FRM 502; Forest industries and Timber Quality Control

Timber quality is usually defined by the wood user and not necessarily by the forester or wood Scientist. Timber that is good for a particular industry and characterised as high quality timber in that industry may not be accepted in another industry. For example, carvin industry may prefer ebony the black wood and rate it highly on the quality scale. That same timber would be rejected in pulp and paper industry because it may be too hard for pulping and the black colour will produce bad or poor quality paper. The forester therefore has to identify the quality requirement of any industry that requires wood. The forester should apply the necessary sivilcultural or management techniques to produce the wood that meet specifications for the industry. e.g. there are certain characteristics of timber species that is good for the paper industry. Therefore for paper production, the forester should manage pulpwood plantation in such a way that high quality wood will be produced.

However, certain timber properties are generally used to assess the wood produced, these may include wood anatomy, chemistry, mechanical and physical properties of the wood. In timber quality control, the factors that control the various timber properties will be examined along with sivilcultural manipulation of these factors to produce timber that satisfy the specifications of every industry under consideration. Timber quality control is an attempt to answer the question of meeting the end use requirement of timber species. In the past with abundant timber, users find it convenient to assign certain properties to many timber species. For example, there were tables of wood properties of many tropical timber giving the impression that such properties were fixed. Timber users had the impressions that the wood properties of *Milicia excelsa* for example will always be experienced by members of its species. However, the rapid use of these resources created the need for plantation forestry. In such a situation, forests are intensively managed and wood properties are no more constant but variables which depend very much on how the forest is managed. Most of the properties

associated with many hardwoods in the past are actual properties of matured or over matured tropical forest species. In plantation forestry, the properties we have represent the totality of all the sivilcultural and management techniques that were utilized by the tree grower during

(i) Plantation establishment and (ii) Plantation tending

INDICES OF TIMBER QUALITY

Although timber quality is to be defined by the wood user, there are wood properties that are very important. The timber grower is to be familiar with these properties to find out the factors that control them. The mastering and the manipulation of these properties by the forester will make it possible for wood that meets the requirement of the wood user to be produced. The most important wood properties are

a. Anatomical features
b. Chemical features
c Mechanical and
d Physical features

CHEMICAL COMPONENTS OF WOOD

The chemical components of wood are Cellulose, Hemicellulose and Lignin

The wood is made up of mainly cellulose which forms 50% of the wood. The remaining half is shared by hemicellulose and lignin. The cellulose is a very stable compound made up of several units of glucose which is polymerized by the wood. The major function of lignin is to hold the cell together in the wood.

Wood Density: It is the summation of all the other properties of the wood . It is a reflection of various structural features of physical, mechanical and chemical properties of wood. Wood density is critical for a variety of end uses. Most wood users prefer wood with a fairly uniform density.

CHOICE AND FORMATION OF SPECIES

(A) How species are formed naturally

(B) How species are formed artificially

Between species variations in wood properties and their importance.

It has been observed that woods from different species have significantly different properties even when they are produced exactly under the same condition. For example, members of the ebenaceae family especially ebony are black. However, Verbanaceae e.g *Tectona grandis* have dark brown extractive. Therefore, it is not possible to produce black or dark brown Triplochiton woods when it is grown under the same conditions as the ebony tree. Because of this wide variation among species selection of species for affotrestaton programme is a very important method of timber quality control.

An industrialist may ask for wood of certain properties for example the paper industry may ask the forester to supply long fibre pulpwood for the production of high quality paper. If the forester chooses the right species for plantation, it will then be easy to produce the pulpwood that meet the requirement of the paper industry. If a short fibre species is selected erroneously, it will b very difficult to satisfy the requirement through the selected species. Again, a species that is resistance to column decay fungi because of the presence of some chemicals in the wood may reduce the cost of preservative treatment. It is therefore better for foresters familiar with properties of species to make use of this timber control quality properties. For effective use of method, foresters categorize species according to their important wood properties in different industries. For example;

1. **FUEL WOOD**
2. **POLES**
3. **SAWN TIMBER**
4. **WOOD- BASED PANEL**

5. **PULP AND PAPER**
6. **OTHERS**

ARTIFICIAL SPECIATION

Artificial speciation: This is the creation of species by man which does not exist before him.

Objective: Artificial species is desirable especially when the species in a locality produced wood that possess only some of (not all) the desired properties for a wood based industry. For example, the wood of a particular species may have long fibre, average density and other desirable properties for pulp such a species may be highly susceptible so agents of bio deteriorate, short- lived and slow growing.

The forester will attempt to create new species from the existing ones that will posses only its desirable properties including other required properties i.e. high resistance to wood decay and fast growth rate and these two additional properties are to be obtained from another species.

In artificial specification, the forester attempts to cross the available species that have the desirable properties to create hybrids that possess all the properties that are desired. The properties of the hybrid should be better and greater than any of the two parents.

FACORS CONTRO.LLING ARTIFICIAL SPECIATION

Artificial speciation requires human participation in the process of creation of new species. There is the need for experience of the workers involved and for labour to be available. Forester must identify different species that are capable of been crossed. Usually, an important factor that prevent natural speciation is geographic isolation of the related species,

1. Wherever human being brings related species together either purposely or accidentally, crossing may take place between species. This is because these related species do not have strong genetic barrier to crossing. They can only maintain their individualism in nature if they are geographically isolated. When they are inter-

planted they can cross pollinate naturally or when they are crossed artificially many hybrids are equally possible.

2. Several trees of one species should be crossed with several trees of another species if speciation is to be achieved. The number of species involved for new species formation must be large for good result to be obtained that is the number of individuals involved must be large.
3. Success of speciation depends also on the generation considered. Very often, people assess the success of artificial speciation on the F1 generation. Therefore when the F1 generation does not show all the desired traits, people sometimes jump to the conclusion that speciation is a failure. Recent findings have shown that it is advisable to assess the success not only in F1 generation but also in F2. F3 and later generations.
4. Artificial speciation also depends on what may be called the genetic age of the species involved. Genetic age in this case refers to the time it has taken from the time these two species we are trying to cross evolve from a common species somewhere. The longer the age, the harder to cross and the shorter the time, the easier.
5. Differences in flowering times – As a result of difference in flowering times, it is expected that storage facilities to store the pollen anytime it is produced by one of the species used for crossing must be put in place. So that when the female flowers are ready, the crossing should be done in such a way that there is no decrease in the vigour of the pollen.

EFFECT OF GEOGRAPHIC VARIATION ON WOOD QUALITY OF THE SELECTED SPECIES

Gene flow:

The factors responsible for the variation are:

a. Altitude

b. Latitude

c. Longitude

Procedure of timber quantity control

The first question asked and answered by the forester is the magnitude of variation in timber quality of the selected species due to geographic location. Towards this end the forester must identify different geographic location where the species occur. The next step is the collection of wood samples from this location for laboratory analysis and then to carry out statistical analysis to assess the magnitude of variation. If the variation is strong then the next stage is to identify the area with high timber quality and also the areas with low timber quality.

If resources required in this sort of project are scarce (manpower, finance, equipment, and time). It is wise for the forester to concentrate only on those areas where the timber quality is high or good enough for the object of management. But if on the other hand, the resources are abundant, it is necessary to collect samples from all the locations.

Reasons for sampling the locations

Establishment of plantation

The next thing to do is the establishment of plantation in the new home from seeds of the selected locations. For a fair comparison you should make sure that all the seeds from the location are grown in uniform environment so as to have good opportunity for competition. Therefore it is important to carry out trials for seeds of the selected locations.

Provenance trial

The trial will reveal the physiological differences like growth rates, resistance to drought, disease and insect attack. Also, adaptations to different soil types by the species will be revealed. All these would indicate acclimatization of the species to the new environment. The best provenance trials are judged by their growth rates, survival percentages and stem form. The best provenances of best species are then passed on to the yield or plantation trials and subsequent trial stages.

Precautions

1. You should make sure that seeds of wood samples exported or imported must be quarantined. (This to eliminate the effect of diseases and disease causing agents-bacteria, fungi and insects destroyed).
2. The business must be conducted in a way that is not suspicious. i.e international relationship must not be subject to abuse. Materials should not be used to import and export banned or contraband goods.
3. You must be careful with labelling. The seed lots and all wood samples should be correctly labelled. A mistake in labelling will ruin the whole exercise therefore to avoid confusion labelling should be done by an experienced worker with indelible ink.
4. Time of assessment: Accurate time to assess the timber quality of provenance trials depends on the object of management of the plantation. Pulp wood plantation period may be 5, 6, 7 years but if it is long rotation plantation, ideal time of assessment becomes difficult. However, it has been observed that there is few correlation between quality of juvenile wood (young wood) and mature wood for predicting timber quality at maturity using early wood formation (Regression method).

5. Survival – we should not only be concerned with the provenance that produces high quality timber in our own environment but we should also be concerned with provenances that will survive the forces of the environment. A provenience may produce high quality timber but may be susceptible to decay fungi in the environment and we may have to reject the species in favour of another which is more resistant to the agent of bio deterioration even though the timber quality is less.
6. Disposal of rejected provenances

   The forester may regard the rejected provenances as undesirable population which may contain the superior gene pool selected. In that case the forester may have to destroy such plantation. On the other hand, the forester may want to use it under control experiment for hybridization to produce new desirable population with good properties.

EFFECT OF SITE SELECTION

Cambium of the vascular bundle in the wood forms the wood because of the meristematic tissue. Effect of site will therefore be on the cambium.

1. Effect of temperature

2. Precipitation and Relative humidity

3. Wind

4. Fire

5. Soil factors

Vegetation and climatic factors

If vegetation covers of different sites are similar then the difference in climatic factors may be a negligible influence in quality of wood placed.

The most sensitive of wood timber quality index to site is ring width which is a reflection of growth rate. When site quality is high the ring width value is high which shows that the cambium is active on good site and less active on poor site.

GENETIC CONTROL OF TIMBER QUALITY

Wood scientists have observed that trees of the same species grown within the same environment or site of the same age planted at the same spacing and which receive same silvicultural treatment have different wood properties. This observation indicates that such between tree species differences are probably genetic.

It is therefore the forester who can then control timber quality by selecting those individual trees within a stand that possess the desirable wood properties together with good form and above average growth rate for future afforestation programme.

Such a programme will result in the establishment of a plantation with superior genetic constitution.

Procedure of genetic control of timber quality

The first step is to ensure that as much as possible, the differences observed among individual trees in a stand are as far as possible genetic. This is not always the case but the forester wants to make sure other factors have been eliminated and they are non genetic factors that may likely bring about differences in wood properties of individual trees. The stand must be of pure plantation. They must be planted at the same espacement to ensure that each individual tree within that stand have the same space.

Note: If a stand has been beating up about 1 – 2 yrs after establishment of plantation, tree selection will be difficult because we may be dealing with uneven-aged stand.

Size of stand

Growth rate

WOOD PROPERTIES (Desirable qualities)

Before we embark on the determination of wood properties, we want to find out if wood properties are related. If strong relationship exists among wood properties, tree selection become easier because it means that selection based on some properties will be an index on selection based on other related properties. If wood properties are not related then tree selection becomes more difficult because it means that we have to select for each of the desirable wood properties. Also it means that a very impressive tree i.e. a tree that combines some of the desirable properties may be rejected because it does not have other important wood properties.

In tree selection on the basis of property, we are looking for individual trees which after possessing the above listed morphological properties also combines the desirable wood properties e.g above average values of density, fibre length and fibre proportion.

Selection on the basis of wood uniformity

Thinning.

When plantations are established, the first situation is that the seedlings have a lot of space above the ground and below the ground because the seedling size is small on the ground. The space available to each seedling is enough for rapid growth. As the plantation gets older, a time is then reached when competition sets in above and below the ground. The crown of the trees will begin to compete for light. The consequence is that the branches that are below the canopy level will be operating at a solar intensity level that is not enough for sufficient photosynthesis. In such cases, the branches fallout. It is therefore clear that as competition intensify with time, the crown is pushed upward. The effect of this is that the point of max

diameter growth (MDG) which is the position below the crown moves up (the point just below the crown).

Because the position of MDG is moved up, the normal tapering of the stem is reduced. There is the tendency of the stem to be cylindrical. The point being made is that the difference in diameter between the base of the leaves and the top is reduced by the fact that the rate of growth is higher at the top. This does not mean that the base diameter is smaller than the top diameter because the lower part of the tree always have more growth rings than upper parts. When the growing pattern is such that the upper part is increasing in diameter more than the lower part this will only reduce the degree of tapering. It does not mean trees are perfectly tapered.

In a situation like this, the conditions existing are;

1. Slender trees
2. Closed canopy
3. Individual trees are less tapered.

The branch free portion is very high. At this point also, the early wood proportion is low depending on the age of the tree. The variation in wood property along the bole especially along the branch free portion is light. The wood from such plantation have less knot because branches have fallen out.

Trees of such nature supply a good quality of poles. Although the diameter is small, the wood is fairly stable and the average density of the plantation may be high. The wood is fairly uniform especially if the stand is old.

The major disadvantage of this tree is that the overall rate of wood formation is reduced. The foregoing is a description of the state of a plantation that is due for thinning. This is a major quality control that can accelerate the growth of trees.

Thinning is the reduction in the number of the standing trees or reduction in volume of the standing trees or reduction in the weight of standing trees. This may be determined as a proportion of the original stocking such as 10% of the number of trees or volume.

The effect of thinning on wood quality will depend on its intensity. When the plantation is judiciously thinned i.e. when we remove enough trees, the crown of individual trees will now have more space. The part of the bole just below the crown will have enough light for buds and subsequent branches to appear. The crown proportion will then begin to increase resulting in the reduction of branch free bole. This gives the impression that the crown is moving downward. Depending on the intensity of thinning there is an increase in ability of individual trees.

When the crown moves downward, the portion of the maximum growth diameter also moves downward. This means that the normal tendency of the tree to the fatter below because of greater number of growth rings is further increased by the downward movement of the point of maximum growth rate.

If there is severe thinning you may get a poorly tapered wood. We are looking for the appropriate thinning regime that will increase growth without actually getting a severely tapered plantation. In young plantation thinning may increase the proportion of early wood because of the description above. In mature plantations thinning may in fact increase the quality of wood especially in plantation for sawn wood because the remaining trees are able to grow faster without necessarily moving the crown significantly downward. Wood density of such plantation may increase because the cambium gets enough resources of food to enable it produce cells that are large and thick walled.

In over mature plantations, thinning does not have any important effect on timber quality because the cambium has reached a point where it tends to decline in activity. Thinning in this case may only eliminate that decline.

On the whole the effect of thinning on timber quality control depends on the severity of thinning, the type of species, the age of the plantation, the site and even the crown class of the individual trees. It is therefore clear that although the most important effect of thinning is to increase ring width, its effect on timber quality in terms of density, fibre length etc is variable. Excessive thinning will negatively affect the form of the tree. A lot of the growth resources will be used not for increasing the volume of the stem but rather for branch formation. If thinning is moderate, it becomes a useful tool of timber control because it will increase the volume and quality of the timber.

Importance

1. To remove disease plants
2. To encourage the availability of sunlight and growth nutrients for other trees.
3. To get fuel wood
4. To get pales.

Pruning

Pruning is the removal of the lower branches of tree by natural or artificial means. it is always good if a plantation or a natural forest will self prune by natural means.

Time to prune

Under certain conditions a plantation will not self prune i.e the lower branches may not fall off naturally. The individual trees of such plantation have very high proportion of crown. The lower part of the tree has very large diameter while the upper part is very thin. This is because the tendency of the tree to have more rings below is now associated with an increase in growth rate because the crown has moved down ward and the point of maximum diameter growth is equally down. In unpruned plantation the crown free portion is very short. The resources for tree growth are channelled into coarse branching. In deliquescent trees, the crown is such that it is not possible to obtain straight bole for sawn timber. The crown wood

which forms the bulk of the biomass is as expected a collection of reaction wood. The branch free portion is very short, swollen and sometimes malformed. Such trees can only be good for provision of shade.

In ex-current trees, such trees have very thin upper part or bole and very fat lower bole. There are so many branches and the wood from such trees is full of knots. Although the wood density of the top may be high because of high incidence of knots the wood may be weak because the knots break the continuity of the wool.

Pruning of such plantation becomes an important technique of improving the quality of wood that will be formed later by the vascular cambium. The rings formed after the lower branches have been well removed will be knot free and useful in industry. It is important to note that knots create a alot of problems especially in veneer and plywood industry because often the knots fall out when veneers are cut leaving holes which have to be patched before plywood is produced. Thus, pruning must be done with caution and must not be severe because it has effect on growth rate.

Application of fertilizers and effect on timber quality

There is no doubt that population is increasing and land is fixed therefore forestry is being forced to establish on marginal land with low fertility. About 60 nutrient elements have been found to have influence in physiological processes involved in tree growth and development. Of these only 16 are at presently considered essential for healthy growth of green plantations. They are C, N, O H_2, P, K, Ca, Mg, S, Fe, Ma, Zn, Cn, Mo, B and U. These are essentials because each of them has a specific role to play in free metabolism. Where they are absent, the complete process of vegetative or reproductive lifecycle of the tree is prevented and deficiency symptoms specific to each element is corrected only by its application. The elements form important part of plant cell, catalyst of various reactions, osmotic regulator and regulators of membrane permeability. Mineral elements have several implement

physiological functions in plants and the tree grower must ensure that the most essential elements are provided. Often a number of these elements are not available especially when trees are growing on poor quality land. This situation has resulted in the need for fertilizers on the land.

Effect of fertilizer on Timber Quality

The effect of fertilizers on the quality and quantity of wood formed is variable e.g the effect of these essential elements to the soil on cambial activity will depend on the mineral status (site quality of the area). If for example, a site is poor in minerals and fertilizer is applied in the right quantity, the effect will first of all lead to the development of the tree crown and consequently accelerate wood formation. Research studies that reported slight effect of fertilizers on timber quality also reported slight effect of fertilizer on rate of wood growth. It is important therefore that fertilizer be applied in the right quantity before it will have significant effect on ring width and wood properties.

The first task is then to identify the right quantity and type of fertilizer needed before its effect could be meaningful. On the other hand a site that is rich in these nutrients, application of fertilizer may not have any significant effect on tree growth and wood formation. This explains the contradiction reported in literature e.g it has been reported that applied fertilizer did not have significant effect on tree growth and timber quality while others have reported the opposite situation. Most of the studies do not say anything about the level of fertility of site before applying fertilizer. Thus, the effect of fertilizer application depends on site quality.

Furthermore, the effect of fertilizer on tree growth and timber quality also depends on the plantation age. In young stand or plantations, fertilizers increase growth rate rapidly but they decrease wood density considerably in matured plantation. Fertilizers may increase the rate of

wood formation but usually they will have slight effect or non significant effect on the density.

Therefore in a plantation, it is good to apply fertilizer to increase yield but with no adverse effect on quality. The negative effect of fertilizer application on the wood density of young plantation results from the fact that such plantation respond to fertilizer application by producing high proportion of early wood.

Tree breeders should select individual trees which can respond to fertilizer application in a positive way i.e individual trees that can increase its density as well as its growth rate when exposed to soils with fertilizers. This suggestion is made because different trees of the same age, same species, growing in a stand respond differently to application of fertilizer of the same concentration and time. Those individual trees that have high density are reduced by fertilizer application than those individuals with low density therefore application of fertilizer to a soil results in making the overall wood produced more uniform in quality.

Summary

Response will depend on: (1) Site quality, (2) Age, (3) Quality of individual trees within the stand, (4) Part of the trees which receives light and growth promoting substances respond less than the branch free portion of the bole.

Apart from these differences, one thing is clear and that is application of fertilizer may decrease average wood density but it increases the volume of wood produced. On the average especially in softwood, 9 – 15% of the density is reduced as a result of fertilizer application. However most plantation owners prefer to accept this decrease in density if the increase in wood volume is far more than the decrease.

N. or P. ors K

This fertilizer may be applied as N_2 as the main fertilizer with some K and P, This may increase wood density as well as volume especially if the plantation is not exposed to pathogens.

2. When you apply N_2 alone to softwoods it may decrease wood density but it will increase volume. production.

3. Application of super phosphates increases density and decreases fibre length and increases volume

It is very important indeed for the tree grower to work out the right amount of the fertilizer to be applied. This requires a lot of experience because different trees species respond differently to fertilizer application. Therefore, a forest manager should design a fertilizer schedule which will relate type of fertilizer to site, tree age and tree size.

IRRIGATION

Water is very important in tree growth. Major source of water in forestry is largely rain water, under ground water or moisture in the air which is measured by relative humidity.

It has been observed that tree growth is controlled by the amount and distribution of precipitation e.g it is a known fact that during rainy season trees grow rapidly but during the dry season growth rate may be very slow or tree growth may come to a halt.

Role of water

1. **Enlargement of existing cells**
2. **Initiation of cell divisions**
3. **Early wood formation**
4. **Late wood formation**
5. **False rings**
6. **Permanent succession of growth**

SPACING

Role in Timber Quality Control

Usually the forester chooses a suitable spacing which will give him the right volume of wood and quality at the end of the rotation. The right spacing is usually determined based on the species or it may just be normal decision after years of experience. It is important to note that spacing depends on site, species and object of management. If the initial spacing is very close that means the stocking is very high. For example,

100hectares of land at espacement of 1.5m x 1.5m will require ≈ 444,444 seedlins or in round figure approximately 500,000.seedlings.

Close spacing is important under the following:

1. Considerable seed problem
2. Juvenile wood is usually useless in sawn timber. Close spacing slows down growth in the early life of the plantation. Initial close spacing leads to commencement of competition very early. The canopy is closed early and weed is suppressed. Close spacing leads to straight bole, reduced branching and tending towards cylindrical.

Such trees give good poles and fuel wood.

Wide spacing

1. This is usually adopted in plantations of those species that genetically tend to have high proportion of branch free bole.
2. They are also used when multiple land use is going to be practiced e.g Agroforestry and agrisilvopastoral farming.

Plantations with wide spacings when the above conditions are not fulfilled show the following:

i. Very fast growth

ii. Wide initial ring width

iii. Poor quality core wood