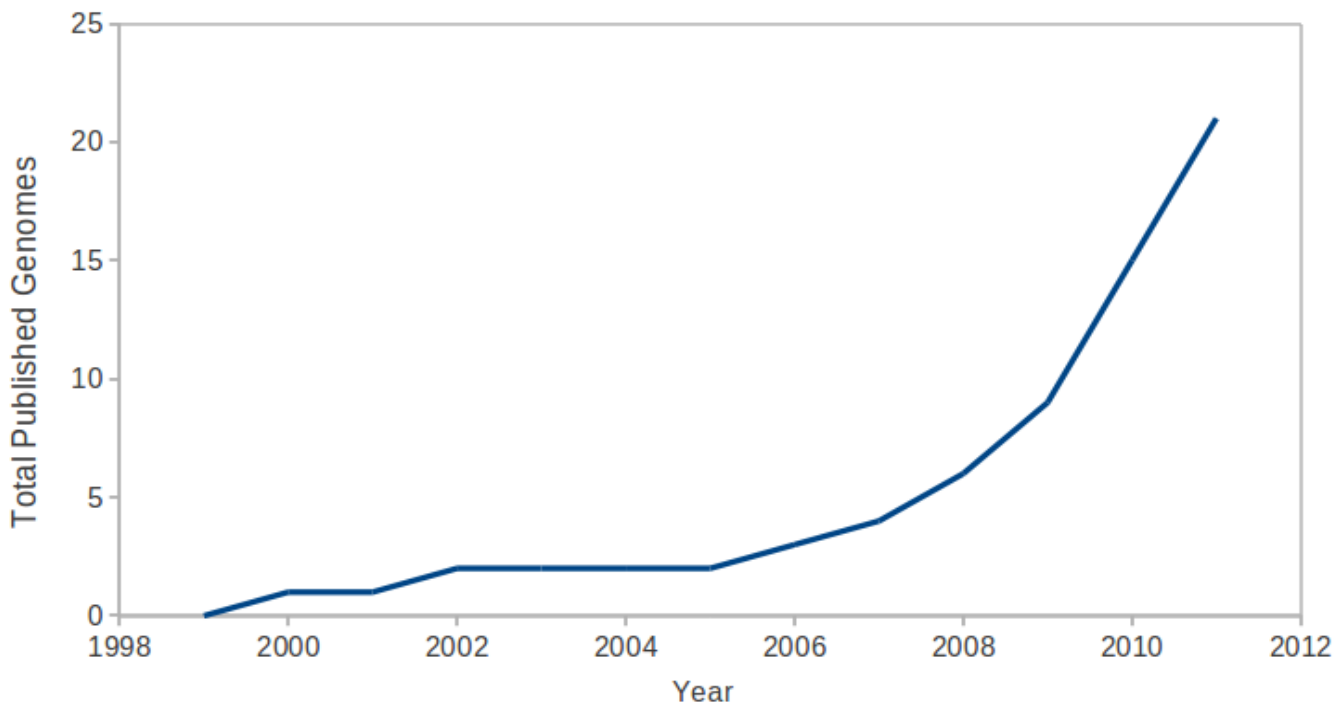
GM crops are soybean, maize, cotton, and canola / rapeseed. Genetically modified plantings of these four crops have increased continually over the last years. See table following:

Some examples:

- Rice (2002)
- Poplar (2006)
- Maize (2009)
- Apple (2010)
- Potato (2011)
- Cotton (2012)
- Barley (2012)

So, as more genomes are sequenced, research into new genes to modify will also accelerate, with a focus on traits that might address global challenges – food security, climate change, biodiversity / environmental protection.....

Growth in Plant Genomes



The desired result from this process could be an altered amount, or quality of desired traits

- 1...faster growth; more biomass (yield); better quality (nutrition, flavour, long lasting (e.g. for storage, or reaching market in good condition)....
- 2...resistance to pathogens (biotic stress – also see abiotic stress, below)

- 3...production of extra, or new, nutrients, (flavours, pharmaceuticals.....)
- 4...more, or better quality, or entirely new flowers / seeds / fruit.....
- 5...ornamental features - bushier/ lower growth.....
- 6...adaptation to new growing regions (day length, seasonality, rainfall, altitude, wind, temperature range.....)
- 7...adaptation to abiotic stress (e.g. from climate change) – salt stress, drought stress, water stress, nutrient stress (e.g. ‘poor’ soils, depleted soils, marginal soils.....)

Consumer and world trade issues...

- 1..health issues...proven to be no greater risk to human health than conventional food
- 2..ecological concerns ; possible unforeseen effects on ecosystem
- 3..economic concerns ; intellectual property law v natural selection
- 4..product labelling should be clear enough to inform consumers fully
- 5..full and sufficient testing to be carried out to satisfy consumer concerns

EU policy...

Use of G M crops around the world is wide spread , but limited in Europe which has a precautionary approach , whereas the US has a product based approach (see map " global status of GM crops")

Genetically modified crops...some examples...

EU ...maize

America...maize, soybean, cotton, canola, sugarbeet, alfalfa, papaya, squash

China...cotton, papaya, poplar, tomato, sweet pepper.

Biotechnology in Animal Health

Animal biotechnology encompasses a range of techniques for the genetic improvement of domesticated animal species. Many biotechnologies have been incorporated into livestock breeding programmes (AI, siretesting, embryo transfer, DNA selection). It also includes the more controversial technologies of cloning and genetic engineering.

The animal biotechnology industry faces a variety of scientific, regulatory, ethical and public acceptance issues.

Biotechnology in Animal Feed

The most common animal feeds are soya, maize, oilseed rape and cotton seeds.

In Europe the animal feed most likely to be genetically modified are soya and maize.

Problems :

- ✓ Environmental impact of GM animal feeds
- ✓ Effect of GM crops on biodiversity
- ✓ Cross pollination (can cause gene escape)

Solutions :

- ✓ Carry out extensive farming (rather than intensive) using on farm feed production
- ✓ Supply chains should be fully transparent and traceable
- ✓ Provide consumers full label information detailing whether animals are GM fed.