COURSE CODE:	FRM 511
COURSE TITLE:	FOREST GENETICS, TREE BREEDING AND CONSERVATION
NUMBER OF UNITS:	2 UNITS
COURSE DURATION:	Two hours per week

COURSE DETAILS:

Course Coordinator: Professor M. O. Adedire*ND, Diploma, M.Sc. Ph.D*

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Office Location: Room E209, COLERM

Other Lecturers: None

COURSE CONTENT:

Terminologies to be defined include, Genetics, Heredity, Variation, MENDELIAN GENETICS, Drawings toexplainthe crossing, Cell Division, Formation of New Cells. DIHYBRID CROSS, MITOSIS OR SOMATIC CELL DIVISION, THE IMPORTANCE OF MEIOSIS, DIFFERENCES BETWEEN MITOSIS AND MEIOSIS, TREE BREEDING AND BREEDING SYSTEMS TREE BREEDING AND BREEDING SYSTEMS, DEVICES/CONDITIONS IMPOSING CROSS POLLINATION, PROCEDURE FOR INTRODUCTION OF EXOTIC SPP IN NIGERIA, TREE IMPROVEMENT PROGRAMME IN NIGERIA, TREE BREEDING PROGRAMMES (TREE IMPROVEMENT) IN NIGERIA, IMPROVED BREEDING MATERIAL,

COURSE REQUIREMENTS:

This is compulsory course for all students in the Department of Forestry and Wildlife Management. In view of this, students are expected to participate in all the course activities and have minimum of 75% attendance to be able to write the final examination.

READING LIST:

Wright, J. (1976) Introduction to Forest Genetics

Terminologies to be defined include

Genetics, Forest Genetics, Tree breeding and Tree Improvement.

Genetics- It is a branch of biology. It is the modern experimental study of the laws of inheritance (variation and heredity). The name 'genetics' was proposed by William Bateson (1861-1926) in 1906.

Simply put, genetics is the study of similarities and differences between parents and their offsprings and between offsprings of the same parents. In other words, genetics is the science dealing with **heredity** and **variation,** seeking to discover laws governing similarities and differences in individuals related by descent.

Heredity- is the tendency of individuals to resemble their parents or the transmission of characteristics from parents to offsprings.

Variation- is the differences in characteristics observed among individuals of the same natural population or species.

The Geneticist's BUSINESS is to find out:

- Why variations occur.
- To determine in what proportions the variant types are to be expected.
- To learn how to make more likely the probability that ideal parents will beget ideal offspring.
- To discover the optimum expression of the inherited potentialities.

The first known recorded work in the field of genetics , was not discovered until 1900, some sixteen years after the death of Gregor Mendel, who discovered the science of genetics. Gregor Mendel (1822-1884) is regarded as the founder and father of genetics; because the first scientific studies in genetics were carried out by him. Secondly, he discovered the basic laws of inheritance and also his studies laid the foundation of the science of heredity and variation (Genetics). Gregor Mendel, an Austrian monk who lived between 1822 – 1884 performed his genetic studies on hybridization of plants, particularly garden pea (*Pisumsativum*).

Before Mendel, a lot of experimental work on hybridization of plants had been carried out, but it was he, Mendel, who could for the first time elucidate and formulate the laws involved in the inheritance of parental characters by the offspring. His work covered a period of nine years (1856-1865).

Among the pre-Mendelian period workers are Joseph Kolreuter, a German botanist who in 1760 hybridized two species of tobacco plants (*Nicotianapaniculata* and *N. rostica*).

The pre-Mendelian period workers were unable to discover the mechanism of inheritance of characters/traits from parents by offsprings because of these reasons:

1. The cytological basis of the mechanism was unknown during their period (i.e. the mechanisms of mitosis and meiosis had not yet been discovered).
2. They were trying to study the inheritance of all the characters/traits of the plants at a time.

Mendel in his experiment used garden pea (*Pisumsativum*) and in studying the inheritance of traits paid attention to only one pair of characters/traits at a time, and traced them carefully through many successive generations

. The character that expressed itself in the F_1 generation was called DOMINANT by Mendel, while the other character that remained suppressed(but not absent in the hybrids) was called RECESSIVE by him.

On selfing the F_1 plants he obtained both tall and dwarf plants in the F_2 generation. On counting the plants, he discovered that three-fourths of them were talls while one-fourth were dwarfs. This gave a ratio of 3:1. this is known as MENDEL'S MONOHYBRID RATIO.

Drawings to explain monohybrid ratio.

Mendel's work has proved that traits are transmitted from one generation to another. The hereditary units which are transmitted from one generation to the next (i.e. inherited) are called genes. A gene can be defined functionally as that part of a chromosome responsible for the development of a particular trait in an organism. Genes reside in a long molecule called deoxyribonucleic acid (DNA). The DNA, in conjunction with a protein matrix, forms nucleoprotein and becomes organised into structures with distinctive staining properties called chromosomes found in the nucleus of the cell.

Geneticists are concerned with (1) genes (2) with the chromosomes that carry them and (3) with the cells in which those chromosomes are found.

Mendel reasoned that there must be two factors separately responsible for each pair of contrasting characters .i.e. tallness and dwarfness. These factors occur in pairs (now known to be arranged in a linear fashion in the chromosome). A member of alleles which manifests in the F_1 is referred to as DOMINANT gene; while the one whose effect is suppressed or 'hidden' is called a RECESSIVE gene. When two alleles (a pair of allele) are present in the dominant or

recessive form, they are said to be in HOMOZYGOUS condition (TT or tt) i.e two members of a pair of alleles existing in the same form. if one member of the allelic form is present in dominant form and the other in recessive form, HETEROZYGOUS (Tt) condition is achieved. Under heterozygous condition/effect, the dominant gene will manifest. for instance, if 2 contrasting colours - yellow and green are crossed, all the F_1offsprings will be yellow.

DRAWINGS TO EXPLAIN THE CROSSING

DIHYBRID CROSS

For the dihybrid cross two pairs of contrasting characters are taken into consideration at a time. Mendel selected a tall plt with red flowers – TRTR and a dwarf one with white flowers trtr, their respective gametes being TR and tr. Four unit xters are, therefore, concerned in the dihybrid ratio. Factors for tallness or dwarfness and for red flowers or white flowers are independently inherited. Artificial crossing was brought about between these 2 plts. In F1 generation all individuals were tall with red flowers – TRtr because tallness is dominant over dwarfness, and coloured flowers dominant over white, subsequently their gametes baring factors TR (tall – red), Tr (tall-white), tR (dwardf red) and tr (dwarf white).

When the seeds from the F1 generation were grown, a segregation. A cross, in with the parents are different from end other 2 characters is called a dihybrid cross. Of xters showing all possible combinations took place in the following properties. 9 red talls, 3 white talls, 3 red dwarfs, and 1 white dwarf. This 9:3:3:1 is the DYHYBRID RATIO. i.e MENDEL'S DIHYBRID RATIO.

Drawing

F2 generation

Male gametes of F1

	TR	Tr	tR	tr
TR	TRTR Tall-red (1)	TRTr Tall-red (2)	TRtR Tall-red (3)	TRtr Tall-red (4)
	TRTr Tall-red (5)	TrTr Tall-white (6)	TrtR Tall-red (7)	Trtr tall white (8)
	TRtR tall-red (9)	TrtR Tall-red (10)	tRtR dwarf-red (11)	tRtr dwarf-red (12)
	TRtr tall-red (13)	Trtr tall-white (14)	tRtr dwarf-red (15)	Trtr dwarf-white (16)

9: 3: 3: 1

The dishybrid F2 generation diagram shows that nos 1, 2, 3, 4, 5, 7, 9, 10, 13 are tall-red

= 9

Nos. 6, 8, 14 …… are tall-white = 3

Nos. 11, 12, 15 …… are dwarf-red = 3

No. 16 …… is dwarf-white = 1

It will further be noticed that nos. 1, 6, 11 and 16 are homozygous (i.e. they have two similar gametes), breeding true; while the rest are heterozygous (i.e. they have two dissimilar gametes), segregating in the next generation.

The homozygotes plants are:

No. 1 (TRTR) will breed true for tall-red

No. 6 (TrTr) will breed true tall-white

No 11 (tRtR) will breed true dwarf-red

No 16 (trtr) will breed true dwarf-white

Mendel found out that the dihybrid ratio obeyed the law of probability which states that "the chance of 2 or more independent events occurring together is the product of the chances of their separate occurrences".

E.g Height (tallness or dwarfness) 3:1 (4) = 16

Colour (red or white) 3:1 (4)

Polyhybrid cross – This could be obtained by considering more than two contrasting xters e.g. three contrasting xters could be taken.

For example, tall and dwarf, red flower and white, and smooth seed and wrinkled.

MENDEL'S LAWS OF INHERITANCE

From the results of his genetic studies on the garden pea, Mendel formulated certain laws to explain the inheritance of xters. These laws are two:

I. Mendel's first law is known as the LAW OF SEGREGATION and states that xters are controlled by pairs of genes of which only one can be represented in a single gamete.

For example, a plant which had a factor or (gene) for round shaped seed and also an allele for wrinkled shaped seed would transmit only one of these two alleles through a gamete to its offspring.

Drawing

Only one gametic type would be obtained from the segregated homozygote. But under heterozygous condition, segregation would yield 2 gametic types.

Mendel's first law of inheritance is also known as the LAW OF PURITY OF GAMETES.

Mendel known nothing of chromosomes or meiosis, as they had not yet been discovered during his time. We now know that the physical basis for this his 1^{st} law is in first meiotic anaphase where homologous (similar) chromosomes segregate or separate from each other. If the gene for round seed is on one chromosome and its allelic form for wrinkled seed is on the homologous chromosome, then it becomes clear that alleles normally will not be found in the same gamete.

II. Mendel's second law, the LAW OF INDEPENDENT ASSORTMENT is based on Mendel'd results of his dihybrid crossings. The law states that the segregation or separation of one gene pair occurs independently of any other gene pair. Or in other words one of a pair of contrasted xters may be combined with either of another pair.

If two pairs of genes are located on different, non-homologous chromosomes, they can be inherited independently. For example, on one homologous (similar) pair of chromosomes are the seed shape alleles and on another pair of homologous are the

alleles for green yellow seed colour. The segregation of the seed shape alleles occurs independently of the segregation of the seed colour alleles because each pair of homologues behaves as an independent mit during meiosis (reduction division of cell).

Drawings

Formula for finding gametic types is:

2^n

where n represents the no. of pairs of xters

e.g. when n = 2; no. of gametic types will be $2^2 = 4$

when n = 3 ; no. of gametic types will be $2^3 = 8$

If n = 4, no of gametic types will be $2^4 = 16$

Gamete*

An understanding of reduction division (meiosis) r halving of chromosome no in the formation of the gametes and the knowledge that the genes carried on the chromosomes are the factors responsible for the transmission of inherited xtics, make Mendel's conclusions easier to follow. Let us briefly review mitosis (somatic or body-cell division) and meiosis or reduction division. Reduction division takes places in all sexually reproducing organisms at some time in their life-cycle. To properly understand the mechanism of

inheritance/laws of inheritance and the fundamental of breeding and tree mpt, a knowledge of the formation of man cells or process of cell division is necessary.

CELL DIVISION

Formation of New Cells

Cell is the smallest unit of life. All living things are composed of these (Ganiete – A sexual reproductive cell; (sex cells). Female gamete is an ovum or egg cell and a male gamete is sperm cell.) basic units, from the simple unit cellular structures of bacteria and protozoa to the complex structures of trees and man. Even within an individual all the cells do not look alike. A muscle cell is obviously different from a nerve cell which in turn is different a blood cell, etc. Thus, there is no such thing as a typical cell type.

All multicellular organisms, plants or animals, no matter their size started their existence as a single cell. This initial cell grows to their (plants or animals) normal size and form. This growth is initiated by the formation of new cells and their enlargement. Hence increase in size of any multicellular organism is due to division of the existing cells of the organism, and not the growth of the cells.

The three xtics of cells are:

1. Cells continue to exist until they are old.
2. Cells store food in form of protein.
3. All new cells are capable of performing the functions of the old cell.

Cell division goes through three main stages.

I. Nuclear division (karyokinesis) which is the initial stage of cell division.

II. Division of the cytoplasm which is known as cytokinesis and follows the division of the nucleus.

III. The separation of the cell itself.

There are groups of methods of cell division.

1. The direct division of cell, otherwise known as AMEITOSIS. This is the way unicellular organisms reproduce.
2. The indirect method of cell division. There are two types
   (i) Mitosis
   (ii) Meiosis

An European botanist who worked during the 2nd ½ of the XIXC.

Polish botanist? Strasburge (1878), German Hiostologist V. Flemming (1882), Russian botanist Christiakov all contributed a lot to the study of the complex process of cell division. Their discoveries serve as the basis for further investigations in this area of scientific study.

MITOSIS OR SOMATIC CELL DIVISION

Mitosis, which was first worked out by Flemming; a German histologist, in 1882, takes place in the processes connected with growth .

Mitosis is mostly restricted to the meristematic regions (of plts) such as the root-tip leaf apices stem-tips; where active cell elongation is going on.

During mitosis two identical daughter cells are produced; and there is the same number of chromosomes in the daughter cells as in the parent cell.

Mitosis takes place in four (4)

Continuous stages:

1. Prophase
2. Metaphase
3. Anaphase and
4. Telophase

Prophase and telophase are lengthy stages, while metaphase and anaphase take place rapidly. Typically the entire process takes about an hour and is followed by interphase.

Interphase: When a cell is not undergoing division, the nucleus contains numerous crooked, often coiled, delicate thread-like structures called chromonemata. These chromonemata cannot be seen by light microscope.

PROPHASE

Cell division starts with early prophase. During early prophase, the thread-like chromosomes could be well identified, because they will be duplicated consisting of two chromatids joining at a region called CENTROMERE .

A chromosome with a median centromere (metacentric) will have arms of approx. equal size. A submetacentric or acrocentric chromosome has arms of distinctly unequal size. If a chromosome has its centromere at or very near one end of the chromosome it is called telocentric.

Nucleolus will start to disappear in the nucleus as the chromosomes continue to coil and become shorter and thickened. Each chromosome is quite separate, and they begin to move out of the periphery of the nucleus.

Late prophase – As the chromosomes begin to move out of the nucleus, periphery the nuclear membrane will begin to disintegrate. A small body outside the nucleus.

1. CENTRIOLE divides into two halves, each migrates away from one another until they are found opposite side of the nucleus. As the daughter centrioles move apart they give rise to the spindle fibre.

2. METAPHASE:- From the beginning, there has been little movement of the chromosomes from their position of formation, but now during meta-phase, the chromosomes will reach the equator of the spindle, led by their centromeres, and get attached to the spindle fibres at the region of the centromere.

3. ANAPHASE

   (a) Early anaphase - When all the chromosomes have arranged themselves, each separates into two independent chromatids, the separation commencing at the centromere and gradually extending away from this point in both directions.

   (b) Late Anaphase:- With the centric mere leading, the chromatids, formed from each chromosome, continue to migrate towards opposite poles of the spindle at a steady rate. As this continues, the shape of the spindle will change to be in form of a cylinder. The new structure is termed stem body.

4. TELOPHASE:- This is more or less a reversal of the events taking place in prophase. The divided chromosomes reach their respective poles and begin to hydrate i.e. assemble.

   A nucleolus will re-appear

   The nuclear memberane is reconstituted.

   The spindle degenerates and the cytoplasm divides in a process called cytokinesis.

   In animals, cytokimesis is accomplished by the formulation of a cleavage furrow which deepens and eventually “pinches the cell in two as shown below.

Drawings

Cytokinesis in most plants involves the construction of a cell plate of pectin originating in the center of the cell and spreading laterally to the cell wall. Later, cellulose and other strengthening materials are added to the cell plate, converting it into a new cell wall.

The two products of mitosis are called daughter cells and may or may not be of equal size depending upon where the plane of cytokinesis sectious the cell. Thus while there is no assurance of equal distribution of cytoplasmic components to daughter cells, they do contain exactly the same type and number of chromosomes and hence possess exactly the same gnetic constitution (genotype).

In mitosis, the chromosome number of each daughter cell remain constant i.e. it exactly the same with that of the original mother cell (Diploid), or 2n) The brief period between two cycles of cell division is known as interphase.

MITOSIS IN DIAGRAMS

MEIOSIS OR REDUCTION DIVISION

Meiosis (first worked out by strasburger, a German botanist in 1888) is a complicated process of nuclear division whereby the chromosome no is reduced to half (n) in the four nuclei so formed by this method.

Meisis occurs in reproductive cells resulting in the formation of spores or gametes. It is the mechanism for the transmission of hereditary xters, which are carried by the chromosomes.

Meiosis actually involves two divisions. The first meiotic division (meiosis I) is a reductional division producing two haploid (n) cell from a single diploid (2n) cell.

The second meiotic division (meiosis II) is an equational division with separates the sister chromatids of the haploid cells. MEIOSIS I

The prophase of meiosis I differs from that of a mitotic division in that homologous chromosomes come to lie side by side in a pairing process called SYNAPSIS. Each pair of synapsed homologues is called a bivalent; since it consists of four chromid strands, a bivalent is also called a tetrad. During synapsis non-sister chromatids may break and re-write with one another in a process called crossing over. The point of exchange appears in the microscope as an overlapping region called a chiasm (chiasmata, plural).

During metaphase I, the bivalent orient themselves at random on the equatorial plate.

At first anaphase the centromeres do not divide, but continue to hold sister chronatids together. The homologues separate and move to opposite poles. That is, whole chromosomes (each consisting of two chromatids) move apart. This in effect is the movement which reduces the chromosome number from the diploid (2n) condition to the haploid (n) state.

Cytokinesis in telophase I divides the diploid mother cell into two haploid daughter cells. This ends the first meiotic division. The brief period between the first and second meiotic divisions is called INTERKINESIS.

By metaphase II, the centromeres have lined up the equational plate.

During anaphase II the centromeres of each chromosome divides, allowing sister chromatids to separate. Cytokinesis in telophase II divides the cells into four meiotic products.

THE IMPORTANCE OF MEIOSIS

In sexually reproducing organisms the gametes are haploid (n) (Geek word haploos, meaning single); and two gametes fuse to form a diploid (2n) zygote

(1) Meiosis for reduction division is (important) because it causes the reduction in chromosome number which is very essential during the time of gamete formation in order to maintain a particular diploid number through successive generations of sexually reproducing organisms.

(2) Chiasmata help in exchanging parts of chromatids between homologous (similar) chromosomes (during meiotic division), thus further ensuring new combinates of xters. Meiosis, therefore, helps in bringing about variation in a population.

(3) It is the mechanism for the transmission of hereditary xters which are carried by the chromosomes.

There are some distinguishing characteristics between mitosis and meiosis. These difference can be summarized as below:

DIFFERENCES BETWEEN MITOSIS AND MEIOSIS

1. Mitosis occurs in somatic cells while meiosis occurs in reproductive cells resulting in the formation of gametes or spores.
2. In mitosis, the chromosome no remains constant (diploid or 2n), while in meiosis, the chromosome number is reduced to half (haploid or n).
3. In mitosis two products (daughter cells) are produced per cycle, while four cellular productions (gametes or spores) are produced per cycle in meiosis.
4. Prophase of mitosis is short, while it is a prolonged one in meiosis and, therefore, divided into sub-stages.
5. Crossing over (exchange of genes) occurs in meiosis and there is chiasma, but there is no crossing over in mitosis.
6. Pairing (synapsis) of identical (homologous) chromosomes (one paternal and one maternal) occurs in meiosis (each pair subsequently acting as a unit), but no pairing occurs in mitosis. In mitosis on the other hand each chromosome splits longitudinally into two. This gives rise to two chromatids).
7. In mitosis the chromosomes are equally apportioned (divided) to the daughter nuclei, i.e the latter are qualitatively and quantitatively the same as the mother nucleus, while in meiosis the four threads of a chromosome go to the four cells (and their assortment is also a matter of chance, i.e. it is not known which thread will go to which cell). Thus meiosis results in four new types of cells.

TREE BREEDING AND BREEDING SYSTEMS

What is breeding? The art and science of changing plants or animals genetically. Breeding is the art and science of changing the genetic construction (genetic make up) of plants or animals population.

Plant breeding (P.B) is the art and science of changing (or manipulating) plants genetic make up to satisfy mains needs (or requirements).

Tree breeding :- (T.B)is the art and science of changing tree species genetically so as to satisfy man's needs.

Forest tree breeders have been able to make some progress in this direction through the study of Genetics. This science has enabled them to transfer desired traits from one plant to another. The tree and plant breeders alike, utilize to advantage the discoveries of geneticsis and combine them with those of other branches of science, particularly cytology, taxonomy, physiology, anatomy and biochemistry, to achieve improvements in trees and crops respectively.

Breeding is an art because it involves the ability of human beings to observe some traits of economic value of the organism under investigation.

On the other hand breeding is a science because it is based on the principles of genetics i.e. on the laws of inheritance.

Throughout ages, unconscious selection of superior plants by man has been going on. But with the discovery of sex in plants it has been possible to hybridize plants. Hybridization concept has added to the understanding of plant breeding.

Mendel's exp paved the way for more understanding of P. B. This has made P.B. to be less of an art and more of science. It then become possible to create new types of plants at will, although the art of selection is still needed.

However, tree/P. B. is now based on the thorough understanding and the utilization of gentic principles. A clear understanding of tree/P.B hinges or depends on the firm knowledge of:

1. Botanical xtics of the spp
2. Plants diseases and their epidemiology
3. Insect pests that feed upon the different plants spp
4. Physiological factors related to adaptation of plants.
5. Biochemxtics affecting utilization and value of the spp.

There are certain problems, peculiar to tree improvement in West Africa and Nigeria in particular.

PROBLEMS OF TREE IMPROVEMENT (TREE BREEDING) IN NIGERIA

1. Non-availability of a genetic base or materials. This is due to exploitation which leads to the loss of gene pool in tree .
2. Lack of adequate information and exchange of information on the breeding systems of native trees. Info' on xtics of local trees.Infor' such as breeding pattern etc.
3. Or in other words scarcity of Basic genetic information about trees.

   Scarcity of traininedstaff .A knowledge of the genetic characteristics to be improved upon.
4. The time factor/ element – Rotation age of trees is an adverse problem for tree improvement.

Thus the main aim of tree improvement programme is always to reduce the rotation.

Consider a situation where F1 are raised, the time it will take to raise F2.

5. Inadequate funds.
6. Lack of technology for tree improvement.
7. Lack of favourable government policies.

STRATEGY TO COMBAT THESE PROBLEMS

The national policy should be geared towards leaving the natural forests as they are so as to provide a large genetic base.

Conservation in-situ is very necessary. Control of exploitation should be more effective and no exploitation should be within strict natural reserves (SNR)

METHODS OF CONSERVING THE GENETIC RESOURCES OF FOREST TREE SPP

The meaning of in-situ conservation maintenance and regeneration of the spp involved in their areas of origin or natural occurrence.

In-situ conservation is highly desirable in cases of spp where the appropriate silvicultural or

1. In-situ – (see its meaning)
2. Ex. Situ see storage

    Vegetative propagation

    (a) grafting

    (b) marcotting

This technique is particularly appropriate for spp which produce seeds infrequently and for recalcitrant.

Recalcirants – Seeds of forest tree spp whose viability could be lost within a short time and unable to withstand either drying or low temperatures or both.

3. pollen storage
4. Tissue and meristem culture techniques.

BREEDING SYSTEMS OR REPRODUCTIVE SYSTEMS

Knowledge of reproductive systems i.e breeding systems is so clearly fundamental to plant and tree breeding that discussion of them must precede any consideration of breeding methods themselves.

For pH/tree breeding purposes all plants are divided into two (2) broad groups.

1. Self-pollinating plants.
2. Cross pollinating plants.

The division of plants into these groups is of great importance because the methods of breeding applicable to the self-pollunating group are for the most part different from these that apply to the cross-pollinated spp.

The important difference between the two groups is related to the influence of inbreeding vs outbreeding on the genetic structure of popns. All plants in popns of outcrossing/cross-pollinating spp are highly heterozygous, while in-breeding/self-pollinating spp often give rise to closely related homozygous lines.

Vegetative propagation (a sexual reproduction) can be used to produce new individuals in some plants. This could be by

1. Budding and grafting (this is possible in pines, Triplochitonseleroxylon K. Schum, Tectonagraundis L.F, GmalinaarboreaKhayaspp etc.)
2. Cuttings (leaf cutting system cutting or root cutting).

   Vegetatively propagated spp are highly heterozygous. If selfing is imposed a high degree of segregation or variability is observed. If selfing is imposed heterozygosity is reduced and vigour and yield (in agric crops) will be reduced.

There are some special modes of reproduction.

(1) Apromixis:- This is a type of a sexual reproduction in which seeds are produced but these seeds do not result from normal meiosis and fertilization. They are vegetative seeds.

   Apromixis may be of different types.

   (a) Parthenocarpy:- This is the development of fruit without fertilization i.e. ovary develops normally into a fruit without fertilization.

   (b) Apogamy:- is the development of an embryo from any cell of the gametophyte other than the egg-cell, evidently without the intervention of gametes.

   (c) Sporophytic budding:- Formation of an embryo from the diploid cells of the nucellus, as in orange, mango etc or even those of the integument, as in onion.

(2) Apospory (apo, means off or without). Apospory is the development of the gametophyte directly from vegetative cells of the sporophyte without the intervention of a spore.

(3) Polyembryony : - If more than one egg in a gametophyte is fertilized, oen embryo may develop from each. The occurrence of more than one embryo in the seed is known as simple polyembryony. This is common in both dicotyledenous and monocotyledemous spp.

Cleavage Polyembryony refers to those embryos that come from a single egg by splitting after a single fertilization.

A plant is classified accordingly to which of the two broad reproductive systems is prominient.

In cross-pollinating spp, there is a high degree of heterozygosity. If selfing is imposed there will be in-breeding depression i.e reduction or loss of vigour.

In-breeding – occurs when crossed are made between close relatives. The extreme case is selfing, or the crossing of a tree with itself.

Out-breeding- describes crosses made between individuals not closely related.

Cross-pollination may be of the following types

1. Xenogamy – (xemos – stranger) Pollution between flowers borne by 2 different plants of the same spp.
2. Geitonogany (geiton-neighbour) BU between flowers borne by the same plants.
3. Hybridism – Pollution beween 2 flowers.

1. Self pollination – transference of pollen gr. From the author of a flower to the stigima of the same flower, evidently bisexual.
2. Cross-pollunation – transference of polen gr. From one flower to another flower. Born by 2 different plants of allied spp or even allied genera.

In self pollinatingspp (i.eautogamousspp) each member of the popn is a vigorous homozygote. These self pollspp reproduce independent of other plants in the population.

In self poll plants there will be no inbreeding depression if the plants should be selfed. If there will be any it will be of insignificant effect.

There are some conditions in plants which impose cross pollination.

DEVICES/CONDITIONS IMPOSING CROSS POLLINATION

(1) Dicling or unisexuality:- Flowers are unisexual i.e. stameus and capele lie in separate flowers – male and female, either borne by the same plants or by two separate plants.

Dicliny or unisexuality is of 2 types.

(a) Monoecious:- when the male and female flowers are on one and the same plants e.g. maize.

(b) Dioecious – when the flowers are on 2 separate plants e.g. carica papaya (pawpaw).

(2) Dichogamy:- This occurs in bisexual flowers. This is the maturity of another and the stigma at different times. There are 2 conditions of ofdichogang.

(a) Protandry:- Male reproductive organ (author) matures before the female reproduction organ (stigma).

(b) Protogymy:- Female reproduction organ (stigma) matures before the male reproductive organ (another).

(3) Self-incompatibility:- This occurs when functional pollen grains of a flower have no fertilizing effect on the stigma of the same flower.

Incomp.is abiochem reaction i.e.certain chemicals inhibit the germination of pollen.

Incomp.is heritable i.e. it is genetical and can therefore be carried from generation to generation. It can take place at any stage between pollution and fertilization.

(i) Fertile pollen gr may not germinate on receptive stigma (stigmatic incompatibility)

(ii) Pollen may germinate, but the growth of pollen tube may be slow and the female egg might have withheld before the pollen tube gets to it.

(iii) Incomp. may be at the ovule. The male and female much may not fuse.

TYPES OF INCOMPATIBILITY

1. Heteromorphic Incomp:- This is caused by difference in the floral morphology. E.gPrimulasinensis has two types of flowers. There is one with long style (Pin) and the other with short style (Thrum)

Pollen from the 2 types of flowers cannot function on their stigma.

A to A poll and fert can occur.

A to B poll and fert cannot occur.

2. Homomorphic incompatibility

This is not as a result of variation in floral morphology. It is caused by the gamage of the plants. It can be

(a) Garmetophytic:- In which incompdepends upon the genotype of the gametphyte.

(b) Sporophytic – where the incompatibility is impressed upon the gametophyte by its sporophytic parent.

Male Sterility

In incompatibility functional pollen grains are produced, but under some conditions cannot function. In male sterility the pollen grains are non-functional.

Reasons (i) Chromosomal aberrations can cause male sterility.

(ii) Gene action i.e. presence of certain genes can cause if

(iv) Cytoplasmic factor/influences can also cause male sterility.

Under the situation of male sterility, anthens of some flowers may not contain pollen at all.

Male sterility, unlike incompatibility, is not a regular mechanism fo controlling hybridity in natural populations. Male sterility occurs sporadically i.e. unexpectedily in populations of both self and cross poldinatedspp, presumably as a result of mutation at any one of the many loli that govern difference vital steps in the formation of pollen.

In nature, such mutations are disadvantageous to the plants. But breeders explore this to their advantage when carrying out hybridization. In hybridgization the 1st stage is emasculation. But if male sterility occurs emasculation process which is tedious will not be done, since emasculation has been genetically carried out.

Emasculation:- This is the removal of anthers or male flowers before controlled pollimation.

There are three types of male sterility:

1. Genetic male sterility
2. Cytoplasmic male sterility
3. Cytoplasmic – Genetic male sterility.

PROCEDURE FOR INTRODUCTION OF EXOTIC SPP IN NIGERIA

Wherever man has gone, his plants have gone with him, and this carrying of plants from place to place has been one of the most important features in the development of agriculture generally throughout the world.

What do we understand by introduction of exotic spp? This is the acquisition of superior plants by importing them from other areas.

There are some factors which necessitate the introduction of exotic spp. These include:

1. When the supplies of indigenous timber and other forest products are insufficient to meet the local demand i.e. to enrich the local flora.
2. When the original spp are unsuitable for the locality or object of management. i.e. wood quality.
3. When an inferior vegetation is to be replaced by more valuable ones e.g. conversation of genuine savanna to a plantation.
4. When object of management is to extend the growth of one sp uniformly over a large area.
5. When the fertility of the soil has so deteriorated that the original spp will no longer thrive on it and must give way to less exerting ones.

Among the consideration used choosing ……

The first thing to be done in introducing an exotic sp is forestry is to carry out species trials. This is necessary to determine the suitability of the sp to the new environment.

Generally, species trials involve

1. Elimination trial

2. Growth trial

3. Field/plantation/yield/crop performance trial.

After concluding that an exotic tree sp can do well in the country there will be need to carry out breeding activities on the species with the aim of improving it.

The first stage of the breeding procedure is provenance trail.

What is a provenance? There have been several published definitions of providence. Wright (1976) reported that "provenance" is a synonym for "origin" or "source". He added that the word has been commonly used by tree breeders to mean "ultimate natural origin".

Simply, a provenance is a seed source and it is usually a well defined geographical location.

It is particularly necessary to do provenance testing (provenance trial) prior to more intensive breeding work, especially when dealing with an exotic. However, provenance testing is also desirable native spp.

Provenance testing is usually carried out for the following reasons:

1. Determination of best seed sources to use in different forest areas.

2. Fixing regions where plus tree selection should be concentrated.

Plus tree: These are those trees in a stand that are phenotypically the best. They are xterised by high growth intensity, good stem quality, good health etc.

Provenance selection is usually the first step in any tree breeding programme. The materials so obtained can later be subjected to further improvement by other means.

Provenance selection leads to effective tree improvement when the spp of interest is

1. geographically widespread,

2. occurs in a diversity of ecological conditions

3. has a long period of exposure to a particular environment and

4. where natural or seminatural population of the sp still exists.

After selecting the best provenances, plus trees are then chosen from such produces . Materials from the chosen plus trees are normally used to estab. Seed orchards either by seeds (seedling seed orchard) or by veg. means (grafting chonal seed orhard.

Seed orchards are special plantations managed to provide abundantly genetically superior seeds on a sustained basis.

Seeds collected from such seed orchards are usually used in carrying out progenly trials or progeny test.

Progeny:- The offspring of a particular tree or a particular combination of one female and 1 male tree

Progeny Test:- The method of assessing the genetic xter of an individual by the performance of its progeny.

Progeny Test:- is an expt, usually replicated, to compare the offspring of different parents, or to compare performance of offspring and parents usually confined to seedling offspring.

Progeny testing may serve different purposes:

1 rank established varieties according to yield potential.

2 Assess the breeding value of parent plants.

3 Select superior genotypes both within and between progency families.

4 Provide improved and known seed sources.

Eli tree: This is a tree which has been proved to be genetically superior by a progency test.

(Evaluation of parents by the performance of their sexual progency.)

TREE BREEDING PROGRAMMES (TREE IMPROVEMENT) IN NIGERIA

SCHEMATIC OUTLINE OF BREEDING PROCEDURE

SPECIES

PROVENANCE

STAND (FOREST, PLANTATION, SEED STAND)

INDIVIDUALS- PLUS TREES (PHENOTYPES)

SEXUAL

PROPAGATION (SEED)

RECOMBINATION & CREATION

PROGENY

1. EVALUATION OF PARENTS
   BY BREEDING
   (ESTIMATION OF GENOTYPE)
   AND REJECTION OF POOREST TREES)

2. SELECTION OF PLUS

VEGETATIVE PROPAGATION

(SLION, BUDWOOD, CUTTINGS

COLLECTION & PRESERVATION

CLONES

5. CLONE COLLECTION
   STUDY OF CLONES
   UNDER UNIFORM CONDITIONS
   (ESTIMATION OF GENOTYPE)
   CONTROLLED POLLINATION

6. SEED ORCHARDS

TREES FROM THE

BEST PROGENIES

PRODUCTION OF

IMPROVED SEED

CLONE STUDEIS

SOURCE FOR PROGENY TRIALS

3. IMPROVEMENT OF ESTABLISHED SEED ORCHARD

4. CONVERSION OF PROGENY TRIALS INTO SEEDLING SEED ORCHARD

7. MULTIPLICATION GARDEN-COLLECTION AND PRODUCTION OF BUDWOOD

8. CLOME PLANTING OF FORESTRY SCALE

ELIMINATION AND SELECTION

IMPROVED BREEDING MATERIAL

PHASE II

SEXUAL PROPAGATION

PROGENY TRIALS

IN PRINCIPLE SAME PROCEDURE

AS PHASE I EXCEPT

VEGETATIVE

PROPAGATION

CLONES

IN PRINCIPLE THE

POSSIBLY FOR ITEMS 3 IN PRINCIPLE THE

SAME AS IN PHASE I

TREE IMPROVEMENT PROGRAMME IN NIGERIA

Plantation forestry is a prerequisite to any tree improvement programme because it allows the tree breeder to select and improve on the selected plant materials.

The beginning of plantation forestry in Nigeria was followed by spp introductions and the application of genetic principles for improving our forests. Several exotic spp have featured in the afforestation programmes in the country. Among these spp are *GmelinaarboreaTectonagrandis*and pines.

The ever increasing plantation establishment of the spp has necessitated the need to supply improved seed for planting.

As a result of this, various improvement programmes have been initiated at FRIN startx with provenance selection which is the 1st stage in any tree improvement provenance trial recorded in Nigeria started in 1968 in Pine.

In 1970, the International provenance trial series of Pinuscaribaca Mor. And P oecarple sch. was organized by common wealth Forestry Institute, Oxford and Nigeria has been participating in its programmes. The trials of P. oocarpa and P. caribaca were first established in Southern Nigeria in 1972 and 1973 respectively. In the same year (1973), the International provenance trials of Tectonagrandis L. f started in Nigeria, while that of GmalinaarboreaRoxb. Began in 1978E

The best provenances of these spp have been identified, and further improvement work is being centered on their reproductive biology. This is necessary because the knowledge of

reproductive biology is so clearly fundamental to plants and tree breeding and improvement in order to design effective breeding programme for them.

Engenti (1976) worked on some aspects of the reproductive biology of Teack (I granidisL.f) and reported the possibilities of using stored pollen of the sp for tree improvement work.

Improvement work on the indigenous hardwood spp is being carried out at the West African Hardwood Improvement Project.

(WAHIP) of the FRIN. The project's activity centres on the improvement f Triplochiton sclera xylon, Terminalia superb, I.ivorensisKhanyaspp, Chlowplora excels, Afzelia Africana and a host of others.

Past and present researchers in the project have and are still doing a lot of work on different areas of improvement of the aforementioned tree spp.

Success of Vegetative propagation of some tree spp.

A lot of encouraging results have been obtained on vegetative propagation of I. sleroxylon (Howland & Bowen, Ladipo, Oni). Work on Clonal selection, branching patterns of I. seleroxylon have been successfully carried out by Dr.Ladipo (the former WAHIP project leader).

It has been found possible to root cuttings from Khanya Senegal ensis, Chlorophoara excels, Manisoniaaltissima (this was reported by Howland and Bowen 1977, Oni 1984).

Ladipo (1981) reported that veg. propagation in the form of budding and grafting as an additional approach to the tree imput of I. scleroxylon has allowed candidate plus trees to be propaged successfully and established as seed orchards (in situ and ex-situ) and materials for flower induction experts provided.

Various workers (Howland, 1975, Ikekhuamen and Britnomn) at different time, have recorded successful grafting techniques for the sp. Their result favoured patch budding. Beside patch budding, WAHIP reports (1977) indicated that preliminary trial by the project showed that top cleft and side veneer methods of grafting auto potted seedlings were all, to some degree, successful. Okoro and Omokaro (1975) examined the possibilities of rooting adult stems of I. scheroxylon by, marcotting or our-layering. Although the result of this work was not conclusive it however indicated that marcotting is possible in I. seleroxylon.

Success has also been achieved in rooting leafy cuttings of this sp. Ladipo (1981) obtained rooting success exceeding 75% for single mode leafy cutting treated with 0.1% Naphthalene acetic acid NAA + 0.1% Indole-3-butyric acid (IBA) in industrial methylated spirit.

It is necessary to mention that success has been achieved in certain aspects of veg. prop. Of exotic spp too. For example, Oduwaiye (1981) reported that it is possible to carry out grafting of Gmalinaarborea all the year round, though this had not been successful with budding.

Grafting of Pimuscargean has also been studied by various workers/researchers in Nigeria (These researchers include Okoro (1976), Oduwaiye (1978), Oduwaiye (1980), Oduwaiye (1983)