GMO-crops: technical possibilities and problems

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Genetic modification

- Adding or changing of traits by introduction of genes from different organisms or by inhibting expression of endogenous genes

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Facts

- GMOs since 1984 (tobacco)
- Most GMOs in 4 crops (so called input traits)
- Different technologies to introduce genes in plants
- Simple approaches (mostly genes from other organisms)
- Molecular farming as option
  - "Coconut oil" in oilseed rape
  - Production of important biochemical compounds (health related components)
  - New fibers for different applications
  - Polymeric sugars next to starch

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1st Generation of Modified Plants

- Improved disease resistance
  (Viruses, fungi)
- Improved pest resistance
  (Lepidoptera, beetles)
- Tolerance for herbicide
  (glyphosate, glufosinate)
- Slow ripening

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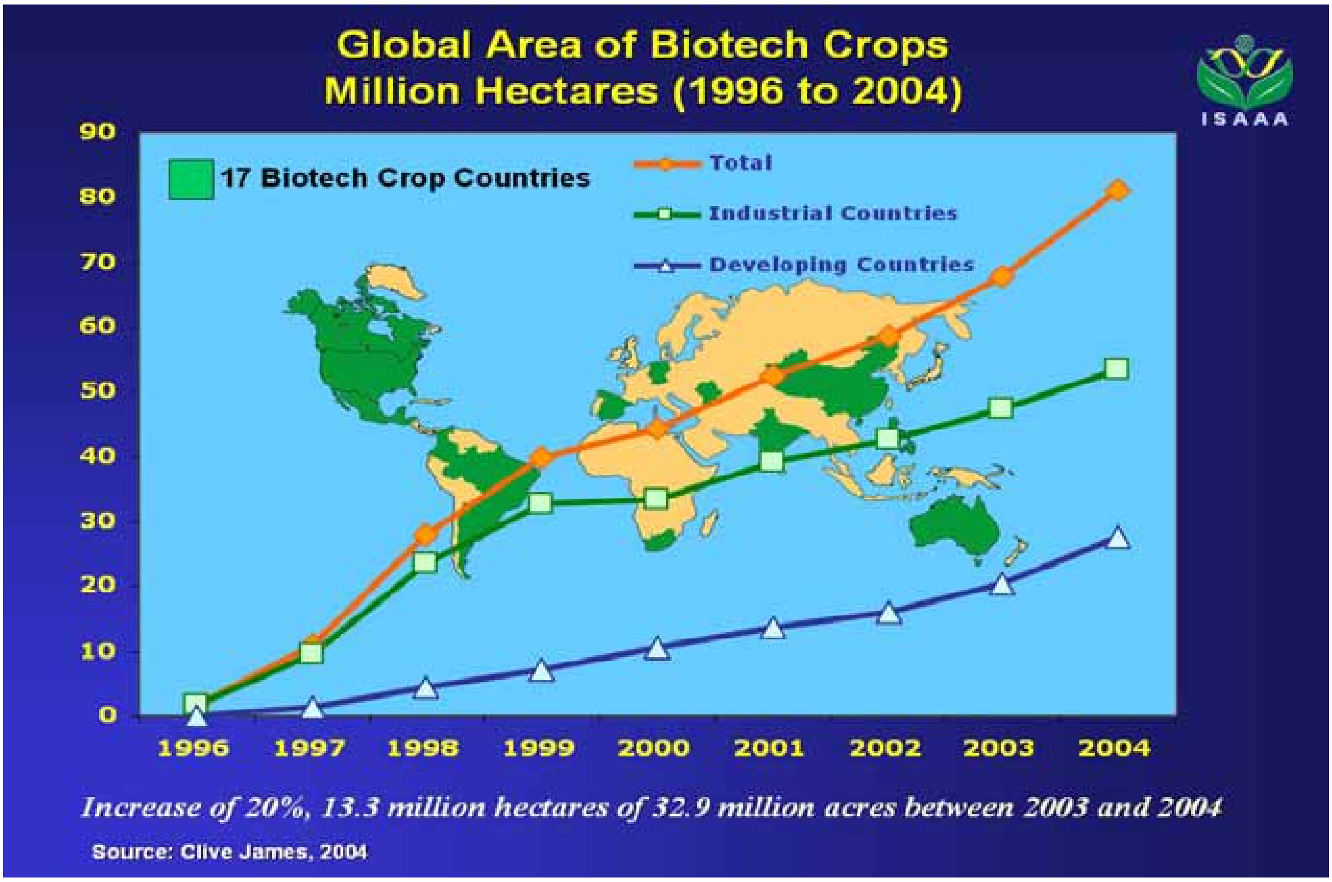

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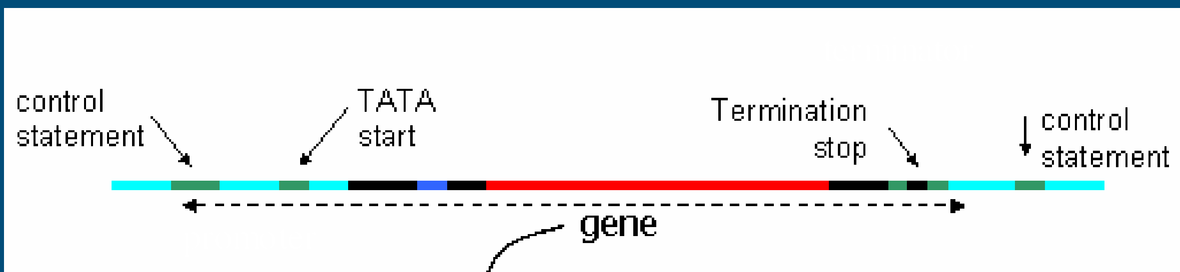
Gene preparation



- Promoter
- Termination sequences
- Translation signals
- Codon usage

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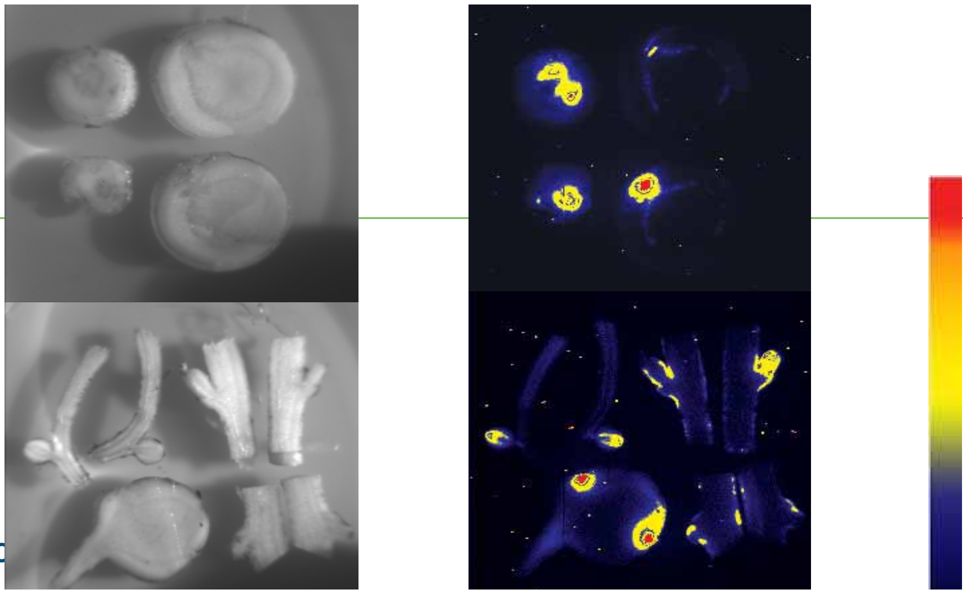
Limitations in the 80/90ties

- Species/ genotype differences
- Promoters not specific
- Copy number
- Position effects
- Selectable marker genes
- Gene silencing

Novel possibilities

- Many genes for traits available
- Transformation (& regeneration) systems for most crops available
- Promoter specificity improved
- Copy number & Position effects
- Selectable marker genes no longer needed
- Gene silencing (RNAi)



Promoter 19094 (line 44.1)

Bea Horvath

Novel possibilities

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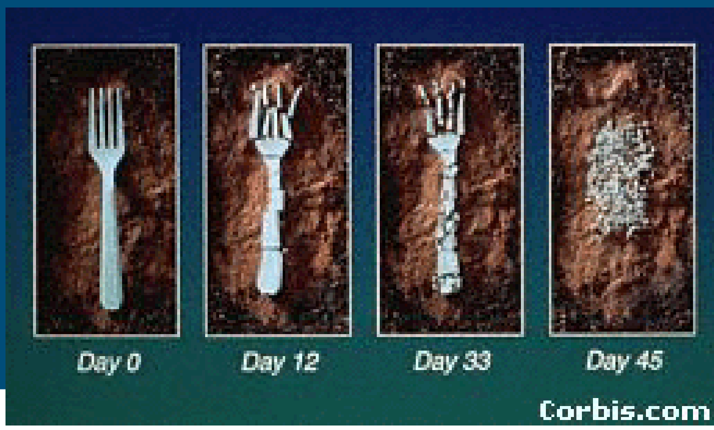
Molecular Farming

a. Starch (amylose-free potato)

b. Biodegradable plastics (polyhydroxybutyrate- PHB)

c. Pharmaceuticals/Edible vaccins (many in development)



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Possible starch modifications

- starch yield
- reduction contaminating substances such as lipids
- granule size distribution
- ratio amylose/amylopectin
- chain-length distribution
- degree of phosphorylation

Farhad Nazarian

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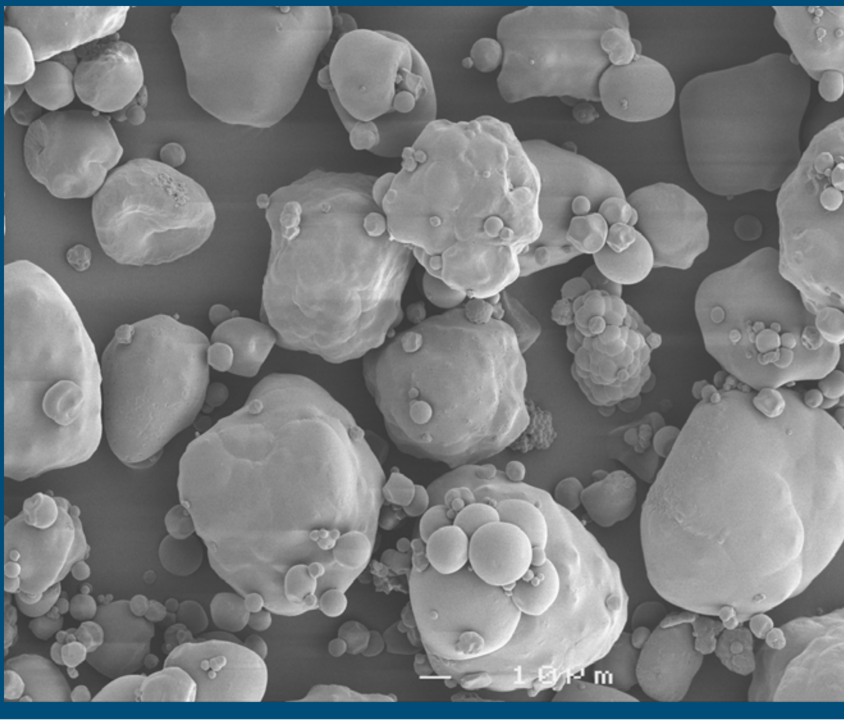
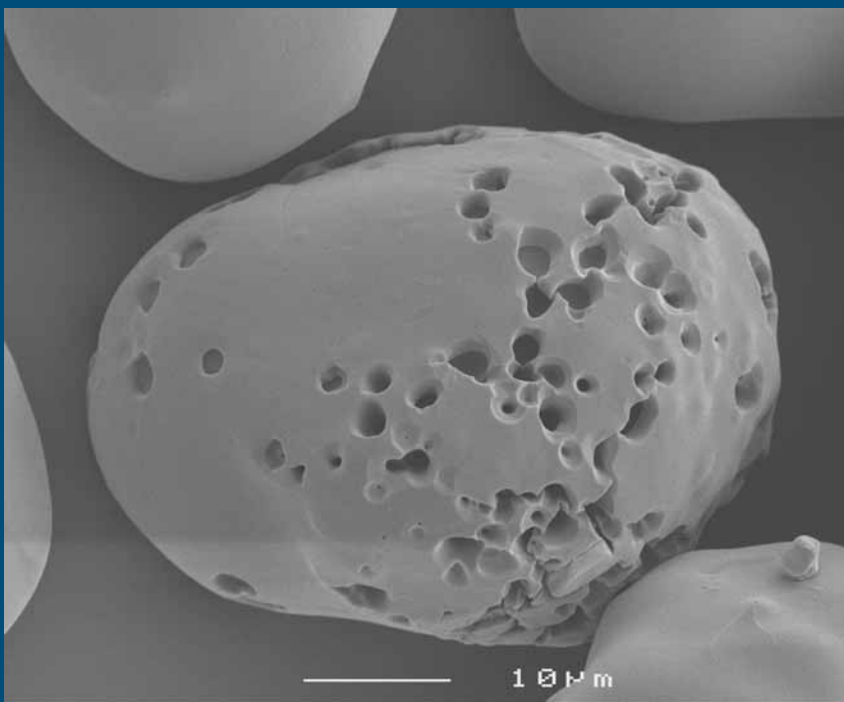
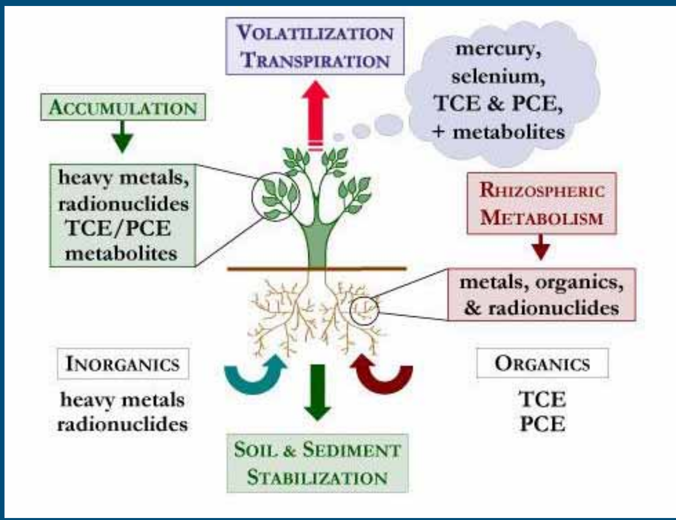
Construct x in Wt background…



…*and in amf* background



Detoxifying Contaminated Soils



Engineered plants to breakdown heavy metals

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SHINE overexpression confers drought tolerance in rice

SHINE overexpression

Reduces stomata

	Stomatal density (cells/0.16 mm²)
Wild-type	56
35S-AtSHN1	38

Enhances drought tolerance

14 day rice seedlings
9 days without water

1 week of recovery
after rehydration

WT 35S-SHN WT 35S-SHN

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Andy Pereira

Crambe abyssinica

- Oil content 35-60%
  - Erucic acid 58-66%
  - Feedstock for industrial oils
  - Highly compatible with mineral oils
- Identification of mutants with high-saturated fatty acids
- High C18:1 & more C22:1
- Replacement of mineral oil for industrial uses
  - 10% of the mineral oil market
  - wax ester and high capric oil production (GMO)

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Elma Salentijn

Experiences and new chances

Experiences:

- More than 235 million ha of GMO grown without problems
- “Clean” GMO-vectors, without selection genes developed
- From main crops all genes will become available
- Plant-gene isolation protocols highly improved
- Knowledge on plasticity of plant-genomes is rapidly increasing

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Not only GMO approaches

- Marker assisted selection as tool to improve breeding efficiency
- Specific crops for biomass production and use
- Specific crops for bio-ethanol production
- High fibre crops
- Breeding for high energy conversion

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Miscanthus sinensis: species of interest

- good agronomic characteristics as potential energy crop
- perennial crop
- seed fertility
- major component species of *M. x giganteus*
- weaknesses on combustion quality

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Oene Dolstra

BIOMIS

Selection Criteria

- High energy yield
  - Full use of growing season
  - Good adaptation to low temperature
  - Disease resistances
- Reduction of costs for plant establishment
- Excellent combustion quality
  - Low dry matter content
  - High bulk density
  - Low contents of adverse minerals

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Biomass for Combustion

- Fouling
- Slagging
- Corrosion

Heat

&

Power

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BIOMIS

Slagging

Fouling on the furnace walls

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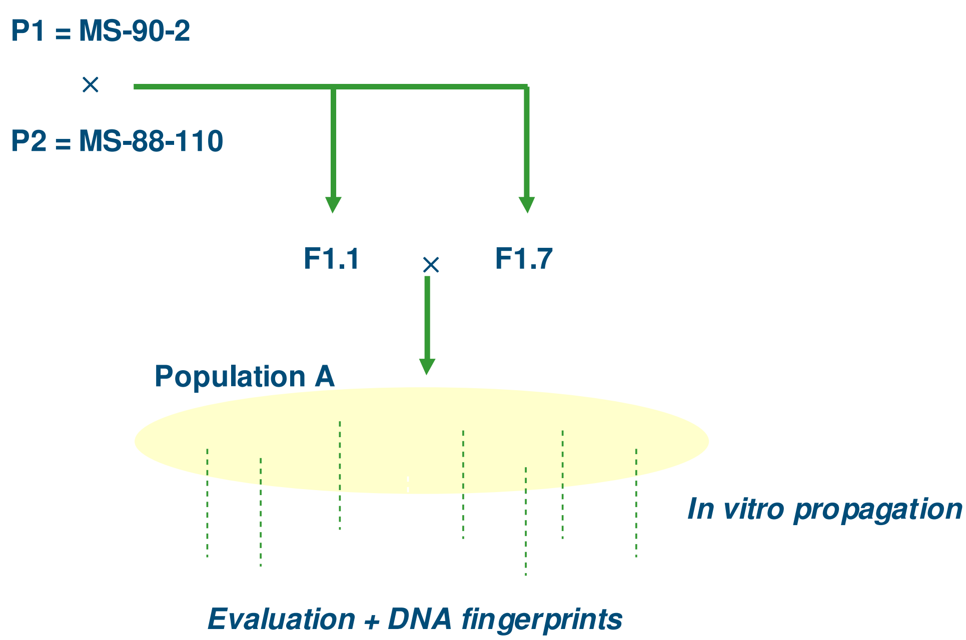
Combustion quality

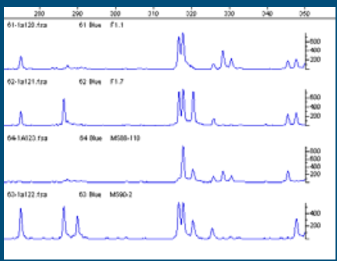
- Major technological quality criterion
- Assessment difficult, time-consuming and costly
- Post-harvest trait, so selection relatively ineffective
- Good characteristic to tackle through marker-aided selection

Mapping Population



Analyses of Variation--->Detection of QTLs

evaluation → genotype means



DNA-profiling → profiles + map

genotype means / profiles + map → QTL analyses with software

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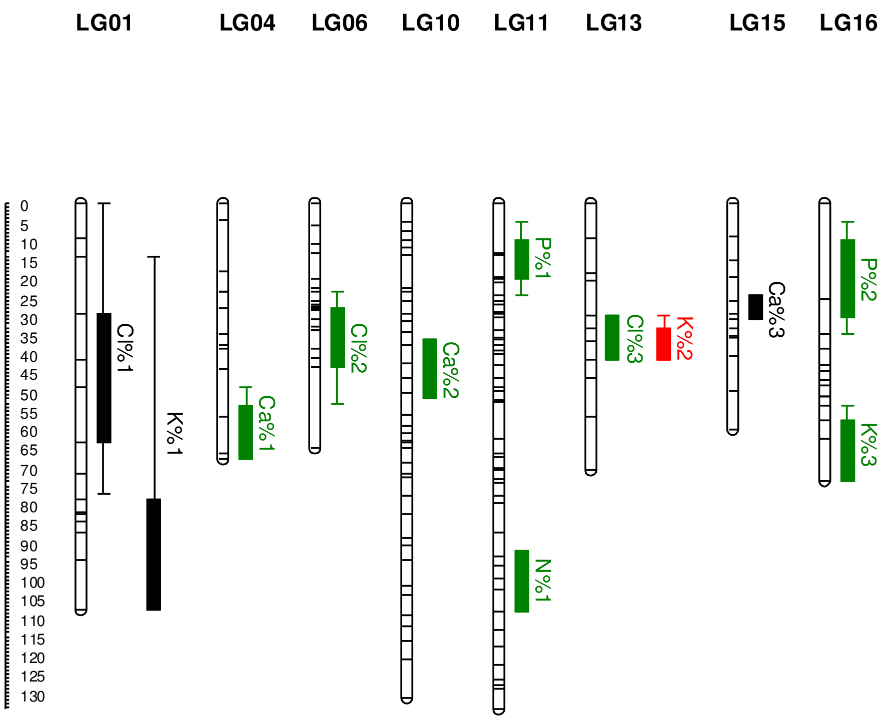
QTLs for Chemical Constituents of Stems



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Conclusions

- GMO approaches are very useful for making customers oils and carbohydrates in large quantities
- Health related and pharma components
- Difficult traits such as adaptation (drought & salt tolerance) come within reach
- Biomass improvement and bioconversion are possible breeding targets (both conventional and GM breeding)
- Multipurpose crops???

GMOs

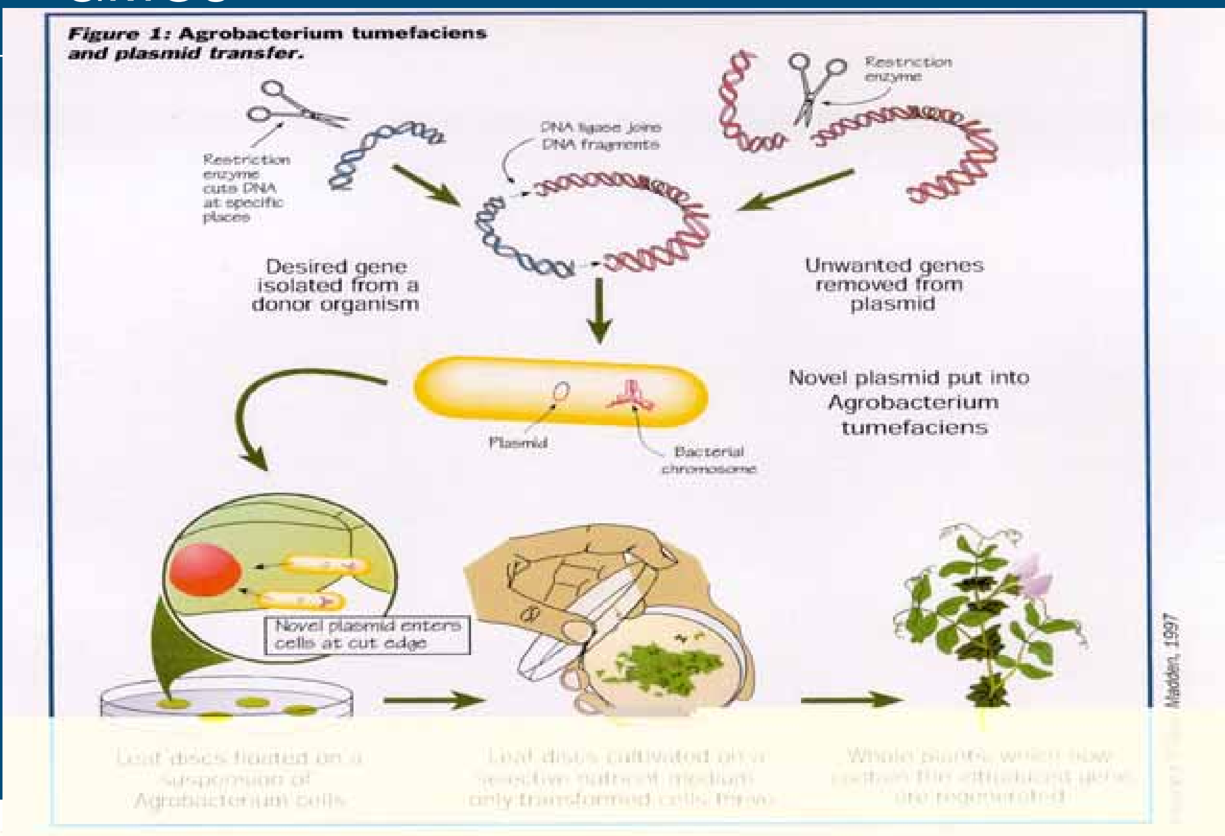

Figure 1: **Agrobacterium tumefaciens and plasmid transfer.**

Share of GM Crops in Total Crop Acreage