

**FWM 403: Silvicultural Techniques**

# **LECTURE NOTE**

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## **ECOLOGY OF TROPICAL FOREST**

Many tropical countries are richly endowed with natural forest resources. Tropical forests are generally marked out by richness in spp. For instance as at early 80's over 600 trees spp have been recorded as being capable of attaining a height of at least 12 metres and girth of about 60cm. these forests together constitute almost half of the world's forest area and contain an enormous quality of renewable raw materials in world of growing needs.

The management of these important renewable natural resources to maintain and where possible increase their productivity on a permanent basis become the main pre-occupation and the most challenging task of tropical foresters. To succeed, the foresters need to understand the type and composition of the forest to be managed as well as the condition under which such forests perpetuate themselves.

Common to all tropical forest formations is the fact that although the forests are rich in tree spp., with hundreds of them sometimes found in a single hectare, each spp. May be represented by only two or three per ha.

Furthermore, the forests are characterized by a low proportion of commercially valuable sp. For instance, of the 2,500 trees spp. Found in Malaysian sown forests zone, only 600 spp out of over 600 are currently considered commercially important with attention frequently restricted to only about 35 of 11cm.

The nature and composition of the forest in various areas thus provide useful indications of its economic value are profoundly influence any attempt at either regeneration or replacement of the indigenous spp. in the area.

Write on structure and composition of Tropical forest type and implication on forest management.

## **FOREST REGENERATION**

Forest regeneration is the process by which a forest is renewed. Premoral tropical forests are regenerated by a new trees spring is up whenever light and other site factors are favourable under the parent stand.

The forest as a natural resources has the remarkable feature of being renewable. Consequently one of the basic objectives in forestry is sustained economic utilization of forest resources or the judicious reaping of the existing crop and its replacement with a new one.

It is a well known fact that the luxceriant rain forest with its great variety of species and coverage of an immense aggregate area is currently exploited for only a few valuable spp.

With the increase in the global demand for wood raw material and the trend is expected to continue for decades to come as a result of rapid progress in industrialization, increasing literacy and expanding world property as well as rising standard of living – all of which lead to an adulterated consumption of wood products. To meet these requirements, attempts should be made to increase the productivity of both natural scatter land forests especially in highly produce areas.

The choice of appropriate regeneration system is based on accurate assessment of the quality, distribution and living conditions of seedlings of desirable spp in the area to be harvested.

The methods considered suitable in various parts of the tropics for ensuring the regeneration of monthly desirable species can be grouped into three.

- Natural regeneration which is obtained from seedlings originating either from natural seedling or from sprouts and other vegetative means.
- Artificial regeneration obtained by total replacement of the old stand through planting young trees or applying seed which is often termed direct sowing.
- Enrichment planting accomplished by planting trees in poetically opened forests where the seedlings present are of unsatisfying species or if of desirable species are either insufficient in number or ill distributed over the regeneration area.

## **NATURAL REGENERATION**

This is the only natural method and it is applicable in forests where there is either an already adequate seedling property of the desirable species all over the regeneration area or it is easy to induce it. This methods involve operations aimed at:

1. Encouraging self sown seeds to germinate and the resulting seedlings as well as all pre-existing young trees of the desirable species to develop through removal of their competitors.
2. Replace exploited forest with strands of higher economical value without markedly altering the characteristics structure of the forest.

The success of this method depends on:

Availability of ecological conditions which guarantees seed availability, seed germination and establishment of satisfactory density and distribution of regeneration or before and after forest exploitation.

- a) Adequate seed supply over the regeneration area where seed is inadequate, there should be sufficient moisture trees of the desired species capable of producing good seed.
- b) Successful germination of the seeds, this largely depend on the inherent qualities of the seed such as seed dormancy of adequate moisture and other physical condition.

Natural regeneration in tropical and sub tropical region is very difficult, the reasons for this are:

- With the stand composed of great variety of species, the process of plant succession which is the basis for natural regeneration has not yet been clearly known.
- Adequate control of the stand is difficult because there is new information about the light conditions inside the forest, growth and light requirements of succeeding tree or growth conditions of samplings.
- Harmful vegetation and weeds (climbing and ligneous plant) thrives, preventing the growth of valuable samplings requiring a great deal of labour for ground floor treatment.

The method of natural regeneration currently adopted in the tropical regions and broadly classified as following

- Section system
- Shelter wood system

- Malaysian uniform system
- Seed tree cutting method

## **SELECTION SYSTEM**

This is applicable in temperate forest to any silvicultural programme aimed at creating or maintaining an uneven aged forest stand. This is usually found necessary where the existing forest is uneven aged and cannot be rendered even-aged without cutting to many young trees premature.

In this about the oldest and not necessarily the largest trees are cut and reproduction is usually by natural means.

Under temperate conditions where the forest stands are usually dominated by a few useful species with prominent annual rings, thus system has been idely used in the tropics where these factors do not hold, the application of the selection systems has been complicated by several difficulties. These include the lack of annual rings as a guide to age growth rates, the big sizes of the merchantable species, the large area worked annually and thus inadequate knowledge of silvicultural characteristics of the tree species involved.

In the tropics, the approach consist of falling a population of trees of the merchantable species above minimum girth limit and carrying out tending operations on the felling site to assist natural regeneration. This has prove successful in the treatment of the tropical rain forest of northern Queensland.

The forest is divided into as many blocks as there are years in the felling cycle and all the annual operations take place in the current block.

The trees are marked for felling either because they have reached maturity or they have to be removed for the general improvements of the stand.

The following are operations which may be carried out on the annual coupes.

- (1) Marking of the yield (those trees). This should be done so as to distribute the falling evenly over the coup and to create no large gap.
- (2) Exploitation following marking
- (3) All dead, dying, diseased and lessening economic trees are felled.
- (4) Tending operations are carried out in order to help the development of the merchantable tree species.
- (5) Any damaged shoots of the of the merchantable species on the felling sites are coppiced.
- (6) Group of natural regeneration are cleared
- (7) If merchant, they will have to be felled before tending operation begin.

The selective/selection system is in the tropical high forest is sometimes criticized are the following group that:

- (1) Its management may be a little complicated and so it requires a highly skilled staff.
- (2) Control and supervision of the felling are not easy because of their scattered nature.
- (3) Large proportion of the un-merchantable species makes the scheme under productive.

Despite the criticisms, the selective system is however not without its own virtues. It is a natural system which does preserve the structure of the forest and the purity of the amount.

The soil is never uncovered and so it is preserved and may be improved. In many cases, it is the only system to adopt as in many watershed protection forests. Forests managed under selective system produce a range of materials to any annual coupe.

### **CLEAR FELLING SYSTEM**

Under this system, all trees, large or small in the area to be regenerated are felled/cut at the rotation age. Occasionally trees below merchantable size, or otherwise determined trees and other unsaleable species not removed by the harvester are knocked down or killed in other ways. This system is simple to apply and requires no skill for marking out the merchantable trees since its ultimate aim is to lay bare the area treated.

Regeneration is effected either naturally by seeds or seedling already on the ground or coming from adjacent trees or artificially by sowing or planting.

This system is being applied in the tropics especially in areas where the shelter wood systems have proved unsuccessful.

Understocked or exploited natural forests to plantations of faster growing and higher yielding species.

Clear felling with natural regeneration appears to be suitable when seed years occur regularly and at frequent intervals, otherwise the kind may be left bare for too long. It is also essential that the forest being cut dominated by the desired species as in plantations.

Regeneration from seed disseminated from outside generally applies to species with light or winged seeds which can be dispersed by wind. The sea which can be re-seeded in this way depends on the height of the adjacent trees and the duration of wind as well as the weight of the seed. To ensure that the soil is not left bare for too long wherever regeneration is solely dependent on the seed from adjacent trees, the clear felling is appropriately modified to ensure full coverage. The clear felling may then be carried out in alternate strips, progressive strips or as patches, the size and shape of which are determined by the silvicultural characteristics of the species to be reproduced.

One of the most advantages (virtues of this approach is the opportunity to avoid delay in the establishment of the new crop that frequently results if one depends on natural regeneration, artificial regeneration also allows for choice of appropriate species. The clear felling system is generally suitable for strong light demanding species as it provides complete overhead light. Unlike the shelter wood system, clear felling system create no felling damage.

The application of the clear felling system however has the following disadvantages.

- In area of high rainfall, and steep slopes, it provides the vegetation cover and thereby reduces soil protection against erosion, landslides and rapid run-off.
- It also causes desiccation and general deterioration of the soil through exposure to sun and air currents.
- Loss of micro-climatic conditions which can adversely affect the establishment of the young plants.

Clear felling usually results in an influx of weed or undesirable species which usually occupy the area. These include:

*Musanga cecropoides, Trema guinantis, Harungaa madagasca riensis, Eupatorium ododrata, Chromolaena odoodrantom etc.*

## **SHELTER WOOD SYSTEM**

This required that regeneration system is natural under the one of modern trees. Regeneration starts and is nurtured under the protections of older stand approaching its rotation age are finally released when it is deemed to have been established by final felling or exploitation. This establishment of a new crop before completion of the preceding rotation is the most fundamental characteristics of shelter wood systems.

Over a period of few years, the older trees are removed progressively by a series of secondary felling to favour the development of the seedling, and sampling of the desirable species. Final felling comes when the last of the over wood is removed and by the next generation will have been properly established.

In the gradual opening of the canopy, the silviculturist is trying to control a delicate balance by letting in sufficient light for the proper development of the tree seedlings and seedlings but not too much light that will encourage an unwanted invasion of wood. One of the principal advantages of this system is that the ground is never completely uncovered and so the microclimate of this forest is not less. One of the many variations of the system is tropical shelter wood system (TSS) which has been practiced in West Africa.

## **TROPICAL SHELTER WOOD SYSTEM**

The general underlying principle of TSS is to regenerate the forest by natural means under the shelter of the existing forest which will be subsequently exploited after the establishment of the regeneration.

TSS was introduced into Nigeria in 1944 and developed in response to what at time regarded as a need for an extensive system at regeneration could keep up with and be financed from improved exploitation to supply mainly export market with commercially valuable tree species. TSS is a variant of the uniform or European shelter wood system (USS/ESS) fashioned after the old Malaysia system.

It is silvicultural system of manipulating forest stand development through operations which involves removal of unwanted or malformed trees by poisoning, controlled exploitation and freeing of regeneration by climber cuttings.

TSS is used in the tropics in the conversion of uneven-aged, highly complex natural tropical rain forest to a more or less even-aged forest stands. To this end, it has the additional aim of inducing the regeneration of greater numbers of the more desirable species than hitherto contained in the natural forest and concentrating these so age – classes are confined by area are not scattered throughout the forest.

The systems entails a series of pre-exploitation and post-exploitation treatment. This treatment have two distinctive objectives.

The first is the improvement of the mixed and usually uneven-aged matured forest by the elimination of over-matured useless tree to create enough space for the rapid growth of the remaining potentially useful systems.

The other objectives is to establish regeneration to replace the stems which have been removed during exploitation or in succeeding treatment.

Regeneration period may be divided into 4 phases

- (1)Initial canopy opening
- (2)Cleaning operation
- (3)Exploitation
- (4)Post exploitation treatment

The TSS was considered satisfactory if there were more than 10 well grown seedling and samplings per ha in a post exploitation treatment.

In the early 1960s it became clear that this system were not given satisfactory results because of

- Improper execution of climber cutting
- Very low stocking of merchantable species averaging 4-5t tress per ha.
- The opening of the forest canopy with the aim of promoting luxuriant growth of sampling and seedlings resulted in the introduction of weeds, wilting and herbaceous climbers.
- Exploitation removed only a merchantable or economics therefore the unwanted matured and nearly matured ones constitute some problems.
- Post exploitation treatment caused certain amount of damage for the regeneration.
- Lack of proper knowledge of the ecology of our forest management.

## **TAUNGYA SYSTEM**

Taungya is a Burmese word which literally means hill cultivation and this is because “Taungya” means hill, while “ya” means cultivation.

However, modern concept of Taungya system is defined as a plantation establishment technique in which forest crops are mixed in combination with temporary cultivation of arable crops.

In most places where it was introduced, its earliest initiation was to meet within forest reserves surrounding farmers; demand for arable land areas where land elsewhere was scarce. The farmer in turn provides the forester with a cheap means of establishing tree crops, by clearing the site and assisting with tending of the trees crop in its initial stages.

Effective operation at taungya this requires the presence of certain basic socio-economic conditions. There must be land hunger, the soil must be suitable and stable for agriculture, a nearby community must be reasonably industrious and under-employed, local farmers rarely on bush fallow system to maintain soil fertility and there must be adequate land for the scheme within comfortable distance from the farming village.

Land hunger and suitability of the soil for agriculture are apparently the most important factors for agriculture.

Other socio-economic factors to be considered for the success of taungya system includes:

Adequate forest land for the scheme

Provision of socio-amenities

Accessibility

Mutual confidence

Species

Agricultural crops chosen should not be those whose nutrient requirement exhausts the soil rapidly, but those that will even replenish the soil.

## **PROCEDURE FOR TAUNGYA SYSTEM**

Provided the local forming population has some idea o the taungya system i.e. that such concept exist and can be applied in their own situation

The initiative to participate in taungya farming should always come from the farmers themselves.

It has been considered essential to have formal but a firm agreement with the farmers from the onset.

The details of such agreement varied from place to place but alsmot invariably clarified the following points

- (1) Cultivators must obey normal forest laws and regulation
- (2) Areas and periods of cultivation are specialized there in
- (3) Who does the necessary complete felling, burning and cultivation, the demarcation are provision of pegs, the periodic weeding, the planting and the provision of the planting stocks etc are all specified.
- (4) Rules concerning the following are laid down in the agreement.
  - a) Rent/security or deposits paid by the cultivators
  - b) Any free labour or paid labour given to the farmers
  - c) Payments of rewards (if any) to cultivators in form of incentives.

- d) Nature of the plantation on vacation i.e. at the end of the agreement.
- e) List of crops that can be grown by the farmers.

## **TENDING OPERATIONS IN TAUNGYA**

- **First weeding**

Farmers are expected to carry out thorough cleaning and hoeing for a radius of 0cm around each plant where food crops are interfering, this should be removed. Climbers pegging was done to avoid this.

- **Second weeding**

All Musanga must be uprooted plus all the operations in above. If cassava is present and spreading widely it will be trimmed. In general, the forestry plants should be given maximum light.

- **First cleaning**

This is done to free crops from climbers and cut out widely growth to ankle height.

In thorny operation, a complete climber cutting is done first followed by assessment to discovered gaps.

## **ADVANTAGES OF TAUNGYA SYSTEM**

- (1) Very cheap means of clearing and forest operations
- (2) Provide maximum light and therefore suitable if light demands.
- (3) It gives excellent silvicultural treatment e.g. site preparation clearing etc.
- (4) Encourages multiple use of land especially whose forest crops are raised side by side with agricultural crops.
- (5) It leads to an increase in the yearly hectare of plantation
- (6) Contribute significantly to the production of the more needed for the nation

### **DISADVANTAGES OF TAUNGYA**

- 1) Total removal of destruction of all existing vegetation cover is essential and this make the venture unattractive except for the very needy.
- 2) Wide escapement to accommodate the farmers lend to poor form owing to delay in self pruning.
- 3) In pure form like in all pure plantation, taungya crops are highly susceptible to insect and highly epidemic.
- 4) It has limited application, ince it requires some socio-economic factors, coupled with some silvicultural characteristics for its success.
- 5) Taungya always bring about socio problems especially where there is no more land to practice it. The taungya farmer may refused to leave as it had happened in Mamu forest reference in Awka Anambra State. The taungya farmers are menace to forestry department there.

- 6) A lot of illegal farming occurred especially when the available space for taungya farming has been exhausted.
- 7) Prepare indiscriminate set fire on plantation so that they could reform the land.

## **ENRICHMENT PLANTING**

Another method which is well established in the tropics. Their term is distinctly applied only to the technique of supplementary seedling regeneration in a naturally poor or degraded forest by means of partial planting. It is therefore a establishment method involving both natural and artificial regeneration.

Enrichment planting is employed to increase the stocking of valuable species in areas where the regeneration of the required species is either scanty, partially successful or completely absent.

It has also been found suitable where species involved cannot be raised satisfactorily in plantation either because of insect or other disease epidemics or because the species requires some amount of shade at least during its first year or two.

Enrichment planting has also been found useful where exploited or degraded high forest cannot be cleared for reforestation planting owing to lack of taungya facilities and the prohibitive cost of doing so by paid labour.

Under these conditions of poor natural regeneration and inadequate financial resources, enrichment planting may be the only way of covering the ground fast to keep pace with exploitation.

By retaining at least part of the canopy during regeneration, the enrichment planting method has ecologically; some of the conservative attributes of the natural forest.

Therefore, the forest has a protective value which the community cannot afford to lose during the period of conversion.

The canopy is self either to reduce initial clearing costs, to avoid totally destroying the forest and its microclimates and influences on its surrounding environment or to assist these species which genuinely grow better under some amount of shade.

It is carried out in two main ways:

- 1) Line planting and
- 2) Group planting

## **LINE PLANTING**

Line planting may be defined as a method of establishing tree crops in lines spaced at intervals equal to or slightly greater than the estimated final crop/tree crown diameter. This idea was conceived and executed forest in Ivory coast.

The forest can be opened by cutting parallel lines equidistant from each other and equivalent to the chosen planting escapement.

Suitable planting stock of proven species is introduced at regular intervals along the lines. The general aim is to introduce vigorous stems of the selected species so that their crowns are in good light conditions while the rest of the stand is sunk in the direction to ensure that the plants get maximum light from the sun.

Details of the operations involved in line planting differ according to the silvicultural requirements of the planted species.

## **GROUP PLANTING**

This method involves tree crops being established in groups. This is a more flexible method which can be applied to all types of forest.

It has been extensively practiced in the West many forests of Uganda where most of the site preparation is done by licensed charcoal burners.

## **PLANTING INTENSITY**

The intensity of planting in both line and group methods depends upon the species involved, its expected survival rate during establishment and the number of final crop trees envisaged, the cost of seedlings and planting them as well as the density of any existing advanced growth.

In line planting it is generally cheaper to have the lines at the final crop. Spacing and to allow for wastages along the lines by planting closely.

Group planting where systematically arranged, should also be spaced at the final crop distance and allowance made for casualties on the spot.

No further tending operation is usually given to group planting. In line planting, failures are replanted usually with the same species. If the results are however particularly poor, another species may be used.

Enrichment planting is however criticized on several grounds

- (1) To some people, it is suitable only where large and veneer wood are in demand.
- (2) If thinning is required, the method is less productive than clear felling and planting.
- (3) To succeed, browsing animals must be either absent, scarce or have legible effects on the planted trees.
- (4) Group planting sounds attractive as a means of filling gaps created by logging or by patching regeneration but in practice, it is extremely difficult to control.

To obtain sweepers from enrichment planting, the following precautions must be taken.

Species appropriate to the ecological status of the vegetation to be enriched must be selected. Generally the species should have the following basic qualities. Easy establishment, fast rate of growth, development of a good early crown to shade out fast growing light demanding weeds and resistance to diseases and insect pests. Colonizing or gap-filling light demanding types have generally have been found successful in this regard.



## **INTRODUCTION TO SILVICULTURAL TECHNIQUES IN NIGERIA FOREST**

Nigeria is known to be rich in forest reserve (Adeyaju 1975, Omoluabi 1990), despite increase rate of deforestation, Recent estimate by FAO (1995) .Reported that 17% of total land area in Nigeria support forest and other wood land. While total forest area now stand at 15,785mg ha, total volume and volume per ha are 1000m<sup>3</sup> and 64m<sup>3</sup> respectively. The management of this important renewable natural resources to enhance their productivity is the most challenging basic for consequent to increase in population and increase in standard of living they demand as for forest products and services is also on the increase. For instance, it has been estimated by 1995 that by the year 2010, consumption of industrial round wood, fuel wood and based panel will rise to 13-8161 and 1178m<sup>3</sup> respectively.

Silviculture comes to forest development in the biological aspect. The silviculture is change with the responsibility of developing appropriate techniques requires for the formation of trees and regeneration of volume forest.

From the view of silviculture, 3 main types of vegetation based on accessibility a trees to water supply are recognized these is the mayroue forest low land round forest formations are all present in Nigeria. In addition to that plantation i.e. man made forest, currently estimated at 213, 730 ha (Omoluabi a others 1990).

Appropriate silvicultural tools in Nigeria must be mineral of the divergent natural forest formation emergent plantation forest influence previous silvicultural treatment as well as site

species challenges in national foresting such as erosion control in the eastern part of the country, reforestation in western part and desertification control in the northern part of the country.

## **WHAT ARE SILVICULTURAL PRACTICES/TECHNIQUE**

Silvicultural practices could be defined as scientifically devised treatments singly or in combination in the forest with the aim of enhancing productivity on a per ha basis. The application of these treatments both in time and space varies with forest formation and the object of management. Some of these practices include choice of species, nursery operation, establishment techniques of seedlings, vegetative propagation, disease control, canopy management, fertilizer application, mycorrhizal inoculation, use of fire etc.

## **STRUCTURE AND COMPOSITION OF FOREST**

Generally, tropical forests are divided into two types: equatorial forest and dry deciduous forest. This is based on the presence or absence of a dry season. While the equatorial forest has rainfall evenly distributed throughout the year, the dry deciduous forest has a distinct dry season.

In Nigeria, for example, the rain forest at Sapoba falls into the equatorial group. This forest has an annual temperature of 24°C. A further requirement for the development of this type of forest is that the soil must be deep and well-drained. There is also a heavy leaf fall from the vegetation which provides a constant source of humus and nutrients that ensure its fertility. These conditions are conducive to the growth of several species and therefore account for the greater number of species per hectare. All these trees (in equatorial forests) are constantly in competition for light, nutrients, and other resources.

growth factors. This competition result in a definite structure for the forest, the tallest tree usually rise above the general level i.e. emergence below this are shorter trees which form a general canopy for the forest i.e. dominant followed by co-dominant, followed by the shrubs and herbs layer.

The dry deciduous forest, this is simplify by the savannah or the wood land, this forest consist of rather open wood land characteristics by tall grasses usually 1.8m helping or more and trees with short boles well developed and in tuber is wood land may have their crown factory and in some cases it may be uniform to prevent grass growth. It is usually divalent into 1 or 2 strata with grass dominating the herbs layer where present as the rawn fall decreases and the dry season becomes layer the forest component decreases in no and become more widely space in extreme case the vegetation becomes mainly of grass, the density of the canopy with the dry deciduous forest also varies with ecliptic condition (soil) and the extent at human interferences grass fire are frequent in the dry season in the savannah in Nigeria, all stages from dense wooded savannah are available.

### **PROCEDURE HOW TO RECOGNIZE THE FOREST STRUCTURE CREED**

- Identify/estimate height of component trees in selected sample plot and sketch the profile.
- Identify the spp. Count and measured the chameter at breast height at all woody trees above the shrubs layer, the plot size is usually 20m x 20m.
- Summarize the frequency of occurrence according to species.
- Summarize the stands basal area on spp base.
- What % age of the trees spp are

1. Taken by industries
  2. What % are in a species family
  3. What % age represented by trees that are not used by industries
  4. what % of the standing basal area can be taken by industry.
- Will you advanced cater the perspective of these forests (a) as silviculture (b) as ecologists. .

### **CHOICE OF REGENERATION SYSTEM**

The choice of an appropriate regeneration system is base on accurate assessment of the quantity, distribution and loving condition of seedling on ground proper decision must be made on what inducement treatment is required, if the seedling population is in adequate where the tending operation necessary to establish and develop the seedling must be determined decision on this matter must be made before the forest is harvested, the required information obtained using a diagnostic linear sampling techniques this technique in instable the use of contiguous sample plots arranged linearly across the forest to assess the presence of require spp. Their abundance and relative treatment from intolerance from weed, 3 plot sizes are commonly use in this assessment which are the 2m, 5m and 10m square plot the 2m<sup>2</sup> plot technique provide information on safety distribution and spp composition economic seedlings present at the time of sampling the 5m<sup>2</sup> and 10m<sup>2</sup> plot techniques are used to judge the success and condition of regeneration for tending preservation and probable composition of the feature crops continue shortly after the nursery record.

Augmenting natural regeneration linear sampling helps as to diagnose the best method for regenerating natural forest. Areas with an adequate nos of uniformly distributed economic seedling are usually regenerated naturally. Under favourable circumstance, the area of the forest their may be cleared and artificially regenerated. The environment planting techniques is used in s naturally poor or degraded forest. The main object of this techniques is to increase the stocking of economic spp where seedling population of the required spp is either scanty or completely absent sometimes etc coiled or degraded high forest can not be cleared completely for reforestation due to high cost of labour and infrastructures in the area, under this condition of poor regeneration and inadequate financial resource, enrichment planting is usually the only way to keep the pace with exploitation, this techniques is also used in protection forest and water shed management. Where it is essential to avoid total destruction of the forest cover and its micro-do mate.

## **DIRECT SEEDLING**

In this method, the forester broadcast the seeds directly onto the forest floor either manually or with the use of helicopter from the air. It's a regeneration method it is generally facal with series of obstacles, in the first place the seeds germinate over a period of time producing various grades and sizes of seedling, many of this seedling may not be able to withstand pest, diseases and relents there is also the tendency to sow much seed per unit plants expected.

## **REGENERATION THRO PLANTATION**

This differ from direct seedling mainly bass –planted seedless are busy taken care of until they have successfully pass the critical stage of germination. It is generating stated/will thrown that anyone can plant trees best not everyone that can plant the successfully combine best right spp with the right sites to achieve the best grant and survival following time provide steps or procedure is require for successful to rest planted foresters can and do achieves the by taken it following procedures.

- Chosen the right spp and provinces
- Planting of good quantity seedlings
- Protecting seedling throughout the period from nursery to planting
- Planting trees incorrect manner and time
- Protecting seedling during initial stange after planting out (frost planting practices)

These are chaw, any foresters who nestlent anyone of them guarantees failure.

### **FACTORS TO BE CONSIDERED IN CHOSEN SPP**

- The closeness of correlation between site factor and silvicultural requirement of your light intercity plot ponds
- The suitability of the spp for the object of management e.g. for poles tenk, macidea diderichii cassia, zenks for fuel wood. It the form to check wind erosion Asdirachta indica, landslide (steep slopes) Ancadinor exidantali, to drawn flooded area or repulate stream flow Antotrophalous cadahana, to to got desertification Acacoa.
- Adaptability of the desired silvicultural system with the chosen spp.
- Effect A the spp on site (particularly on the long term basis

- The cost of regeneration this is with respect to (a) Insect and tuggii attack (b) weed growth and control (c) Self provisory ability of your spp e.g. Gliricodoa a sepium
- Market demand must be guaranteed

## **NURSERY MANAGEMENT**

Prior to afforestation programme in Nigeria trees were allows to regenerate naturally.

This graduated to enrichment planting. This method of natural regeneration failed since the system could not med wood demand on sustain yield basis. Alyson indigenous trees have low growth rate consequently fast growing egotist tress were introduced, with the introduction of plantation programme, the necessity to produce seedling in the nursery became necessary. Hence the argument of temporal and permanent nurseries with the introduction of these nurseries, healthy and vigorous seedling could be produced and the quality and quantity control. Generally nurseries are divided into 2.

### **Temporary nursery**

This type of nursery serves for short come in producing planting stock for definite site at a particular time. As sson as the planting programme is accomplished. The temporary nursery is abandoned. The nursery is usually sited where residual organic mater of exploited forest area can be utilized.

In some cases, when the nutrient of the area is exhausted, the temporary nursery is moved from one place to another. Temporary nursery is usually sited very close to the operation site. Therefore the risk of seedling damage is reduced. Also, considerable time is gained.

From lifting of seedling to the play site, However, the retention of experience labourer as attached below as soon as the nursery is shift, new set of labourer is employed. Temporary nursery may not be close to a village where labourer can be early employed.

### **PERMANENT NURSERY**

This is nursery where every facility for seedling product are available, such as irrigation system, seed, stores and mechanized nursery equipment. It is however very extensive to complicated a permanent nursery because of the amount of capital cutting a large quantity of seedling can be produced them in temporary nursery. The cost of transportation of seedling is very high.

### **SELECTION OF NURSERY SITE**

- (1) Physiography (landscape, terrain or topography)
- (2) Labour
- (3) Accessibility

It is also reported for beating-up operation

Water supply – water must be close to the nursery either from the stream or public system. Lack of moisture in plant even far a day especially in dry region can lead to high mortality (Bharatu,

1973). The quality of water is very important. Seedlings such as pine are very sensitive to water at pH level. The pH should be less than 7. The waste must be liable to ensure continuity.

Site preparation – The past history of the site must be known so as not to inherit areas infested with pathogens. If the area chosen is a forest area or derived forest, there will be a need for brushing the forest floor followed by providing and burrowing. In addition to cleaning the nursery site it is necessary to fell trees outside the nursery as they may intensify in future operations.

## **NURSERY LAY OUT**

A well layout nursery takes into consideration results of ground survey so as to identify certain features or land marks of a particular area. The main structure of any nursery include, fencing, building for offices and stores, potting shed, seed germination area, central growing area containing potted plant and irrigation system.

## **FENCING**

The entire over must be surrounded by fence. The fence should be of reinforced concrete or steel with a top height above ground level of about 2.4m. this is an extensive methods alternatives are live fences with trees/shrub.

The essence of fencing is to curb incidence of theft and menace caused by rodents and other animals. It is desirable to have 2 gates situated on the side facing the main approach to the nursery.

## **HYGIENE IN THE NURSERY**

Various diseases are associated with seedlings in the nursery, these categories of fungi, virus, bacteria, some of these are as follows

- (1) Damping-off disease: this is a fungi attack on young seedling in the germination bed, the characteristic symptoms is the stem rot at the collar which causes the seedling to fall over. The causal organism is *Phytophthora*. Control is usually by fungicides and sterilizing the soil or avoid water-logging in the pit.
- (2) Insect attack: Attack causes loss of leaves, premature leaf fall and leaf distortion, regular phyto sanitary spray with Lindane (gamma HCH) has proved effective in controlling the attack on *Triplacyton sclerexylon* on cobs.
- (3) Pest: Rats and mice are the most troublesome of the pest, they attack the seed bed and exume the seed and cut seedling. Prevention can be effected if the seed bed is covered with wire mesh of size number 4.

## **RECORDS IN THE NURSERY**

The efficiency of a nursery is based on 2 factors which are production and cost. The nursery manager must be able to produce the required quality of healthy vigorous plant at the correct line and at a reasonable cost. This could only be achieved with proper planning. Production records deals with the measurement of input and output. The basic unit of measuring manpower is Man-hour although this is usually broken down to man hour.

On stocking distribution, species composition, size and competitive status of natural regeneration are accumulated.

#### Procedure for DLS (2 x 2) in quadrat technique

- Cut a base line across the area to be regenerated calibrate it into unit of 10m or 100m depending on the size of the area and mark and this unit with number pegs for easy identity cation.
- Determine the intensity of sampling and select a regular number lines at appropriate point along the base line.
- Cut the choosing lines and throw all the slope to the left sides to locate the right side free for easy inspection.
- With the use of tape, demarcate 2 x 2m quadrat plot continuously on the right hand side using tree 2m poles.
- Prepare a record sheet for each sampling line and record the line number, quadrat number the species presence, abundance, size class and degree of freedom from climbers or shade.
- Collect all the data and sample line together and now prepare the distribution maps, this will show the following
  - a) Seedling of currently useful species
  - b) Seedling under tangle/shade
  - c) Seedling that belong to particular important family e.g. Melicia excels
- Assuming that 60% well distributed stocked quadrat will ensure success of natural regeneration you will then recommend that the forest should be regenerated naturally, it so give reason and vice versa.

The basic principles involved in field seed collection are briefly stated below.

He should be followed closely to ensure that you have sufficient seed and that quality seedlings are available for year map screening activities.

- (1) Understand general phonological characteristics of the species; genera or generally of the desired family.
- (2) Make pre-collection visits to selected site to determine that seed is mature or to spot development problems.
- (3) Collect seed from desirable trees (100k at morphology).
- (4) If seed is needed for research, it is vital that seed is collected from a large or broad spectrum of all available phenotypes.
- (5) If seed is needed for general planting. Collect seed as they are available but ignore very poor trees
- (6) Where collection is general, do not differentiate seeds, but where it is not (Provenance) separate all sources (10 trees source is sufficient).
- (7) Use container (Nelson bay to collect seed from field)
- (8) On arrival in the laboratory spread seed out to ensure cool drying. Do not expose seed to oparismus as temperature could be so high as 60°C and this will kill seeds
- (9) Process seed by clearing where they are winged or podded. Remove all seeds.
- (10) Leave extracted seed to dry further in shade or A/c laboratory.
- (11) Test seed for moisture content (stirred at % ml in tight container)
- (12) Remove all plant (empty) seed, diseased or those with exit holes. Also remove deformed seeds.
- (13) After cleaning store seed at appropriate condition

- (14) Keep good record of seed sources and treatment
- (15) Obtain phytosanitary certificate before seed is given out to other countries.

# **SILVICULTURAL PRACTICES AND SUSTAINABLE FOREST DEVELOPMENT IN NIGERIA**

## **INTRODUCTION**

Nigeria is known to be rich in forest resources (Adeyoju, 1975). Despite increased rate of deforestation, recent estimate by FAO (1995) reported that total 17% of total land area in Nigeria supports 1 or arid other woodlands.

While total forest area now stand at 15,735 million hectares, total volume a volume per hectare are 1000m<sup>3</sup> and 64 respectively.

The management of this important renewable natural resources to enhance their productivity is the most challenging task for foresters. This task is urgent principally because consequent to increase in population and increases in standard of living, the demand for forest products and services is on the increase. For instance, it has been estimated by FAO (1995) that by the year 2010 consumption of industrial roundwood, fuelwood and wood based panels will rise to 13.8, 161 and 117 million m<sup>3</sup> respectively.

Silviculture comes into forest development in the biological sector The silviculturist is charged with the responsibility of evolving appropriate techniques required for formation of new and regeneration of old forests. From the viewpoint of silviculture, three main types of tropical vegetation based on accessibility of trees to water supply are recognized. These are the mangrove forest, the lowland rainforest and the dry forest or savannas The above forest formations are present in Nigeria in addition to established plantations in all of these vegetation zones currently estimated at 213,730 hectares (Omoluabi et al, 1990).

Appropriate silvicultural tool in Nigeria must be mindful of the divergent natural forest formation, emerging plantation management, influence of previous silvicultural treatments as well as site specific

challenges in national forest development. Prominent in this category are erosion control in the east reforestation in the west and desertification control in the far northern parts of Nigeria.

## **WHAT ARE SILVICULTURAL PRACTICES**

It is generally accepted that silviculture is concerned with understanding the life history and general characteristics of forest trees with particular reference to environmental factors. Since foresters must produce the desired forest products, appropriate silvicultural tools must be applied to the forest estate.

Silvicultural practices can be defined as scientifically devised silvicultural treatments applied singly or in combination to the forest with the aim of enhancing productivity on a per hectare basis. The application of these treatments both in time and space varies with forest formation and object of management. Some of these practices, such as choice of species, nursery operation, establishment techniques, vegetative propagation, disease control, canopy management, fertilizer application, mycorrhizal inoculation, use of fire and a host of others. Few of these will be discussed to highlight their relevance to forest development in Nigeria.

## **SOME SILVICULTURAL PRACTICES IN NIGERIA**

1. **Choice of Species** Appropriate choice of species is fundamental both in the formation of new forest or enrichment of old forest. In other words, introduced species must be ecologically adapted to avoid losses due to mortality and degradation of soil. Choice of species must be mindful not only of the prevailing economic environment but also by the biological environment. In Nigeria, provenance trials have been conducted to ascertain the ecological range of economic exotic species. Consequently *Gmelina arborea* and *Tectona grandis* have been found to do better in the southern part of Nigeria while *Azadirachta indica* is found to cover a wider ecological range from the South to the North. With the emergence of new challenges such as agroforestry and

desertification/erosion control, choice of species will assume higher prominence. This is with respect to screening for disease and pest, nutrient and water requirement. where species are being introduced for enrichment planting or as an under storey component of an agroforestry system, their light compensation and saturation points must be determined. In desertification control programmes, drought tolerant species with low nutrient demand should be preferred.

## **2. Nursery operation to seedlings establishment**

Most afforestation or reforestation projects in Nigeria Establishment of forest nursery. The objective is to produce vigorous seedlings of high morphological and physiological grade that can guarantee even development after planting out silvicultural practices are required to guarantee such quality seedling at this crucial stage because defects carried over from nursery taken time to detect and when detected may be too late to rectify. Some silvicultural practices at this stage determine the productivity of the forest. These include seed size selection. Oboho (1991) showed that seedling biomass was positively related to seed weight in *Azadirachta indica*. Earlier Nwoboshi and Ohaha (1979).

Reported that size of stumps of *Gmelina* affect survival and rapid establishment after planting. Light requirement is also important at this stage. Appropriate light intensity is required for satisfactory germination. This must be determined for seeds. This is because, irrespective of differences in temperature, while some species are nonphotoblastic e.g. *Khaya Senegalensis* and *Azadirachta africana* (Fasehun 1984) others such *Terminalia superba* are photoblastic (Somade and Obiaga 1993).

To ensure survival and even development on the field seedling must be screened for physiological character before planting out. Such treatments are necessary because morphological character may or may not tally with physiological vigour in seedlings. This is very necessary particularly in desertification control programmes. Consequently to avoid high seedling mortality on the field, their ability to withstand drought must be ascertained.

Irrespective of the seedling vigour, establishment techniques on the field influences seedling survival and development. Appropriate establishment techniques specific to species and site (Awodola and Okoro, 1994) has been demonstrated as a silvicultural tool in reforestation programmes.

### **3. Use of Fertilizer:**

The application of fertilizer as a silvicultural tool is well documented. Trees like all crops, need adequate supply of all the essential nutrients in order to grow and produce quality wood when nutrients are inadequate, growth is hindered and quality of nursery stock and harvest product becomes poor. Although deficiencies in nutrients are not generally found among trees growing on their natural habitat, this does not guarantee growth at their maximum rate. In Nigeria studies have shown that tree species either in the nursery or in their natural habitat respond positively to higher levels of soil fertility (Nwoboshi 1969, Jackson 1973, Fagbenro and Iwara 1982, Fagbenro and Aluko 1987, Aluko and Aduayi 1987, Awodola 1991). Stoeker and Arneman (1960) reviewed the effect of fertilizer on nursery seedlings and concluded that healthy planting stock with well developed and sturdy root system has greater promise of successful growth after transplanting. In permanent forest nurseries where continuous removal of tree seedlings causes heavy drain in soil nutrient, fertilizers and inorganic soil amendments are required to replenish the drain. Available evidences both from nursery and field suggest that in Nigeria, appropriate fertilizer application is an indispensable silvicultural tool for sustained forest development.

### **4. Mycorrhizal inoculation:**

The use of mycorrhizal as a silvicultural tool is gaining prominence in tree crop production (Skujins and Allen, 1986). Both ectomycorrhizal vesicular-arbuscular mycorrhizal fungi are known to increase nutrient uptake, particularly phosphorus and biomass accumulation in low phosphorus soils (Ekwebelom and Reid 1983, Nelson and SatIr 1982). Mycorrhizal fungi can also

increase droughts tolerance of host plant (Levy and Krikun 1980, Osonubi 1989) due to increased Stomata conductance (Alen and Boosallis, 1983, Osonuhi 1989).

In Nigeria, mycorrhizal inoculation has the potential of increasing productivity both of plantation and natural forest. More especially this practice can expand the ecological range of some economic species to include the semi-arid zone. For instance, Okon and Osonubi (1988) reported there drought tolerance in *Gmelina arborea* seedlings consequent to inoculation with an indigenous ectomycorrhizal and suggested that otherwise marginal land with respect to moisture may now support *Gmelina* cultivation. Osonubi et al (1991) has shown that *Acacia auriculiformis*, *Albizia lebeck*, *Gliricidia sepium*, *Leaecaenia leucocephala* benefited from symbiotic association with either ecto or vesicular-arbuscular mycorrhizal.

## **5. Vegetative propagation of Indigenous species**

Despite the ban on exportation of wood, internal wood, internal wood consumption is yet to be fully achieved in Nigeria. This is due to high rate of deforestation, low rate of afforestation and increased demand for timber and other wood products. There is also the problem of slow rate of growth. The natural forest can only produce 1.6-2.4 million m<sup>3</sup> of wood annually on a sustained yield basis (Oseni 1984). This has led to introduction of plantation forestry using mainly exotic species. While these provide sources of pulp and fuelwood, they lack the capacity to re-establish the commercial and ecological advantage of indigenous hardwoods (Oni 1989). To remedy this, propagation of indigenous hardwood has proved a promising silvicultural tool to improve indigenous hardwood species for subsequent plantation establishment. Although initial effort in vegetative propagation of hardwoods commenced with *Triplochiton Scleroxylon* (Redhead and Blight 1962, Choro, 1974), success has greatly improved with introduction of improved techniques. To date success has been recorded for *Khaya senegalensis*, *Khaya grandifoliola*,

*Mansonia altissima*, *Entadrophragma anglolensis*, *Chlorophora excelsa*, *Terminalia ivorensis* and *Terminalia superba* (Oni, 1984).

With the introduction of cloning, it is now possible to identify desirable clones besides establishment of gene banks. With proper use of selected clonal stocks in Nigeria, forest development can be sustained. This is because thousands of quality plantlets of desired characters could be produced independent of season for rapid afforestation or reforestation programme.

## **6. CANOPY MANAGEMENT**

These are silvicultural practices on the forest canopy aimed at maximizing photosynthetic efficiency and inducing natural regeneration of economic tree species. Technically the aim is to reduce within (intra) and between (inter) tree competition for nutrient water and light so as to achieve

Optimum growth and development in trees. In practical terms, these are reflected in operations such as pruning, thinning, selective or complete poisoning, climber cutting or any combination of these silvicultural treatments. In the Nigerian high forest, Kio (1978) demonstrated that climber cutting and opening of the canopy by poisoning or exploitation are effective treatments in promoting recruitments of saplings and poles from seedlings and their subsequent growth and survival.

## **7. Use of Fire**

Fire properly utilized is a silvicultural tool. Fagbenro (1980) and the effects of fire on tropical soils and indicated that infiltration capacity, macro and micro pore space, essential nutrients, soil reaction, water and wind erosion, microbial population and organic matter increased, decreased or unaffected by burning. In Nigeria evidences have shown that proper use of fire is an acceptable silvicultural tool. Ola-Adams and Charter (1980) showed that at Ago-Are forest reserve, early burning and fire protection encouraged tree production. These authors reported that after seven years of treatments total number of trees (over 10cm GBH) in the late burnt plot declined by 9.7% while in the early burnt plot the number increased by 12.8%. Recent findings (Adegeye and Ayodele, 1998) from Olokerneji forest reserve revealed that early burning and full protection from fire improved top soil fertility, while late burning maintained fertility at lower soil depth. Prescribed burning also favoured bacterial and fungal activities in the burnt plot than the protected plots. Prescribed burning do positively influence wood quality at the early stages of establishment. The use e tire us a silvicultural tool shoula be standardized to enhance forest productivity.

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