

GENERAL OVERVIEW OF AGRICULTURAL BIOTECHNOLOGY IN GHANA AND THE AFRICAN PERSPECTIVE

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PRESENTATION OUTLINE

- Brief definition of Biotechnology
- Applications of Biotechnology in Plant Breeding
- Genetically Modified Organism (GMOs)
- Basis of Genetic Modification
- Genetic Modification in the past and present
- Prospects of Genetic Modification for Ghana and Africa
- Conclusion

WHAT IS BIOTECHNOLOGY?

By definition, biotechnology refers to any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for a specific use.



Classification of Biotechnology

Conventional Biotechnology:

uses microbiology and other biological agents to make new products.

Examples

- Fermentation
- Baking of Bread
- Local brewing of alcohol
- Cheese production
- Vaccine production

Modern Biotechnology:

Use of techniques that bring about specific man made changes in the genetic materials (DNA) in plants, animals and the microbes to generate useful products and services.

It is also known as:

- Gene Technology
- Genetic Engineering
- Genetic modification
- Recombinant DNA Technology

IMPACT OF BIOTECHNOLOGY

Biotechnology has made significant impact in

- Medicine
- Industry
- Animal Breeding
- Plant breeding
- Crop production



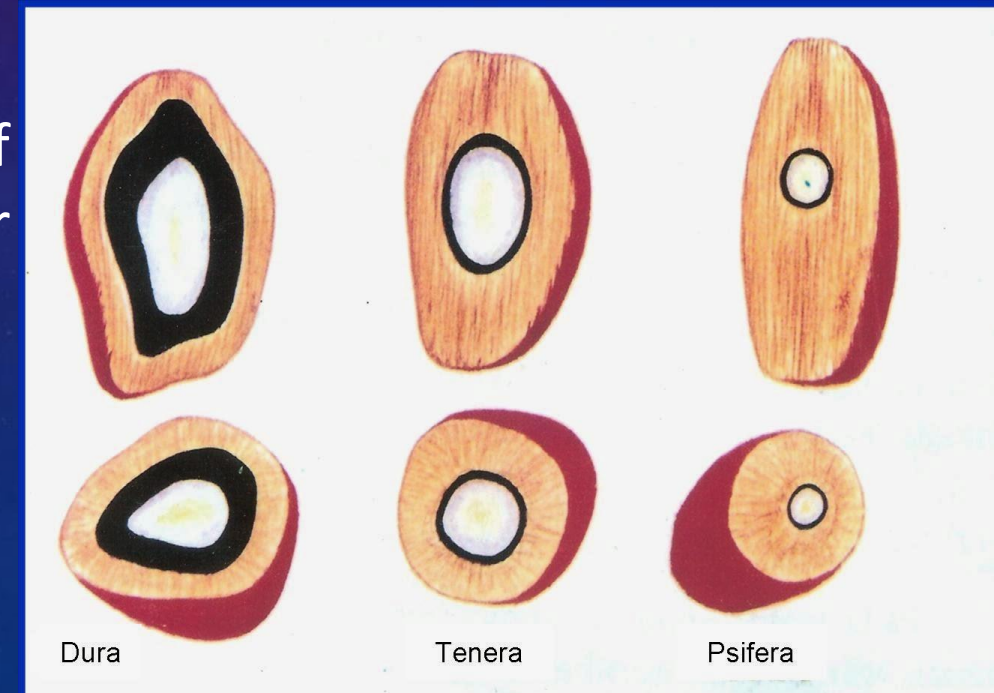
APPLICATION OF BIOTECHNOLOGY IN PLANT BREEDING

1. MARKER – ASSISTED SELECTION

An **indirect selection process** where a trait of interest is selected, not based on the trait itself, but on a marker linked to it or DNA sequences linked to the trait.

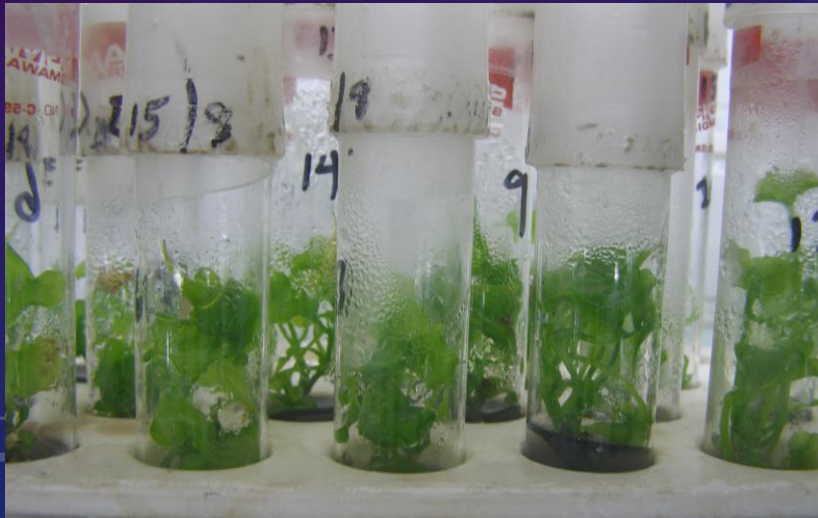
For example, selection of disease resistance, the level of disease resistance is not quantified but rather a marker allele that is linked with disease resistance is used.

E.g. Oil palm breeding



2. CELL AND TISSUE CULTURE

Growing of cells, tissues or organs in artificial medium under sterile conditions



Yam plantlets

- Rapid Multiplication
- Disease elimination
- Long term germplasm conservation
- Genetic engineering

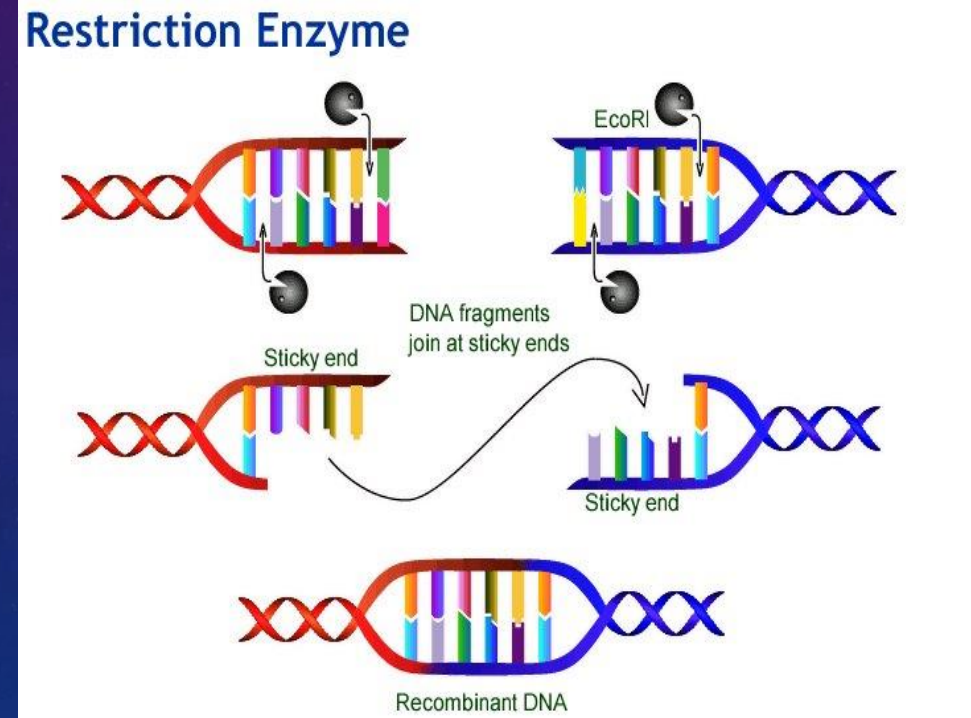


Plantain multiplication

3. RECOMBINANT DNA OR GENETIC ENGINEERING OR GENETIC MODIFICATION (GMO)

Direct transfer of genes from one organism to another. Organisms may or may not be related.

- Highly specific
- Overcomes genetic barriers
- Saves time and labour



Genetically Modified Organisms (GMOs)

What is a GMO?

An organism in which one or more genes have been introduced into its genetic material (DNA) from another organism using recombinant DNA technology or genetic transformation techniques.

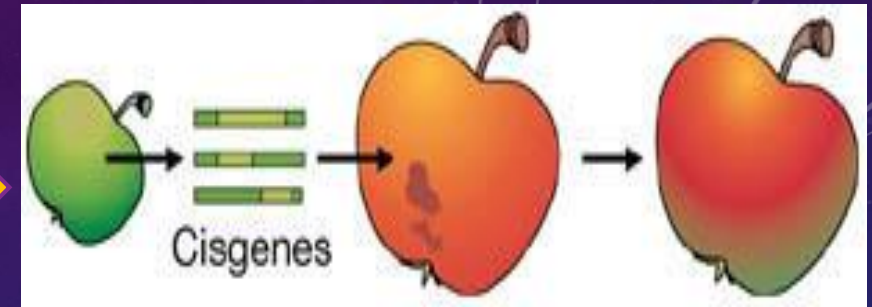


*Food products obtained from genetically modified organisms are termed **GM foods**.*

Types of Genetic Modification

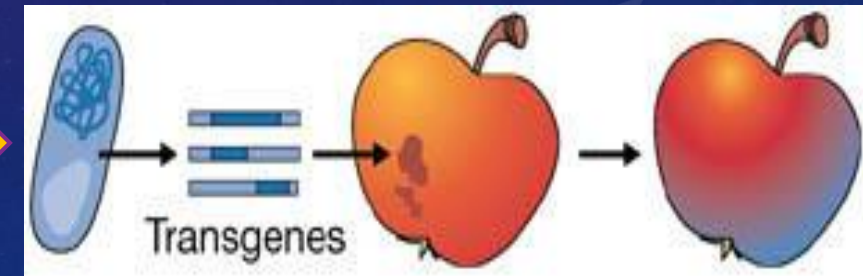
Cisgenesis

Genetic modification of a recipient plant with a natural gene from a crossable—sexually compatible—plant



Transgenesis

Genetic modification of a recipient plant with one or more genes from any non-plant organism, or from a donor plant that is sexually incompatible with the recipient plant



Genetically Modified Organism

In some cases more than one gene can be inserted into one living organism. This is known as stack genes.

Above ground Corn borer

Weed control Glyphosate tolerance

Below ground Rootworm



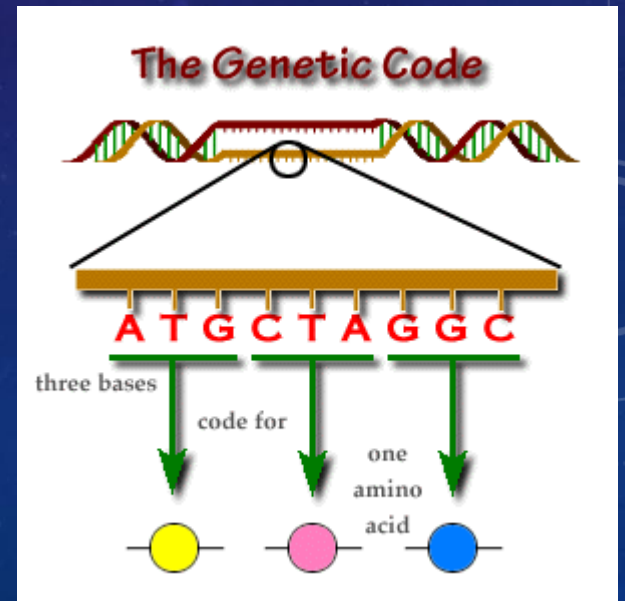
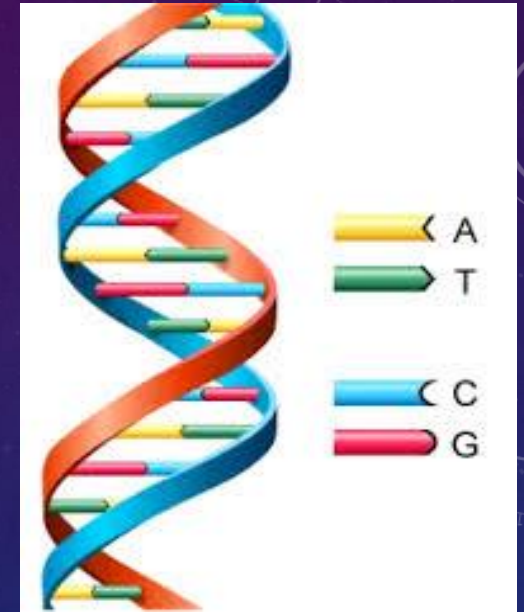
Pest, diseases and weeds can be controlled at the same time

Basis for Genetic Modification

- ❖ Genes form long strands called DNA.
- ❖ DNA stores all the genetic information

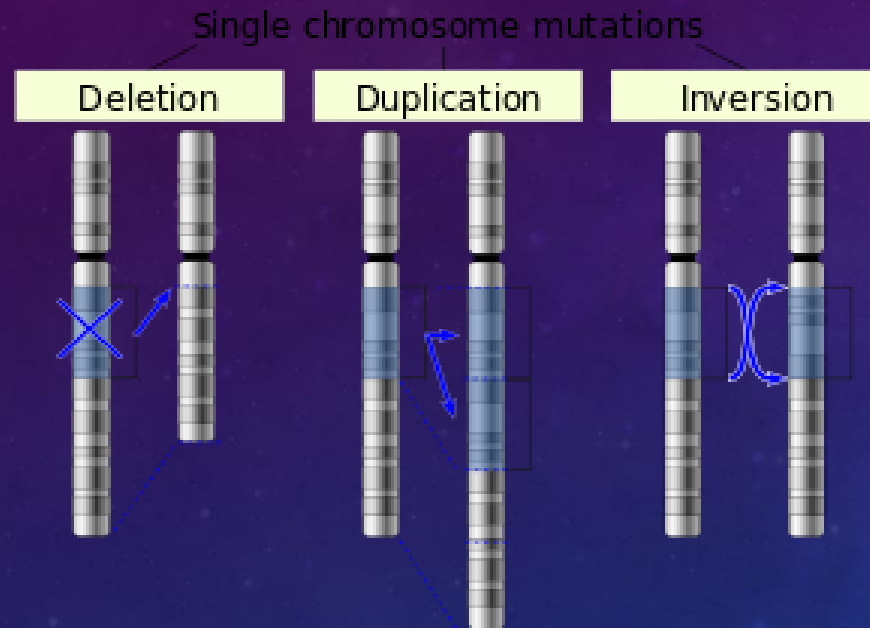
The chemical compound of DNA is the same for all living organisms and hence they can be moved from one species to another. This is the basis for genetic modification.

In Genetic modification, **genes** and **not** chemicals or fluids or organisms are transferred into another organism.



Genetic Modification in the Past

1. Spontaneous Mutation



This mutation occurs as a result of background radiation

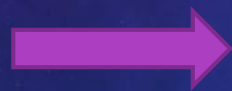
Genetic Modification in the Past

2. Selection

Farmers selected seeds from vigorous, high yielding plants and used them for sowing in the following season. Selective sowing of seeds with preferred traits, from year to year led genetic modification of wild plants into domesticated crops (Conway, 2012)



Teosinte



Maize

How your food would look if it hadn't been genetically modified over millennia?



watermelon



corn



banana



aubergine / eggplant



carrot



cabbage, kale, broccoli, etc.

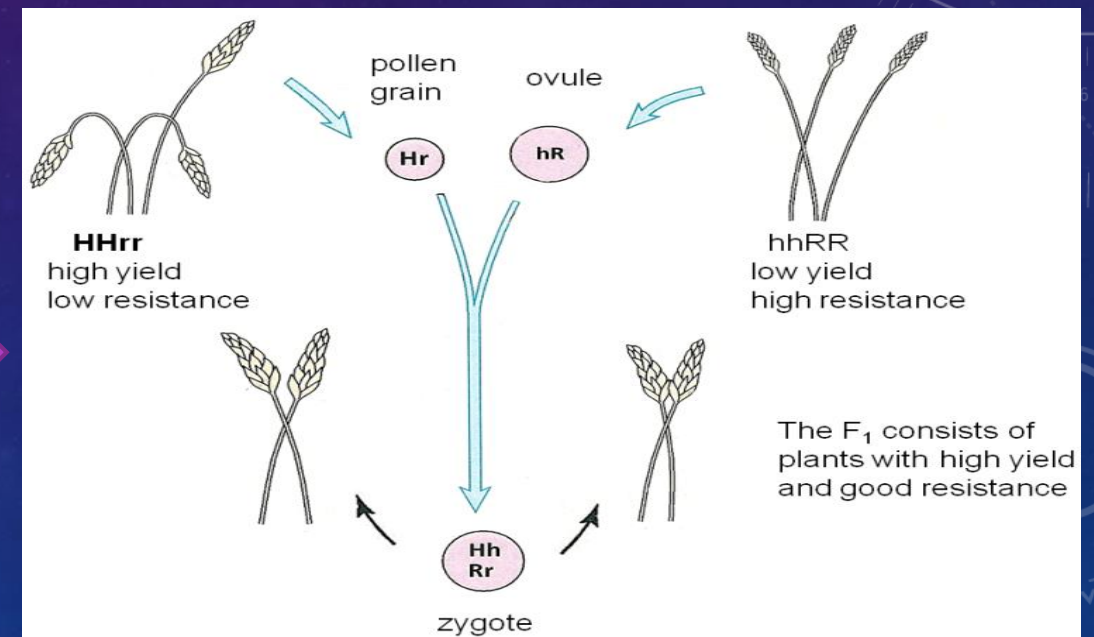
<http://gawker.com/is-the-gmo-labeling-movement-just-a-long-con-to-get-you-1699015048>

Genetic Modification in the Past

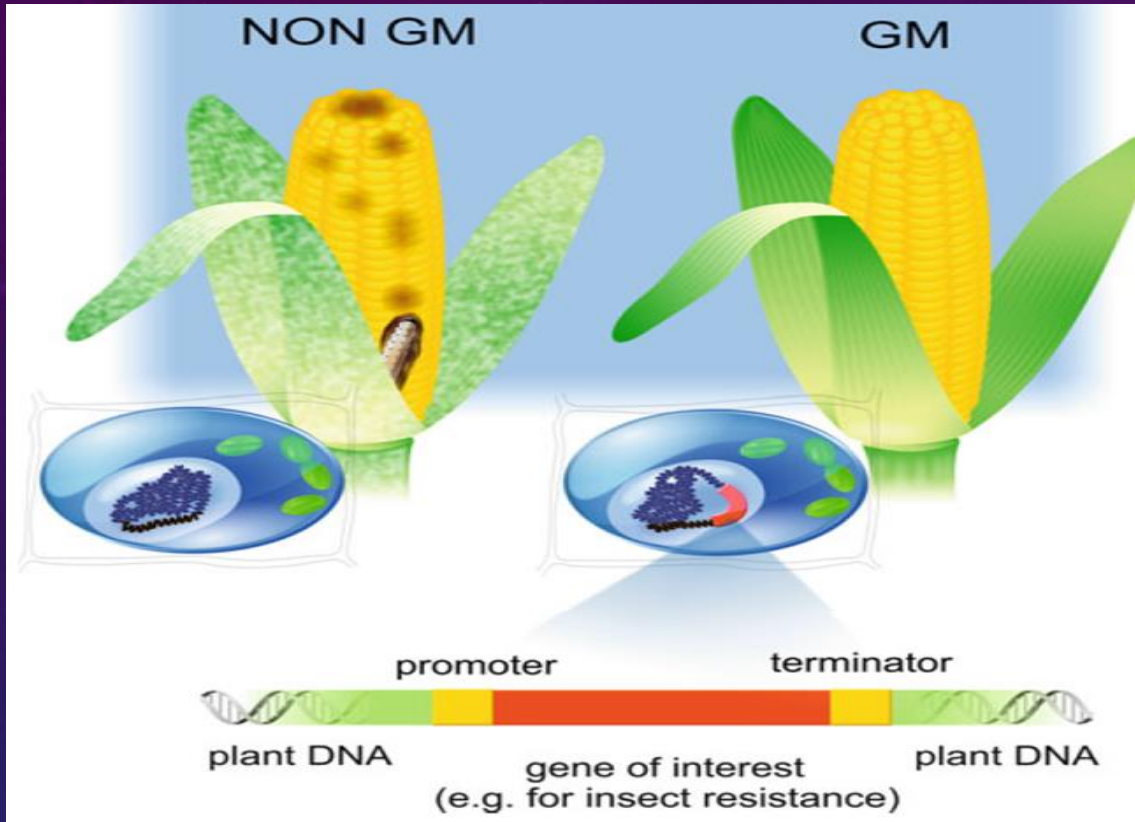
3. Conventional hybridization:

Artificial hybridization including conventional cross pollination and unnatural wide crosses.

Development of plants with high yield and good resistance to diseases



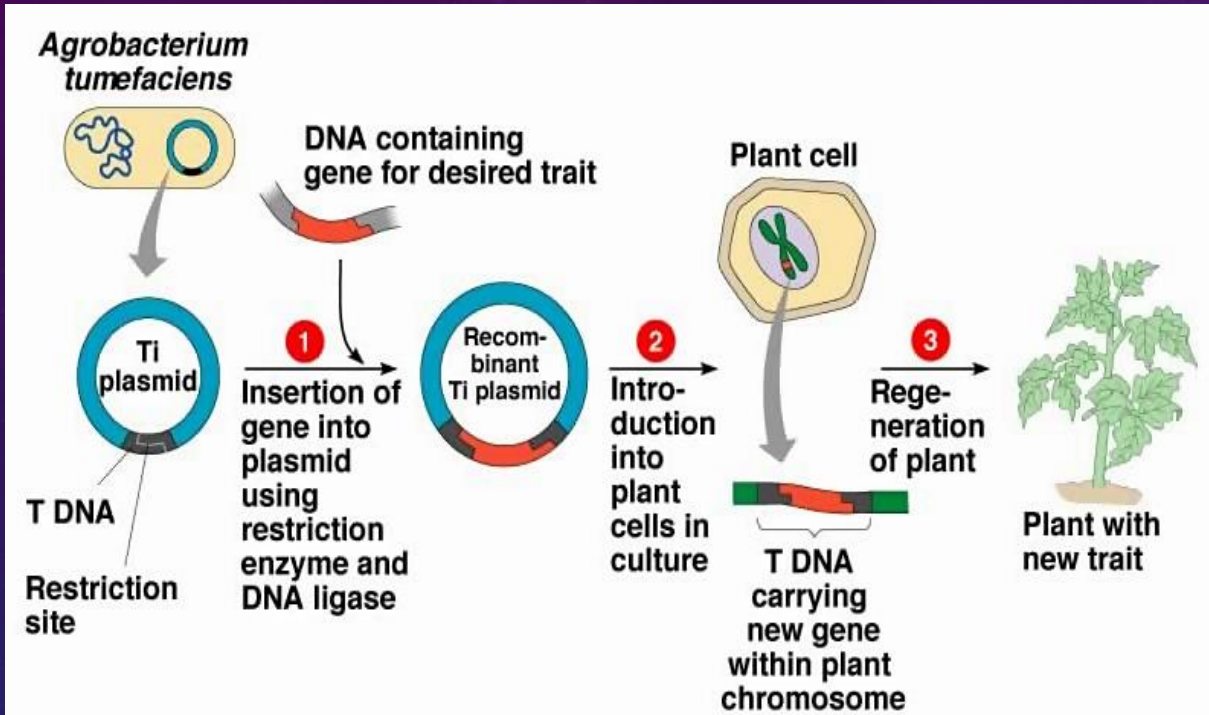
GENETIC MODIFICATION/ENGINEERING IN THE PRESENT



A gene of a specific trait of one organism is isolated, cut, and moved into the genome of another organism via *Agrobacterium* or particle bombardment.

Although plant and animal breeding is now considerably more sophisticated than a century ago, in its essentials, it has little changed.

Genetic transformation



Agrobacterium tumefaciens



Direct transfer



GM Crops under Confined Field Trials in Ghana

Species	Genetically conferred trait	Institute
Cowpea	Pest resistance	SARI
NEWEST Rice	N use efficiency Water use efficiency Salt tolerance	CRI



Courtesy: PBS Ghana

PROSPECTS OF GENETIC MODIFICATION/GM CROPS IN GHANA

- Creation of new plant varieties and animal breeds with higher yields thereby ensuring food security.
- Higher economic benefits for resource poor farmers
- Resistant to pest and diseases



PROSPECTS OF GENETIC MODIFICATION/GM CROPS IN GHANA

- Reduction in the use of chemicals.
- Protection of the environment
- Tolerance to drought, salinity, chemical toxicity

- Production of crops with enhanced nutritional value e.g. Golden rice (enriched with provitamin A).



Modification of plant nutritional content: Increasing the vitamin A content



Golden rice produces provitamin-A (beta-carotene)

SOME PROBLEMS THAT NEED URGENT GENETIC MODIFICATION SOLUTIONS



Cassava Brown Streak Virus (CBSV) Disease Devastation in East Africa



Availability of cassava tubers on the market does not mean that there are no problems with the cultivation of the crop.

SOME PROBLEMS THAT NEED URGENT GENETIC MODIFICATION SOLUTIONS



“Bosom nsia” cassava variety without ACMV infection



Bosom nsia with African Cassava Mosaic Virus (ACMV) infection



SOME PROBLEMS THAT NEED URGENT GENETIC MODIFICATION SOLUTIONS



Genetically engineered plantains/bananas are needed to solve the black sigatoga disease associated with plantains, Cape St Paul disease in coconuts. These are diseases that require genetic solutions.

If the gene technology can stop it, why not use it?

Conclusion

- Modern biotechnology or Genetic modification has become one of the best tools in plant breeding which is used to solve crop production crises .
- Thus, its application is driven by a need (eg low yield, diseases and pests, drought)
- Has huge potential to:
 - improve crop yield and income of farmers,
 - improve their livelihood
 - ensure healthy environment for both humans and animals.

The application of biotechnology especially genetic modification is complementary to conventional plant breeding but not a “silver bullet” to all the problems associated with global food production.

Which one is safer?

Industrial vaccines



this is safe

Edible vaccines



but this is not! WHY?

Why no public concerns about use of vaccines?



THANK YOU