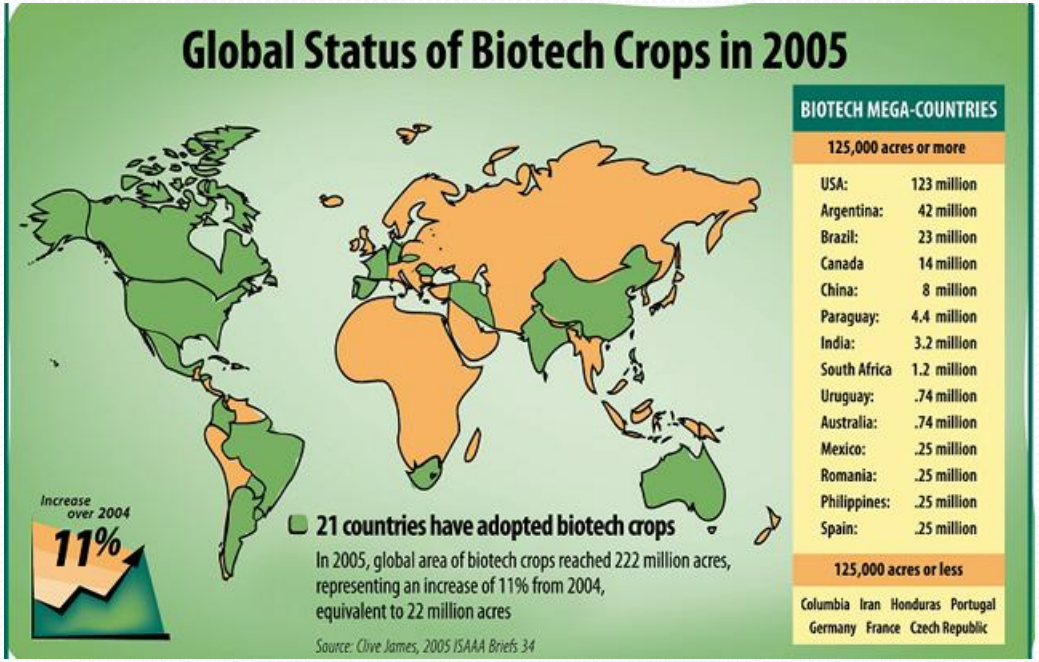
Agricultural Biotechnology

Introduction

- Agricultural biotechnology includes a range of tools that scientists employ to understand and manipulate the genetic make-up of organisms for use in the production or processing of agricultural products.

Why is agricultural biotechnology important?

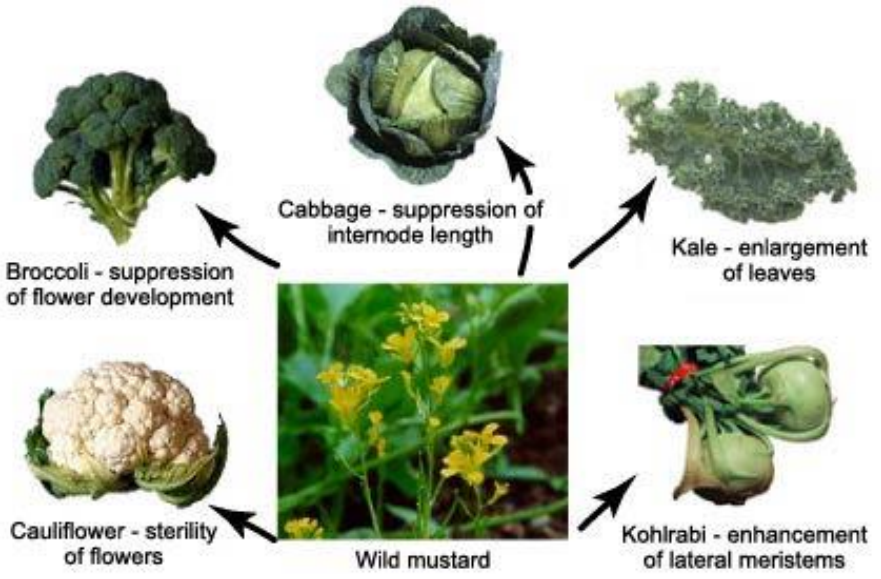
- In a world where 800 million people, living mostly in rural areas, go hungry every day, food demand is set to double in the next thirty years and arable land is limited, advances in agriculture are critical if we are to reduce hunger and promote growth and development in a socially acceptable and environmentally sustainable way.



Current Areas of Research

1) Crop Improvement Research

- Very rudimentary biotechnology.
- "Artificial Selection"
- Based on basic Mendelian genetics where two plant types of the same species are crossed to produced a better plant type.
- Example: Crossing a plant that has a high tolerance to disease with a plant that has a high fruit yield gives you a disease resistant plant with a high fruit yield.



2) Creating Gene Banks

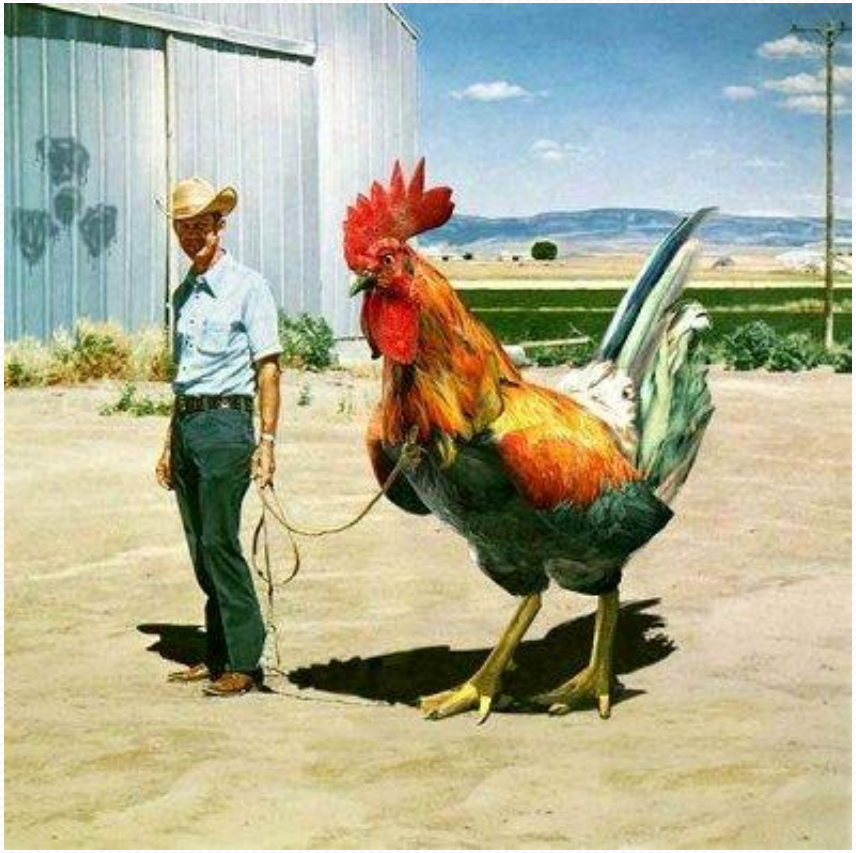
- A gene bank is large holding of plant types with their given traits and now with the genes for these traits genetically marked.
- Crop scientists can now select a variety known to hold a specific characteristic, mark the gene responsible for the trait and cross it with another variety known to hold a second desirable characteristic.
- These techniques are simply traditional breeding techniques made more efficient by new information about genes and new technologies.

United Nations Gene Bank

- The United Nations' gene bank holds over 530,000 samples of wild and domesticated crops in public trust.

3) Genetic Modification

- Inserted genes from other species into plants/animals in order to increase yields or protect against pests or environmental conditions.
- They are tested to ensure no adverse environmental or health effects.



Examples of Agricultural Biotechnology

1) Induced Mutation Assisted Breeding (IMAB)

- Mutations are the cause of "better" varieties of plants.
- In the 1970s, the International Atomic Energy Agency (IAEA) and the Food and Agriculture Organization of the United Nations (FAO) decided that it would be a good idea to speed the process along.

1) Induced Mutation Assisted Breeding (IMAB)

- They subjected many plant varieties to mutagenic agents (like radiation) to induce mutations and then selected for the desired “new” traits that appeared.
- IMAB has resulted in the introduction of new varieties of many crops such as rice, wheat, barley, apples, citrus fruits, sugar cane and banana.
- The only drawback is ensuring the mutagenic agent is not passed into the food item.

2) Micropropagation

- Micropropagation involves taking small sections of plant tissue, or entire structures such as buds, and culturing them under artificial conditions to regenerate complete plants.
- Micropropagation is particularly useful for maintaining valuable plants, breeding otherwise difficult-to-breed species (e.g. many trees), speeding up plant breeding and providing abundant plant material for research.

2) Micropropagation of Bananas in Kenya

- Micropropagation represents a means of regenerating disease-free banana plantlets from healthy tissue.
- In Kenya, banana shoot tips have been successfully tissue-cultured.
- An original shoot tip is heat-treated to destroy infective organisms and then used through many cycles of regeneration to produce daughter plants.
- A single section of tissue can be used to produce as many as 1 500 new plants through ten cycles of regeneration.
- Micropropagation of banana has had a tremendous impact in Kenya, among many other countries, contributing to improved food security and income generation.
- It has all the advantages of being a relatively cheap and easily applied technology and one that brings significant environmental benefits.

3) Genetic Engineering

- There are three levels of genetic engineering:

a) Close transfer: taking a gene from one plant species and inserting it into another plant species (same kingdom)

b) Distant transfer: taking a gene from one species and inserting it into another species from a different kingdom (i.e. bacterium gene into a plant)

c) "Tweaking": the genes already present in the organism are "tweaked" to change the level at which a particular protein is made

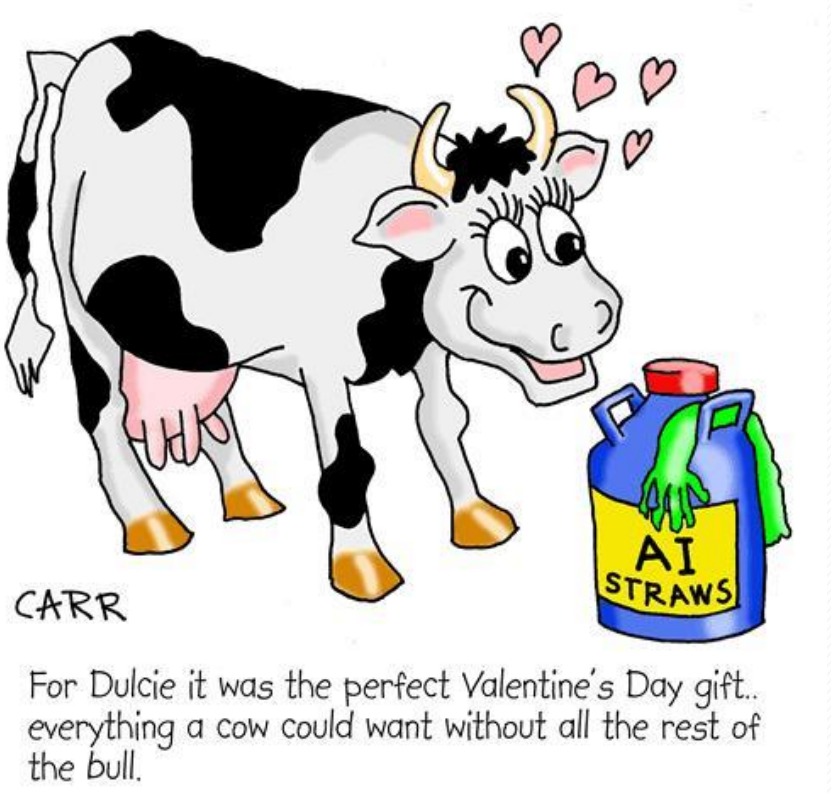
- All of the above would create a GMO.

3) Genetic Engineering Example: The Protato

- Researchers at Jawaharlal Nehru University in India have developed a genetically engineered potato that produces about one-third to one-half more protein than usual, including substantial amounts of all the essential amino acids.
- Protein deficiency is widespread in India and potato is the staple food of the poorest people.
- The "protato" was developed by a coalition of Indian charities, scientists, government institutes and industry as part of a 15-year campaign against childhood mortality.
- The campaign aims to eliminate childhood mortality by providing children with clean water, better food and vaccines.
- The protato includes a gene from the amaranth plant, a high-protein grain that is native to South America and widely sold in Western health-food stores.
- The protato has passed preliminary field trials and tests for allergens and toxins.
- Final approval from the Indian Government is probably at least five years away.

4) Artificial insemination (AI) and multiple ovulation/embryo transfer (MOET)

- These processes have aided the global diversity and strength of livestock.
- AI is the transfer of sperm and MOET is the transfer of ova or a fertilized embryo from an animal in one part of the world, to an animal in another part of the world.
- The drawback is the need for a well organized and funded farm to do this.



Homework

1) What are some areas of research currently focused on in agricultural biotechnology?
2) What is one example of agricultural biotechnology? Explain it. Do you think it was a worthwhile endeavour?
3) Answer the questions to the article on Bt Corn and hand those in.