

Scene Fourteen



Photograph of a gel showing PCR analysis of DNA isolated from 5 different rice tissues (#1 to 5), All 5 samples are repeated to eliminate human error. The gel is stained with ethidium bromide. Molecular weight marker (M) is one Kb ladder.

Friday morning

Scene Fourteen:

Friday morning

Place:

Classroom

Characters:

Efia, Ekow, all other students and the biology teacher

Situation:

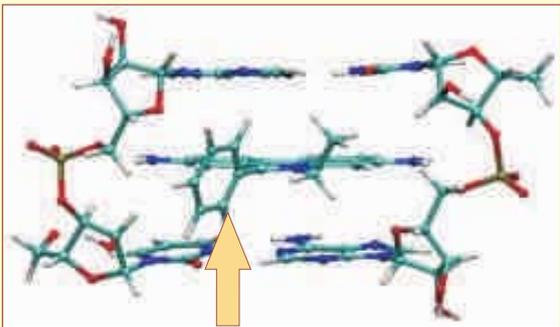
The biology class continues with discussions on the application of MAS

DNA analysis:

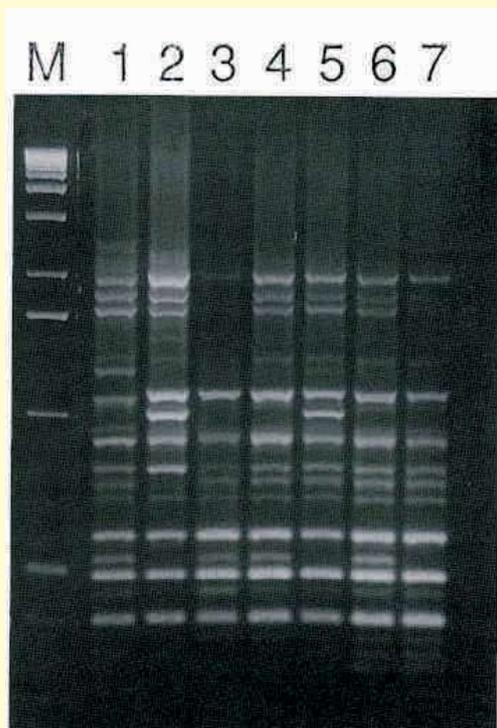
Visualization of DNA in an agarose gel using ethidium bromide stain



A small sample of DNA is amplified using **Polymerase Chain Reaction (PCR)** and isolated from 5 different tissues of rice plant; young leaf (1), old green leaf (2), green panicle (3), panicle before flowering (4) and root (5). The samples are repeated for verification. "M" is the molecular weight which confirms the size of DNA. The gel is stained with ethidium bromide and visualized under fluorescent light.



Ethidium bromide is an intercalating agent commonly used as a nucleic acid stain. When exposed to ultraviolet light, ethidium bromide will fluoresce with a red-orange color, intensifying almost 20-fold after binding to DNA.



RAPD analysis of DNA rapidly isolated from healthy leaves of different rice plants using primers. The gel was stained with ethidium bromide.

Source:
Rapid DNA isolation for marker assisted selection in rice breeding
Kangle ZHENG, Prasanta Kumar SUBUDHI, Jessica DOMINGO, Gerard MAGPANTAY and Ning HUANG
Plant Breeding, Genetics and Biochemistry Division, IRRI, P. O. Box 933, Manila, Philippines

Scene Fourteen:
Friday morning

Place:
Classroom

Characters:
Efia, Ekow, all other students
and the biology teacher

Situation:
The biology class continues
with discussions on the
application of MAS

Teacher:

Good afternoon students. Shall we discuss further about marker-assisted selection or MAS?



Efia:

Yes. MAS is used to identify and select a specific trait and therefore must be a good biotechnology tool. Is there an example you could give us about the use of MAS?



Teacher:

Yes, Efia. Molecular markers are especially advantageous to detect agronomic traits. These traits can be either a resistance to pathogens or tolerance to stress. Besides this, markers are also useful for setting quality parameters and quantitative traits.



Ekow:

But is there an example where MAS has already been used?



Teacher:

Yes, Ekow. How about cassava? Would you like to know an example of the use of MAS to select a trait in cassava?



Ekow:

Yes! It will be interesting to know how MAS has been used to grow better cassava.



Teacher:

Let me tell you about a real example of the use of MAS in cassava trait selection. Let us see whether we can explore the way of breeding

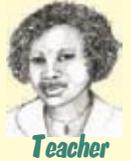


cassava that is resistant to cassava mosaic disease or CMD. Well, you all know now that the cassava mosaic disease or CMD is an economically important disease of the food crop cassava in Africa. In the research lab, scientists identified QTLs associated with resistance to CMD.



Efiya:

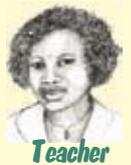
So, how did they do this experiment teacher?



Teacher:

Well, they used an F1 progeny derived from a cross between two parents.

F1 progeny is the first "filial" generation or first-generation "hybrid" produced by cross-pollinating two compatible parent plants. Filial is the name given to the generation following the parental generation. Therefore, it is called F1 progeny.



Teacher:

One parent is a CMD resistant accession and the other is a susceptible landrace. There are two new terms here; one is accession and the other is landrace.

Any new trait is recorded as an accession of that plant. So the CMD resistant trait of cassava is an accession. An accession is a new variety added to the gene bank. In simple words it is a new addition of a particular species which has improved value.

Landrace means a crop that has evolved and genetically improved through conventional agricultural methods. It also means that it has not been influenced by modern laboratory breeding practices.



Ekow:

So one parent is from the laboratory and the other is grown in the field under natural conditions.



Teacher:

Yes, Ekow! These two parents were crossed to identify QTLs associated with resistance to CMD.



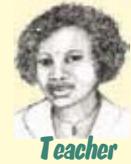
Dhakiya:

So the two parents here are the CMD resistant accession and the CMD susceptible landrace. The CMD resistant cassava plant is resistant to

cassava mosaic disease while the CMD susceptible cassava plant can be infected by cassava mosaic disease.

Teacher:

That is correct Dhakiya. The landrace sample is collected from the field. The CMD resistant accession is obtained from the gene bank.



Ekow:

This is so interesting. So what happened to the F1 population teacher?



Teacher:

The F1 population was evaluated in the field for two growing seasons in Nigeria.



Efia:

That is a long experiment!



Teacher:

Yes! But then from this population the average disease severity scores were calculated and used for QTL analysis.



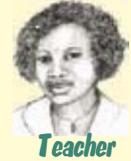
Kunto:

Did they find anything?



Teacher:

Yes! They detected five highly significant marker-associated QTL effects.



Dafina:

What is the most significant information they observed from this experiment?



Teacher:

Well, the significant information they observed was that the marker trait associations were due to markers donated by both parents. This means that the CMD resistance is polygenic. Polygenic means it is controlled by or associated with more than one gene. Also the CMD resistance is recessive in nature which means it will be expressed only when the determining allele is present in the homozygous condition in that plant. This also means that both parents must have at least one recessive gene for CMD resistance.





Efiya

Efiya:

This is so exciting. It will be wonderful to study plants like this to understand their characteristics. I think biotechnology tools are cool. We can learn so much about a plant by using biotechnology tools and that is besides being able to conserve PGR as accessions for future use.



Ekow

Ekow:

Efiya, you are showing off by using the new term we learnt today. Accessions eh? Very good Efiya



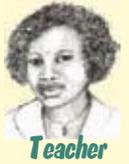
Efiya

Efiya:

So what was the final conclusion of this study?

Teacher:

They identified the QTL associated with the main source of CMD resistance in Africa.



Teacher

Kunto:

I really thought that I would not understand anything about biotechnology tools that can be used for conserving information about plant varieties. But I am wrong. It is so interesting to know that we can pin point a specific trait of a plant and store it and use it for breeding if necessary.



Kunto

Teacher:

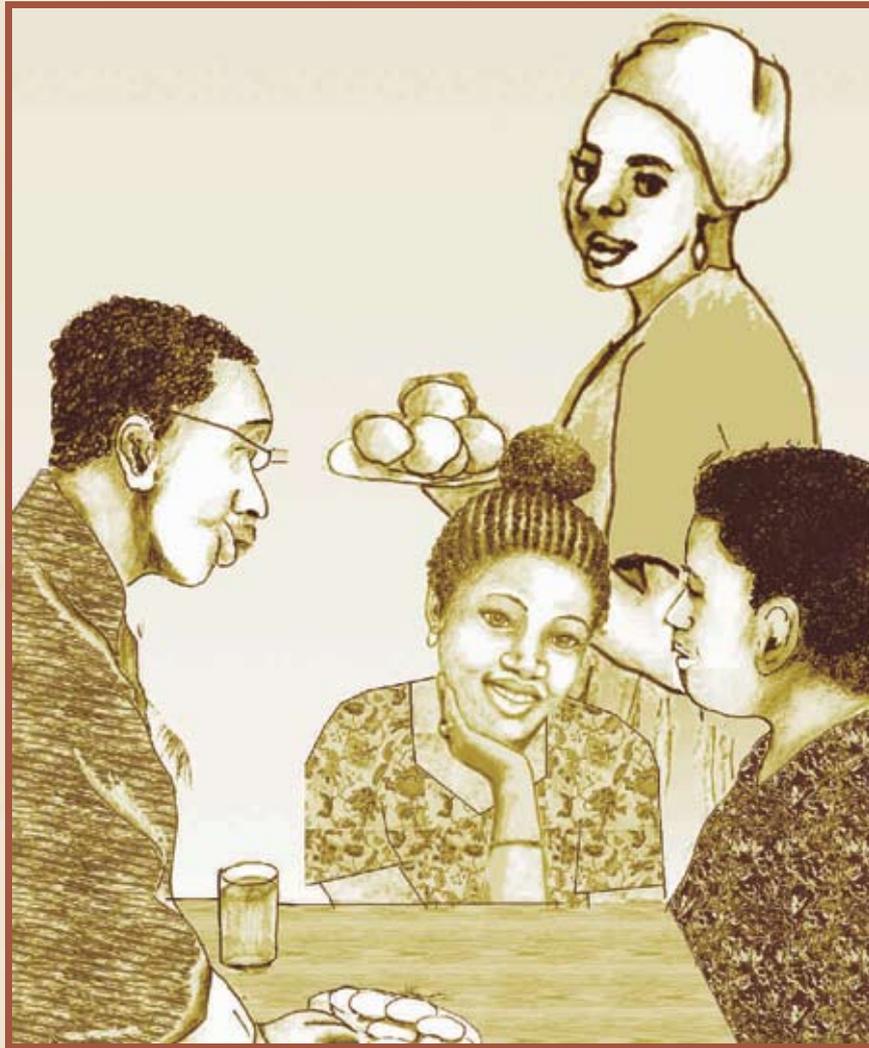
Kunto, I am very happy to hear that, especially from you, because you are the quietest one in the class.



Teacher

Students, it is time to close our discussion. Remember that in future, once a week, in the biology class, you will have a chance to say what you have understood from our discussions. You can share what you have heard or read about biotechnology tools and how they can be used to conserve PGR for future use. At the end of the year the three best presentations will win prizes. Tomorrow is Saturday. Enjoy your weekend and I will see you next week.

Scene Fifteen



Saturday morning

Scene Fifteen:

Saturday morning

Place:

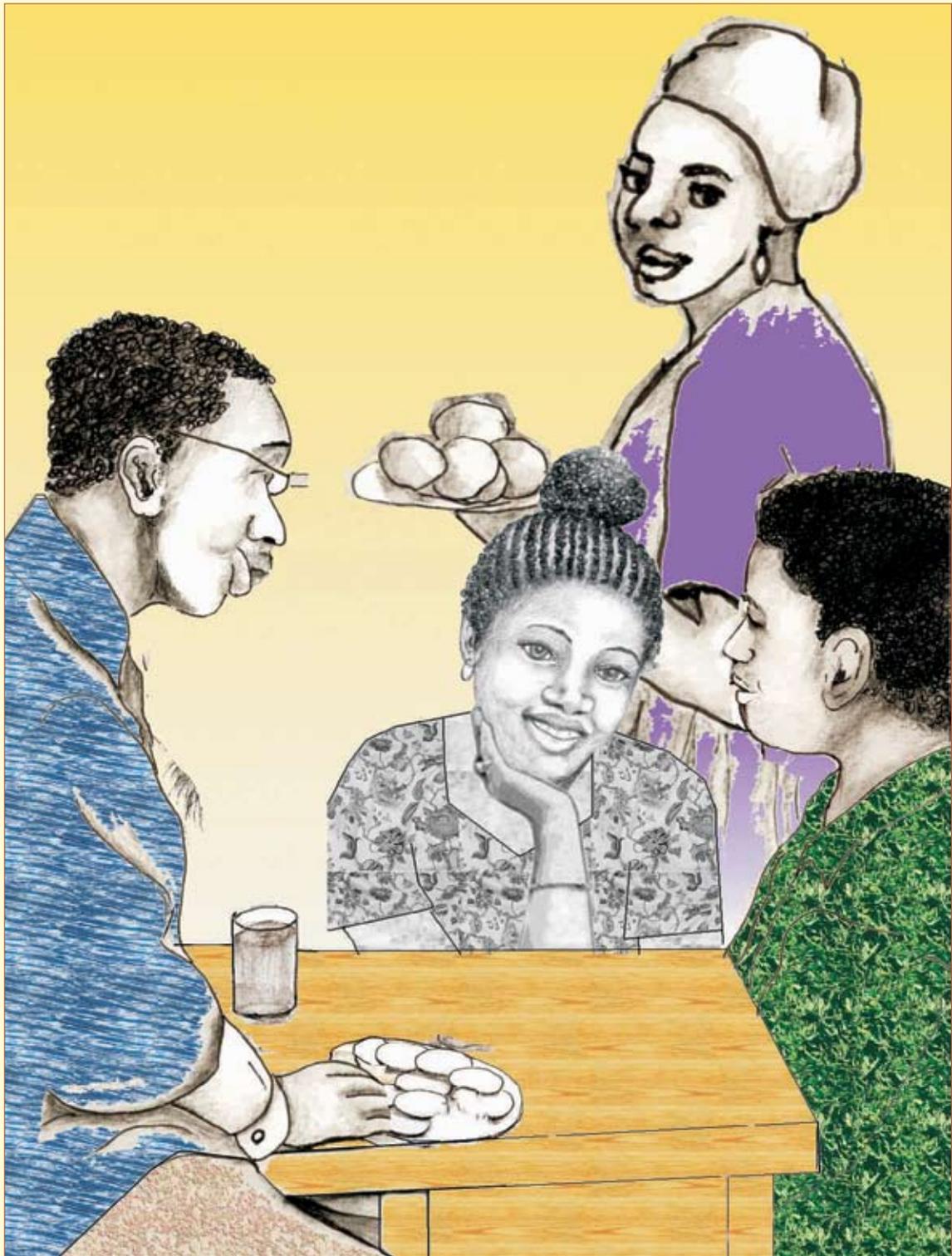
Home

Characters:

Efia, Ekow, their parents and grandparents

Situation:

Grandparents' visit



Ekow! “You can ride your bike in the evening; now, stay home and talk to your grandparents”

Scene Fifteen:
Saturday morning

Place:
Home

Characters:
Efia, Ekow, their parents and grandparents

Situation:
Grandparents' visit

Ekow:
Mum, may I go out and play?



Mother:
Ekow, it is too hot now and your grandparents will be here any minute. Eat your breakfast now and get ready to tell your Grandma what you have learned in your biology class about cassava. You can go out and play in the evening.



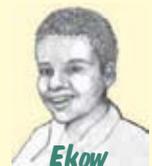
Ekow:
Oh, Mum, it is Saturday. I want to ride my bicycle. Efia is the one who wants to become the conservation specialist. She can explain to Grandma about the "lost" but "not lost" cassava.



Mother:
Ekow, does this mean that you know nothing about what you have learned in your biology class and so you are passing on the responsibility to your brilliant sister? Is that it?



Ekow:
No, not at all! I can explain things just as well as Efia. OK, you got me. I will talk to Grandma.



(When the grandparents arrive, Efia and Ekow explain to Grandma what they have learned about the new biotechnology tools that are used for cassava genetic resource conservation and use.)

Scene Sixteen



Monday evening

Scene Sixteen:

Monday evening

Place:

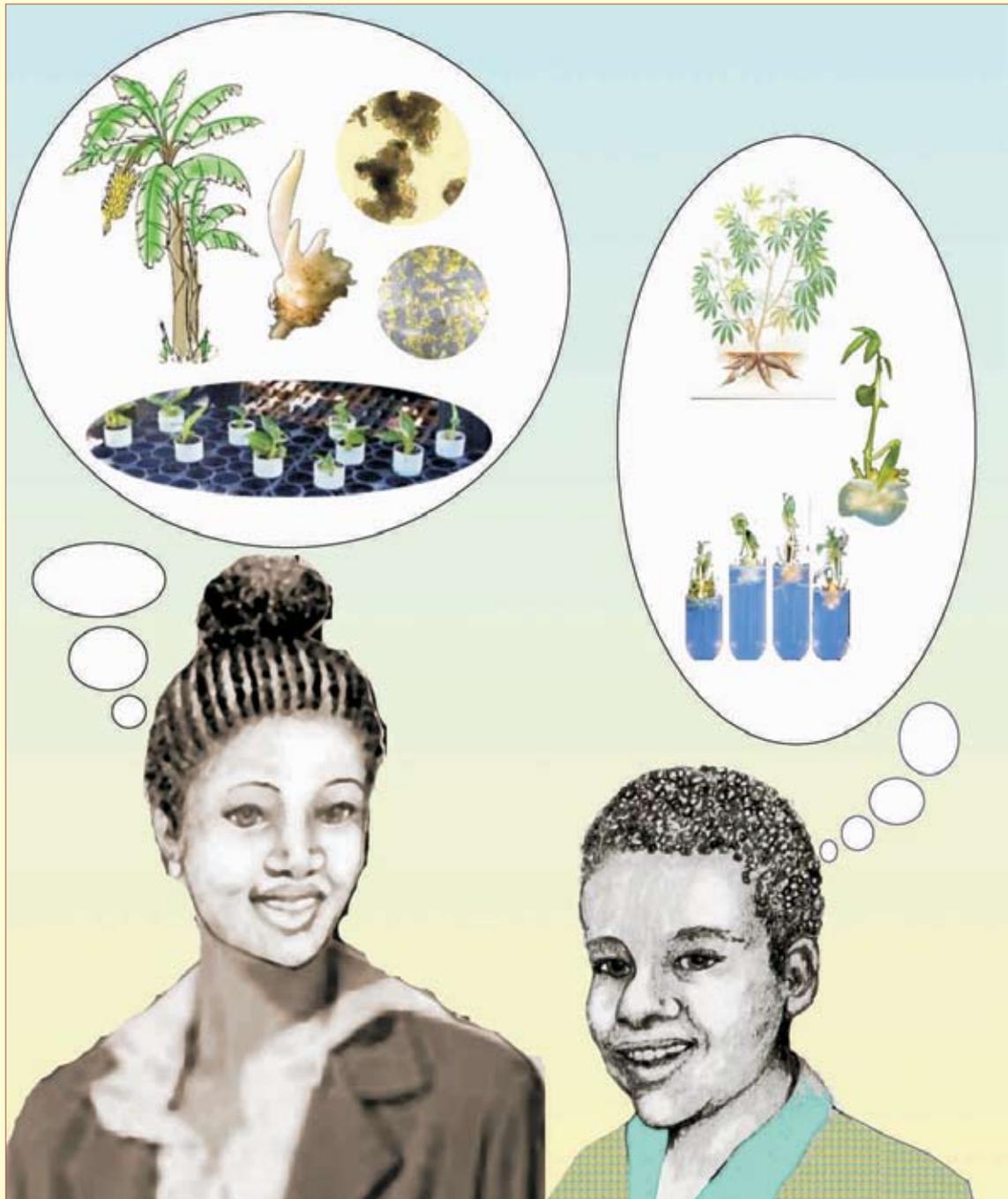
On the way home

Characters:

Efia and Ekow

Situation:

Efia and Ekow discuss their potential presentations



What do Efia and Ekow plan to do for their project work in their next biology class?

Scene Sixteen:

Monday evening

Place:

On the way to their home

Characters:

Efia and Ekow

Situation:

Efia and Ekow discuss their potential presentations

Ekow:

Efia, have you thought about a theme for your presentation? Will you prepare a poster? What kind of presentation do you have in mind?



Efia:

Ekow, I do not have a specific project in mind, but I am hoping to prepare a presentation that will have new information for our classmates. I think I will ask dad to organize a trip to his office in the plant genetic resources center and find out what other major crops they conserve and distribute.

I am interested in knowing more about micropropagation as it seems to be a simple technique but very efficient in helping farmers. So my project will be to identify a crop that is useful for everyone in our country and write a report on how micropropagation is used to increase this crop type so that it can be available to farmers.

I could make some dishes out of this crop produce and prepare a dish for Grandma and Grandpa and also take one to school. Have you thought about a project for yourself?

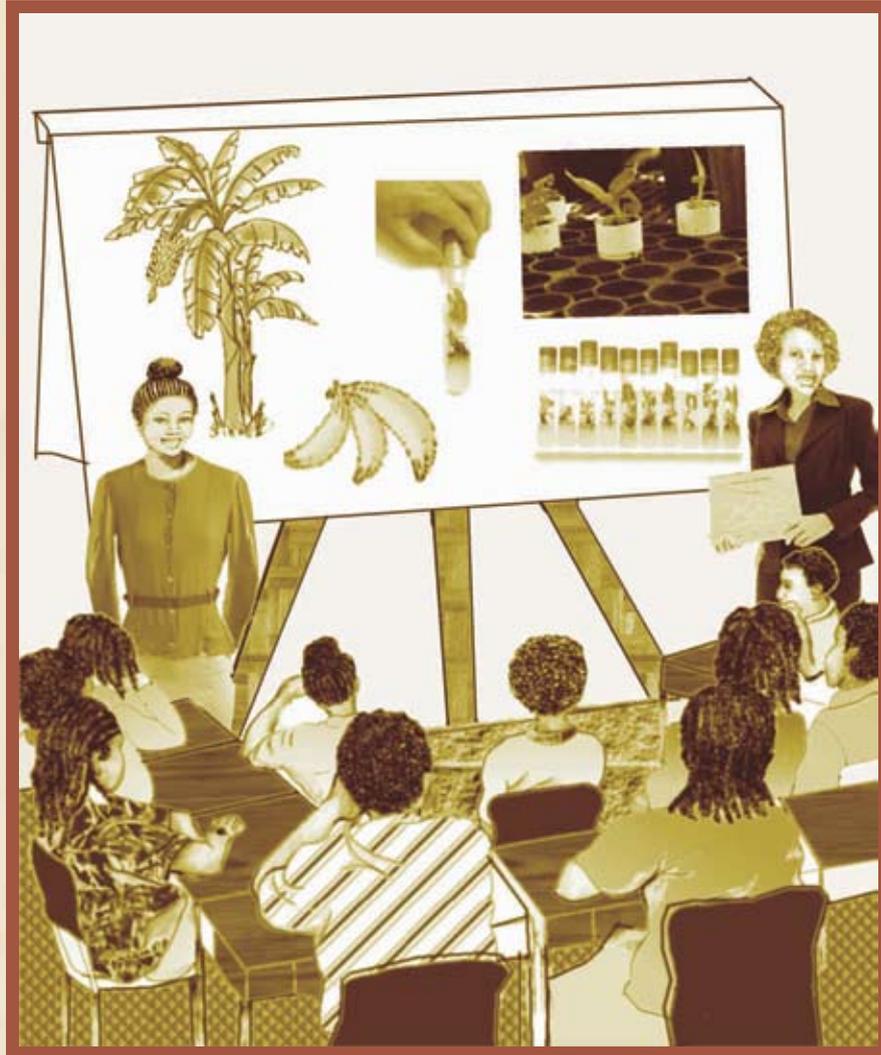


Ekow:

I am thinking of asking Uncle Sasi to take me to the plant tissue culture distribution centre where I could get small cassava plants to show to the class. I could prepare a display to show the steps in growing healthy plants.



Scene Seventeen



Friday of the following week

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Friday of the following week

Place:

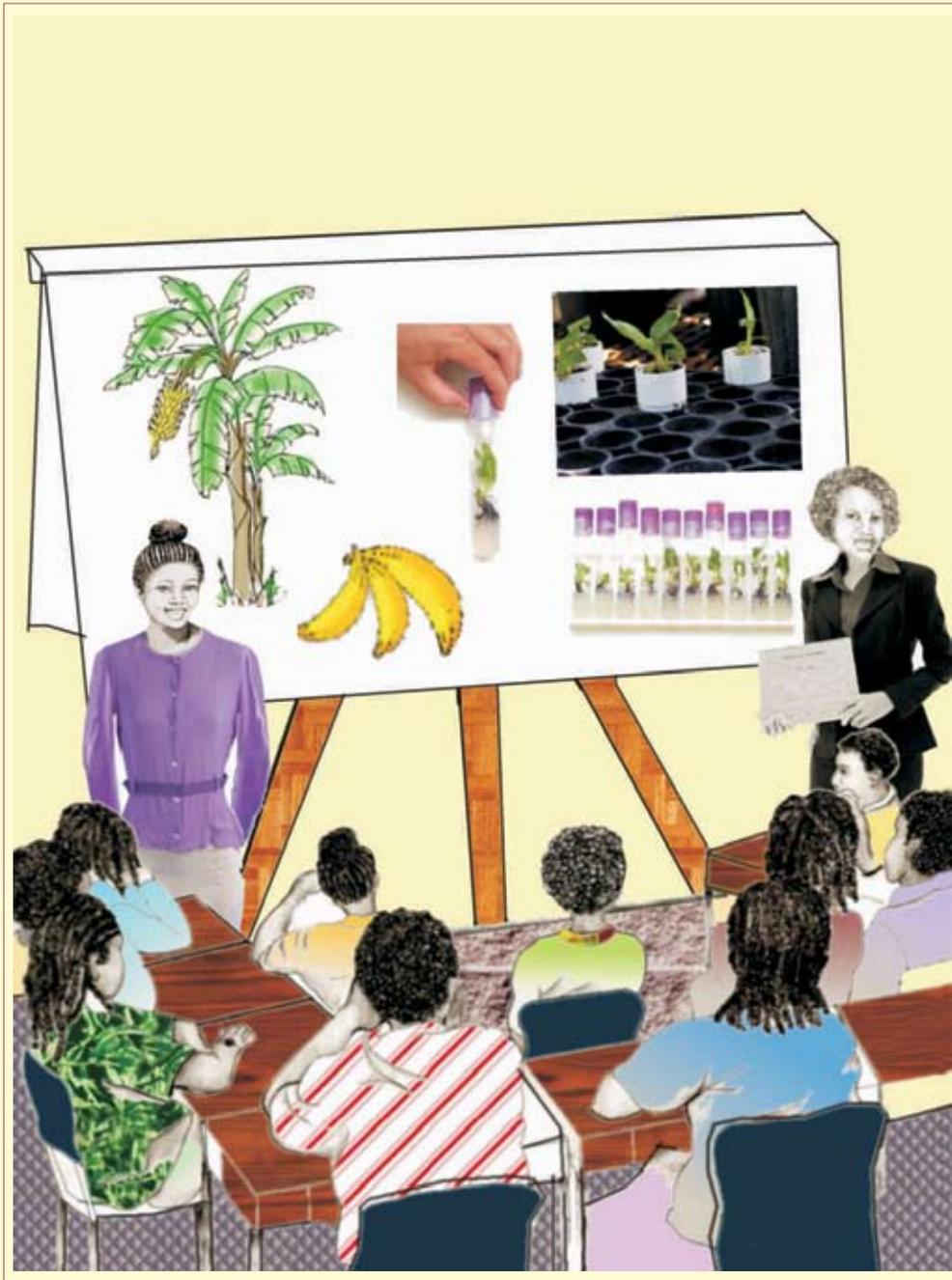
Classroom

Characters:

The students and the biology teacher

Situation:

The students present their projects



Effia presents her project work on banana micropropagation

Scene Seventeen:

Friday of the following week

Place:

Classroom

Characters:

The students and the biology teacher

Situation:

The students present their projects

Teacher:

My dear students, I am very impressed with your spectacular presentations! Efia, your banana cake is delicious. Ekow, your display is extremely creative. Dhakiya, I liked your painting; it is very artistic. Dene, your slide show was most interesting. Thandiwe, your poster is very original. All of you did an excellent job.

We will now vote on the best three projects. Take a piece of paper and write down the three projects that you think are the best. As we agreed at the beginning, the top three projects will win prizes. Those who do not win a prize, please remember that you have another chance to try your best during our annual school day exhibition and win a prize. I am very proud of all of you.



Teacher

Annex I

Stages of plant tissue culture:

The plant tissue culture technique involves three main stages in the tissue culture process:

STAGE I is the initiation phase.

It concerns the establishment of plant tissue in vitro by sterilising the material and initiating it into the culture.

The steps involved are:

1. A small amount of parent tissue or a number of cells are taken.
2. The tissue or cells are then transferred to plates containing sterile nutrient agar jelly. This is a gel made from algae which provides an ideal growth medium.
3. Auxins (plant hormones that trigger growth) are added to stimulate the cells to divide by mitosis.
4. Cells grow rapidly into small masses of tissue.

STAGE II is the multiplication phase.

At this stage, the in vitro plant material is re-divided and placed in a medium with plant growth regulators that induce the proliferation of multiple shoots. This process is repeated many times until the number of plants desired is reached. This is micropropagation.

5. More growth hormones are added to stimulate the growth of stems.

STAGE III is the root formation phase.

It involves the introduction of hormones to induce rooting and the formation of complete plantlets.

More growth hormones are added to stimulate the growth of roots.

Following these three stages, the plants are then moved from the laboratory to the greenhouse for acclimatization and further development.

The tiny plantlets are transferred into potting trays where they then develop into plants. This process is called the “regeneration” of plant material.

Annex II

Application of plant tissue culture:

1. Conservation, maintenance, transfer and distribution of plant germplasm:

Cell culture offers enormous opportunities to collect, handle, manage and store germplasm in sterile conditions. Cell culture is used for the study of single cells, groups of cells and for the isolation of protoplasts. It is also used for the development of cell lines for the improvement of various types of resistance such as salt or drought tolerance cell lines and toxin resistant cell lines.

2. Micropropagation:

This is rapid vegetative multiplication of valuable plant material for agriculture, horticulture, and forestry. This process assures the good result that is expected from the germplasm during multiplication and also allows fast and efficient distribution.

3. Production of disease-free plants:

When the apex of a shoot is used for multiplication by tissue culture, we get disease-free plants because the shoot apical meristem (a group of dividing cells at the tip of a stem or root) is free from pathogens.

4. Plant breeding:

Tissue culture has also been successfully used in plant breeding programmes.

5. Production of disease- and pest-resistant plants:

Plants grown from tissue culture usually pass through the callus phase and show many variations. These show some agronomic characteristics such as tolerance to pests, diseases, etc.

6. Cloning:

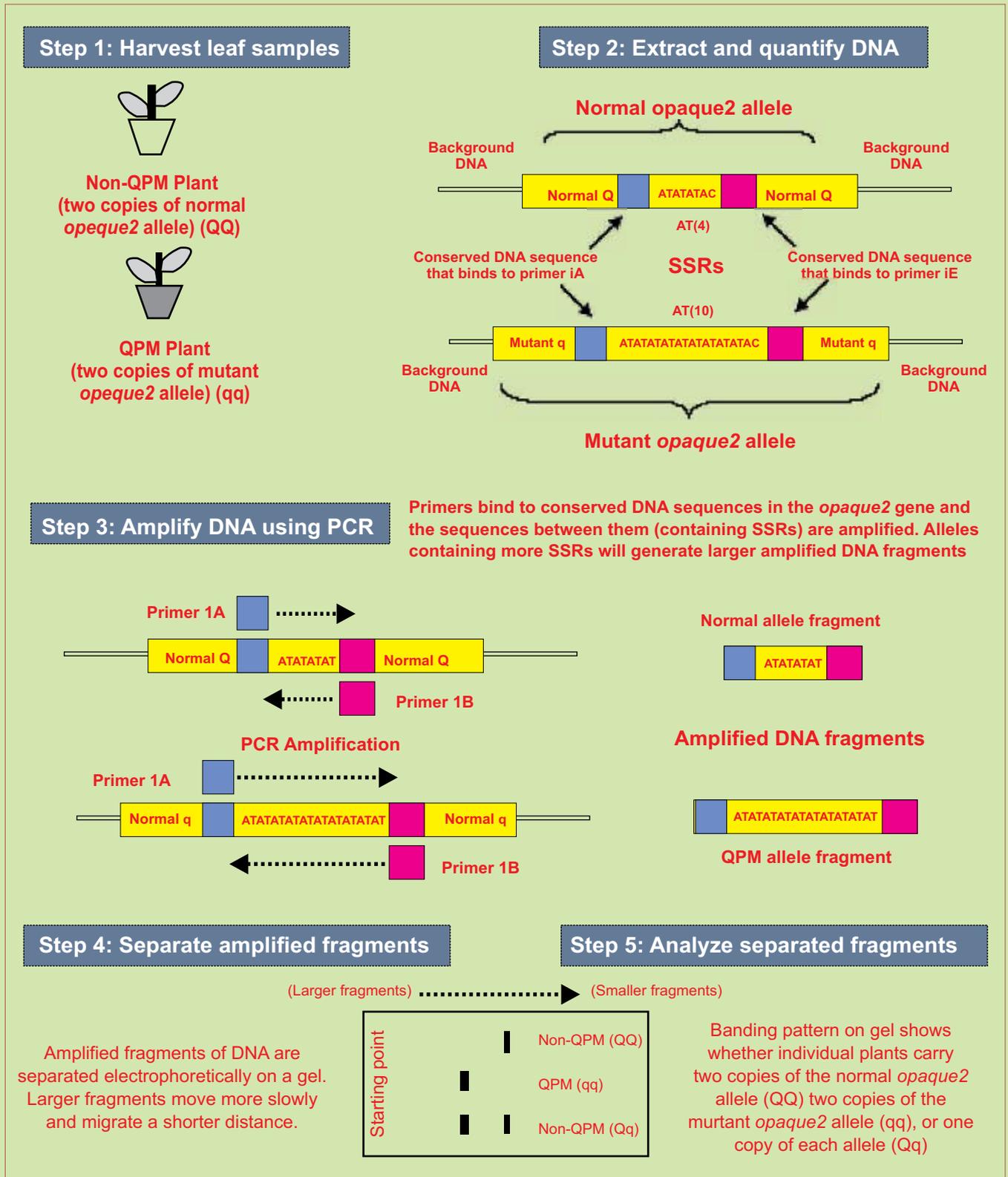
Propagation by tissue culture also helps in producing clones. By using the shoot tip, it is possible to obtain a large number of plantlets. Unlimited numbers of plants that are genetically similar, (clones) can be produced in a short span of time by tissue culture.

Annex III

An example of “Molecular marker analysis using SSR markers”

Source: IS MARKER-ASSISTED SELECTION COST-EFFECTIVE COMPARED TO CONVENTIONAL PLANT BREEDING METHODS? THE CASE OF QUALITY PROTEIN MAIZE by

Kate Dreher, Michael Morris, Mireille Khairallah, Jean-Marcel Ribaut, Shivaji Pandey and Ganesan Srinivasan from International Maize and Wheat Improvement Center (CIMMYT), Mexico City, Mexico



Annex IV

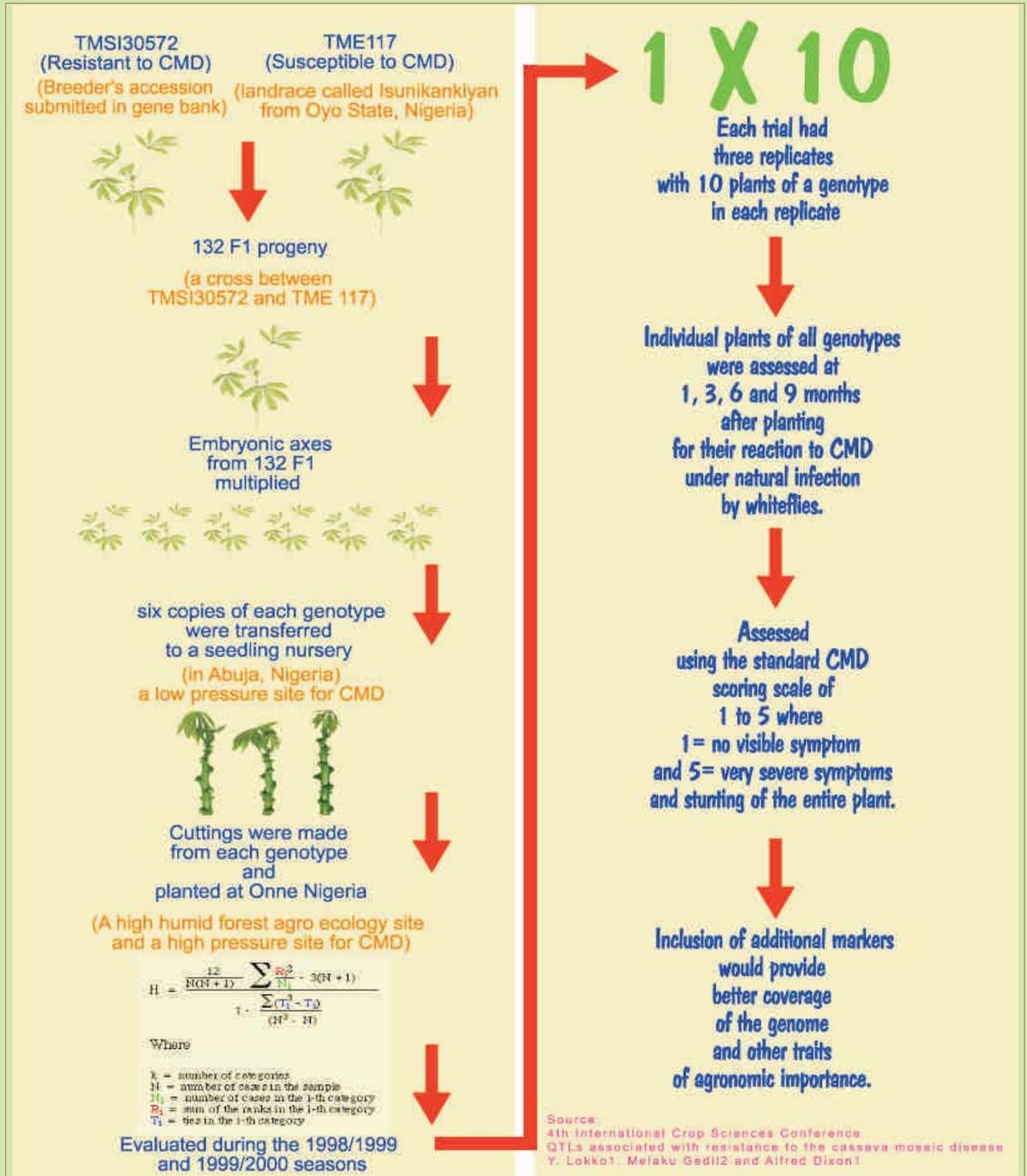
Steps in identifying QTL associated with CMD.

Source: Proceedings of the 4th International Crop Science Congress: QTLs associated with resistance to the cassava mosaic disease

Y. Lokko¹, Melaku Gedil² and Alfred Dixon¹

¹International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria

²Georgetown University Medical Centre



Glossary

Accession: A new variety that is added to the gene bank.

Acronym: A word formed from the initial letters of a name, such as PGR for plant genetic resources.

AFLP: Amplified Fragment Length Polymorphism (AFLP) is a Polymerase Chain Reaction (see PCR) - based method of generating molecular markers. With this technique, the DNA sample treated with restriction enzymes is amplified. This technique allows selective amplification of restriction fragments giving rise to large numbers of useful markers, which in turn can be located on the genome relatively quickly and reliably.

Allele: A variant form of a gene. In a diploid cell there are two alleles for every gene (one inherited from each parent and they could be identical). Within a population there may be many alleles for a gene. Alleles are symbolized by a capital letter (upper case) to denote dominant character, and by a small letter (lower case) to denote recessive character.

Aseptic: Sterile, free of contaminating organisms such as bacteria, fungi and algae.

Asexual propagation: Vegetative, somatic or non-sexual reproduction of a plant without fertilization.

Asexual reproduction: Reproduction that does not involve the formation and union of gametes from the different sexes. It occurs mainly in lower animals, micro-organisms and plants. In plants, asexual reproduction is by vegetative propagation (e.g. bulbs, tubers, corms) and by formation of spores.

Axenic: Disease free

Base pair: A pair of nitrogenous base (a purine and a pyrimidine) held together by specific hydrogen bonds. The length of a nucleic acid molecule is often given in terms of the number of base pairs it contains.

Biotechnology: Any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use.

Biotechnology tools: All techniques that use biological material to make, modify or improve plants, animals or microorganisms.

Cassava: A shrubby tropical plant (*Manihot esculenta*) widely grown for its large, tuberous, starchy roots.

Cell Culture: A population of plant or animal cells or micro-organisms grown under controlled conditions.

Chromosome: In eukaryotic cells, chromosomes are the nuclear bodies containing most of the genes largely responsible for the differentiation and activity of the cell. They contain most of the cell's DNA in the form of chromatin. Each eukaryotic species has a characteristic number of chromosomes. Bacterial and viral cells contain only one chromosome, which consists of a single or double strand of DNA or, in some viruses, RNA, without histones.

Clone: Group of plants genetically identical in which all are derived from one selected individual by vegetative propagation.

CMD: Cassava mosaic disease, a disease caused by a white fly that carries the virus within it.

Conservation: saving plants so that they can be used when needed in the future.

Crossbreed (v.): To produce (an organism) by the mating of individuals of different breeds, varieties or species; otherwise also known as hybridize.

Crossbreed (n.): An organism produced by mating of individuals of different varieties or breeds.

Cryopreservation: The preservation of germplasm resources in a dormant state by storage at ultra-low temperatures, often in liquid nitrogen. Currently applied to storage of plant seeds and pollen, micro-organisms, animal sperm, and tissue culture cell lines.

Cultivar: An internationally accepted term denoting a variety of a cultivated plant. A cultivar must be distinguishable from other varieties by stated characteristics and it must retain its distinguishing character when reproduced under specific conditions.

Database: An organized body of related information.

Diploid: The status of having two complete sets of chromosomes, most commonly one set of "paternal origin (from the father)" and the other of "maternal origin (from the mother)". Somatic tissues of higher plants and animals are ordinarily diploid in chromosome constitution, in contrast with the haploid gametes.

DNA: Abbreviation for **D**eoxyribo-**N**ucleic **A**cid. A long chain polymer of deoxyribonucleotides. DNA constitutes the genetic material of most known organisms and organelles. Usually it is in the form of a double helix. Some viral genomes consist of a single strand of DNA, and others of a single- or a double-stranded RNA. See "base pair, genetic code".

DNA fingerprinting: The derivation of unique patterns of DNA fragments obtained using a number of marker techniques; historically these were RFLPs, but lately they are generally **PCR** based. Synonym: genetic fingerprinting.

Encode: The gene product specified by a particular nucleic acid sequence.

Enzyme: A protein which, even in very low concentration, catalyses specific chemical reactions but is not used up in the reaction. Generally enzymes are named by the addition of the suffix - "ase" to the name of the substance they digest (the substrate). They are classified by a standard numerical system: the Enzyme Commission (EC) number. Enzymes are classified into six major groups, according to the type of reaction they catalyse: 1. oxidoreductases; 2. transferases; 3. hydrolases; 4. lyases; 5. isomerases; 6. ligases.

Enzyme cutting: Cutting a DNA at a specific place in a sequence with a specific enzyme.

Explant: A portion of a plant aseptically excised and prepared for culture in a nutrient medium.

Ex situ conservation: Literally means "off-site conservation". It is the process of protecting an endangered species of plant or animal by removing it from an unsafe or threatened habitat and placing it or part of it under the care of humans. While ex-situ conservation is comprised of some of the oldest and best known conservation methods known to man, it also involves newer laboratory methods.

Extinct: No longer existing or living.

Extinction: The ceasing of existence of a species. The moment of extinction is generally considered to be the death of the last individual of that species

F1 progeny: First-generation "hybrid" resulting from sexual or asexual reproduction.

Field gene bank: A facility established for the *ex situ* storage and maintenance, using horticultural techniques, of individual plants. Used for species whose seeds are recalcitrant, or for clonally propagated species of agricultural importance, e.g. apple varieties.

Gene: The unit of heredity transmitted from generation to generation during sexual or asexual reproduction. More generally, the term is used in relation to the transmission and inheritance of particular identifiable traits from one generation to the other. The simplest gene consists of a segment of nucleic acid that encodes an individual protein or RNA.

Gene bank: The physical location where collections of genetic material, in the form of seeds, tissues or reproductive cells of plants or animals are stored. It may be a collection of cloned DNA fragments from a single genome. Ideally the bank should contain cloned representatives of all the DNA sequences in the genome.

Gene map: See "genetic map".

Gene mapping: The construction of a localized (around a gene), or broad-based (whole genome) genetic map. More generally, determining the location of a locus (gene or genetic marker) on a chromosome.

Gene pool: The sum of all genetic information in a breeding population at a given time.

Genetic diversity: The heritable variation within and among populations which is created, enhanced or maintained by evolutionary or selective forces.

Genetic map: The linear array of genes on a chromosome, based on recombination frequencies (linkage map) or physical location (chromosomal map).

Genetic marker: A DNA sequence used to identify a particular location (locus) on a particular chromosome. See "marker gene".

Genetic material: Used to store the genetic information of an organic life form. For all currently known living organisms, the genetic material is almost exclusively DNA.

Genetic variation: The phenotypic and genotypic differences among individuals in a population.

Genome: It is the entire complement of genetic material (genes plus non-coding sequences) present in each cell of an organism, virus or organelle. The complete set of chromosomes (hence of genes) inherited as a unit from one parent.

Genus: (pl.: genera) A group of closely related species, whose perceived relationship is typically based on physical resemblance, now often supplemented with DNA sequence data.

Genotype: This can be observed at (1) the locus, (2) trait or (3) organism level.

1. The allelic constitution at a particular locus, e.g. Aa or aa.
2. The sum effect of all loci that contribute to the expression of a trait.
3. The genetic constitution of an organism.

Germplasm: 1. An individual, group of individuals or a clone representing a genotype, variety, species or culture, held in an *in situ* or *ex situ* collection. 2. Original meaning, now no longer in use: the genetic material that forms the physical basis of inheritance and which is transmitted from one generation to the next by means of the germ cells.

Heterozygous: Heterozygote is an individual with non-identical alleles for a particular gene or genes. The condition is termed "heterozygous". Opposite: homozygote.

Homozygous: Homozygote is an individual that has two copies of the same allele for a given gene on its two homologous chromosomes. The condition is termed "homozygous". Opposite: heterozygote.

Hybrid: The offspring of two genetically unlike parents.

Inheritance: The transmission of genes and phenotypes from generation to generation.

***In situ*:** In the natural place or in the original place. 1. Experimental treatments performed on cells or tissue rather than on extracts from them. 2. Assays or manipulations performed with intact tissues.

***In vitro*:** Outside the organism, or in an artificial environment. Applied for example to cells, tissues or organs separated from the plant or animal and cultured in glass or plastic containers

***In vivo*:** Within the living being. An experiment performed in or on the living tissue of a whole organism is called *in vivo* experiment.

Landrace: In plant genetic resources, an early, cultivated form of a crop species, evolved from a wild population, and generally composed of a heterogeneous mixture of genotypes.

Liquid nitrogen: Nitrogen gas condensed to a liquid with a boiling point of about -196°C. Commonly used as a medium for long-term storage of biological materials. See "cryopreservation".

Locus: (pl.: loci) A site on a chromosome.

Marker gene: A gene of known function or known location, used for marker-assisted selection or genetic studies.

Marker-assisted selection (MAS): The use of DNA markers to improve response to selection in a population. The markers will be closely linked to one or more target loci, which may often be quantitative trait loci.

MAS: See "marker-assisted selection".

Micropropagation: Miniaturized *in vitro* multiplication and/or regeneration of plant material under aseptic and controlled environmental conditions.

Molecular marker: A genetic marker which is assayed at the DNA level. (This assay is to: 1. test or evaluate and 2. Measure the quantity of a given substance in a sample, chemically or by other means.)

Microsatellites: Simple DNA sequences, usually 2 or 3 bases long, repeated a variable number of times in tandem. They are easy to detect with PCR. Microsatellites, also known as Simple Sequence Repeats (SSRs), are widespread throughout eukaryote genomes. A typical microsatellite marker has more variants than those from other marker systems.

Nucleotides: One of the structural components, or building blocks, of DNA and RNA. A nucleotide consists of a base (one of four chemicals: adenine, thymine, guanine, and cytosine) plus a molecule of sugar and one of phosphoric acid.

Phenotype: The visible appearance of an individual (with respect to one or more traits) which reflects the reaction of a given genotype with a given environment.

Plant genetic resources (PGR): The reproductive or vegetative propagating material of: 1. cultivated varieties (cultivars) in current use and newly developed varieties; 2. obsolete cultivars; 3. primitive cultivars (landraces); 4. wild and weed species, near relatives of cultivated varieties; and 5. special genetic stocks (including elite and current breeder's lines and mutants).

Plant-lets: A small rooted shoot regenerated from cell culture following embryogenesis or organogenesis. Plantlets can normally develop into normal plants when transplanted to soil.

Plant tissue culture: See "tissue culture".

Plasticity: Plasticity of a cell or tissue means that it is able to adjust to environmental conditions.

Polygenic: Character controlled by many genes of small effect. (Polygene is one of a number of genes, each of small effect, which together act to determine the phenotype of a quantitative trait.)

Population: A defined group of interbreeding organisms.

Propagation: The duplication of a whole plant from a range of vegetative materials; adapted for *in vitro* culture as micropropagation.

Pubescent: The leaves of the plant are covered with fine, hair-like structures.

Quantitative trait loci (QTL): A locus where allelic variation is associated with variation in a quantitative trait. The presence of a QTL is inferred from genetic mapping, where the total variation is partitioned into components linked to a number of discrete chromosome regions.

Restriction enzyme: An enzyme, specifically an endo-deoxyribonuclease that recognizes a short specific sequence within DNA and catalyzes double strand cleavage of the molecule.

RFLP markers: These are detected by treating DNA with restriction enzymes which cut DNA at a specific sequence. For example, the EcoR1 restriction enzyme cuts DNA whenever the base sequence GAATTC is found. Differences in the lengths of DNA fragments will then be seen. RFLPs were the first molecular markers to be widely used.

Their use is, however, time-consuming and expensive and simpler marker systems have subsequently been developed.

RAPD markers: These are detected using PCR. The analysis for RAPD markers is quick and simple, although results are sensitive to laboratory conditions.

Repository: A place where something can be submitted and stored safely.

Ribonucleic acid (RNA): An organic acid polymer composed of adenosine, guanosine, cytidine and uridine ribonucleotides. The genetic material of some viruses, but more generally it is the molecule, derived from DNA by transcription, that either, carries information (messenger RNA), provides sub-cellular structure (ribosomal RNA), transports amino acids (transfer RNA), or facilitates the biochemical modification of itself or other RNA molecules.

Seed bank: A place where plant seeds can be kept safely for hundreds of years. It has the unique feature as a conservation technique of making plants rapidly and easily available for investigation and evaluation.

Selection: A system for either isolating or identifying specific genotypes in a mixed population.

Single base pair: A set of two nucleotides bound by hydrogen bonds.

SNPs: Single Nucleotide Polymorphisms is a genetic marker resulting from variation in sequence at a particular position within a DNA sequence. SNPs are commonly the result of transition changes (A for G, T for C), but also transversions (G or A for T or C) and single base deletions. Such variation is extensive throughout all genomes, and offers the particular advantage of being detectable without the need for gel electrophoresis.

Stock plant: The source plant from which cuttings or explants are obtained. Stock plants should be well maintained to optimize explant and cutting quality.

Tissue culture: The *in vitro* culture of cells, tissues or organs in a nutrient medium under sterile conditions.

Totipotency: The ability of a cell or tissue to be induced to regenerate into a complete organism.

Totipotent: Plant cells that are capable of generating a whole new plant

Trait: One of the many characteristics that define an organism. The phenotype is a description of one or more traits.

Variant: An individual that is genetically distinct from others in the population.

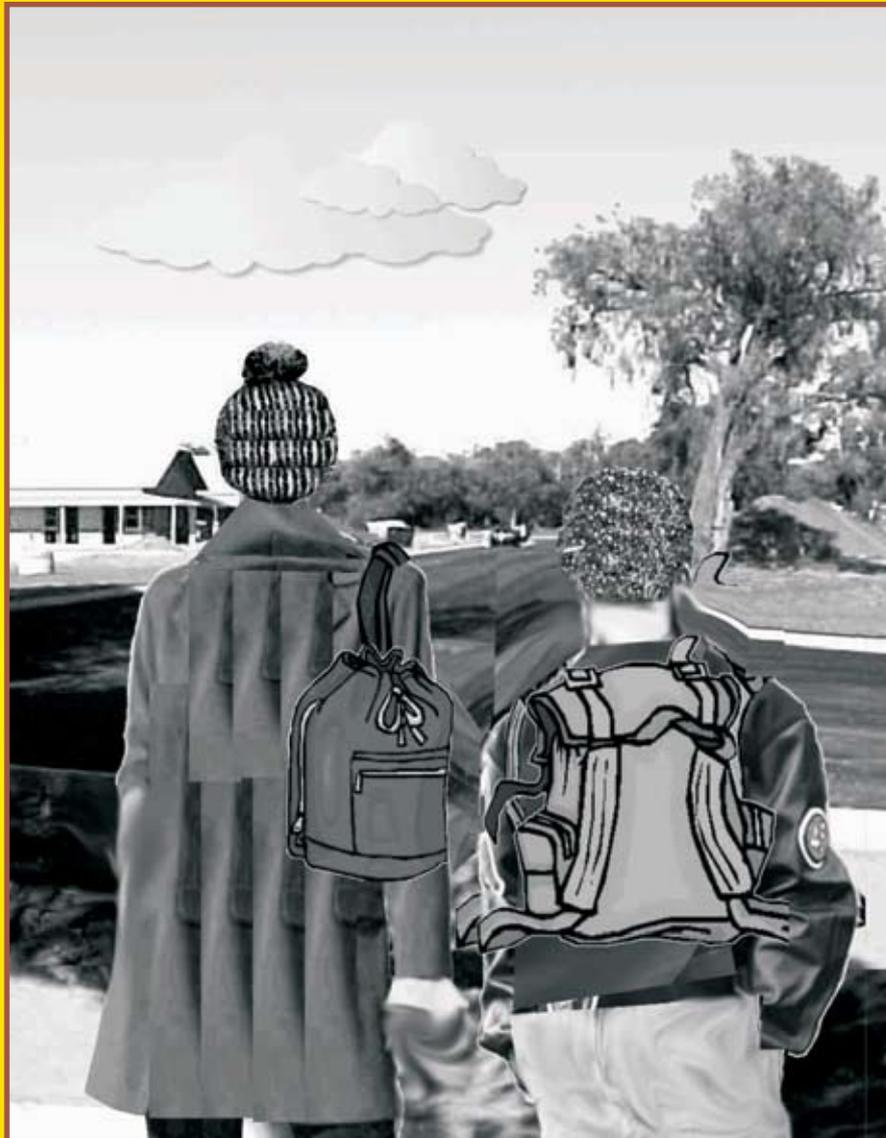
Variety: 1. A naturally occurring subdivision of a species, with distinct morphological characters. 2. A defined strain of a crop plant, selected on the basis of phenotypic (sometimes genotypic) homogeneity.

Vegetative propagation: See "asexual propagation".

Vegetative reproduction: See "asexual reproduction".

Viability: The capability to live and develop normally.

Participate and Learn



For further information, please contact:
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