Gmelina arborea international provenance trials

SELECTION OF TRAITS AND THEIR ASSESSMENT

General Considerations

The characteristics selected for assessments were basically the same in the two evaluations. However some modifications and additions were made. These are described for the individual characteristics as relevant below.

Staff members of institutes or organisations hosting trials worked jointly with Danida Forest Seed Centre staff on the evaluation of the trials and, in this way, became acquainted with the assessment system. Any further assessments initiated by the host countries themselves could then be done according to the same system, thus, as far as possible, ensuring that results would be comparable on a continuous and world wide scale.

The system takes into account only those characteristics which are most important in general forestry. The intention was to leave work to the host countries regarding detailed investigations of any disease occurrence, form factors, leaf morphology, wood characteristics and the like.

In the presentation on the Gmelina-homepage of Danida Forest Seed Centre only the characters of most importance are shown. However, all characters, which were assessed have been described in the following, and interested parties can obtain results for those characters not shown on this homepage.

Traits for Assessment

The traits for assessment, i.e. measurement and scoring, comprise:

Number of trees alive
State of health
Height
Diameter or girth
Pilodyn measure (relative wood density)
Bark Thickness
Axis and branching habit
- Axis dominance
- Axis persistence
- Number of forks or big dominant branches

Basal swelling
Stemform

These characteristics were used directly or modified to a number of variables which were used in the analysis as follows:

Adaptation

Survival

This is calculated as the proportion of live trees of all trees planted.

State of health

CLASS	INTERPRETATION	LABEL
1	Tree affected by both pest and disease	G: for attack by insect C: for attack by disease
2	Tree affected by either pest or disease or physical damage	F: affected by fire
3	Tree healthy	U: appear unhealthy, but cause not evident

Classes for health scoring

Emphasis is put on registering if the trees appear healthy or not, i.e. do not show symptoms of disease or pest attack. The kind of agent that may have caused the problem was indicated. In case of differences between provenances, specialists in disease and pest should assess the situation more thoroughly.

A simple recording in 3 classes was used to assess health, see table above.

The proportion of trees in each plot without symptoms of disease or pest attack was used for analysis.

Production

Height

Height was included in the assessment only to a limited extent and was not included in the analysis and evaluation. The work was mostly done by the local research organisations from their most recent routine assessment. In some trials, height was measured on selected trees, i.e. the plot-mean-tree. Measurements were in decimetre or metres. If there was more than one stem per plant, all dominant or co-dominant stems were measured.

Diameter

Diameter, i.e. the diameter at breast height (DBH) recorded in centimetre, was considered the most important measure of growth. Two variables were calculated from the DBH and used in the analysis. They are the average tree size, which is the average tree cross-sectional area at breast height (in square centimetres), and the basal area per hectare calculated from the sum of tree cross-sectional area at breast height and the plot area (in square-metres).

Relative wood density

An estimate of the relative wood density was obtained through measurements with the 'Pilodyn'. The 'Pilodyn' is an instrument developed originally to test for decay in line poles. The instrument has been found useful, too, for obtaining relative values for wood density. The test consists of injecting a spring-loaded steel striker pin into the wood. The penetration of the pin depends on the density and quality of the wood. The depth of penetration is read on a scale to the nearest millimetre.

Readings were taken at breast height in the same compass direction on all trees in an experiment. If the point of testing happened to be at a place with a defect or epicormics, the test point was moved downwards until an apparently fault free place was reached. Only one reading per tree was taken. Sometimes a correction was needed because of wear of the instrument.

The data were used directly in the analysis.

Bark thickness

Bark will in some hardwoods often account for a considerable proportion of volume production, i.e. up 30% of the total volume for inter-mediate sized trees, and up to 15% for larger trees. Since diameter is mostly measured on bark, an adjustment for differences in bark thickness may be useful where the produce is sold in a de-barked form, viz timber for paper. Measurements at breast height by a special bark measurer fitted with a scale in millimetres.The data were adjusted for tree size (diameter), and the adjusted values were used in the analysis.

Stem characteristics

Some characters could not easily, or not at all, be measured quantitatively and they were assessed by scoring. The total visible variation of a character was divided into scoring classes that should be discernible in the field. Each class is given a code number so the higher a value, the better a quality.

Axis and branching habit

Gmelina trees tend to fork or branch more frequently than for example teak trees. A tree is assumed to have a primary axis which, if nothing else happens, would continue to grow to form the trunk of the tree. The primary axis may, however, break due to physical damage, drought or disease. It is further characteristic for Gmelina that one or more side branches may compete with the top shoot (primary axis), often to the extent where the top shoot loses dominance and even dies.

In the attempt to analyse the provenance trials for the above feature, we assessed: 1) system of axis dominance, 2) axis persistence (level of forking and crown formation), and 3) frequency of forking and branching.

The point where the crown starts may occasionally come under dispute, where one or more heavier branches have developed on the stem below the obvious crown and are tending to compete with what appears to be the main stem. Since we are concerned with revealing heritability of characteristics, attempts were made to distinguish between main axis and branches.

1) System of axis dominance

Figure 3 shows 7 major classes of axis dominance. Trees in the classes 1, 2 and 3 have lost the primary axis, whereas trees in the classes 4, 5, 6 and 7 have retained their primary axis with increasing dominance from 4 to 7. The trees were scored according to class number, and the proportion of trees per plot belonging to classes 5-7 was used for the analysis.

2) Axis persistence

Persistence, the height of the unbroken axis is an important characteristic related to timber bole. The longer a tree is able to retain its primary axis, and the fewer large and competing branches the tree has, the higher we assume the quality of the resulting log to be.

Axis persistence was assessed by roughly estimating the relative height above ground where the axis is broken.

The total tree height was divided visually into four equal parts and the classes and their corresponding numbers or scores were defined as shown in Figure 4. The level of forking or branching was then referred to the appropriate class and the corresponding score is recorded. In addition a label "A" was given when it was evident that the main stem had broken due to pure physical factors (wind e.g.).

The plot-wise average of all classes was used for analysis.

Persistence could have been assessed by measuring the height to the forking or branching point, but this would have taken considerably longer time than the above mentioned method.

3) Frequency of forking and branching

A tree may fork repeatedly, or big branches may grow from several points along a stem to compete with the primary axis. A high frequency of forks may indicate an inherited property. We therefore recorded the frequency of forking and branching for each tree. This was done merely by counting the number of times a tree forks and branches. A fully dominant primary axis (class 7) was recorded with the frequency "1" since this particular case can occur only once in a tree.

Stem straightness

This characteristic includes 9 classes. Stem straightness is scored with much emphasis on the upper stem and on the longer limbs. The lower part of the stem alone may give a false idea of the tendency of a tree to grow straightness because of ‘filling in' by differential diameter growth.

If a tree has more than one stem at breast height, the straightest one is chosen for assessment, as it indicates the tree's potential for good form.

In the process of assessing, bends connected with forking and axis break are disregarded. Also, butts and protrusions are ignored.

The nine classes of straightness can conveniently be grouped into three as shown in Figure 5.

The simple plot averages were used for analysis.

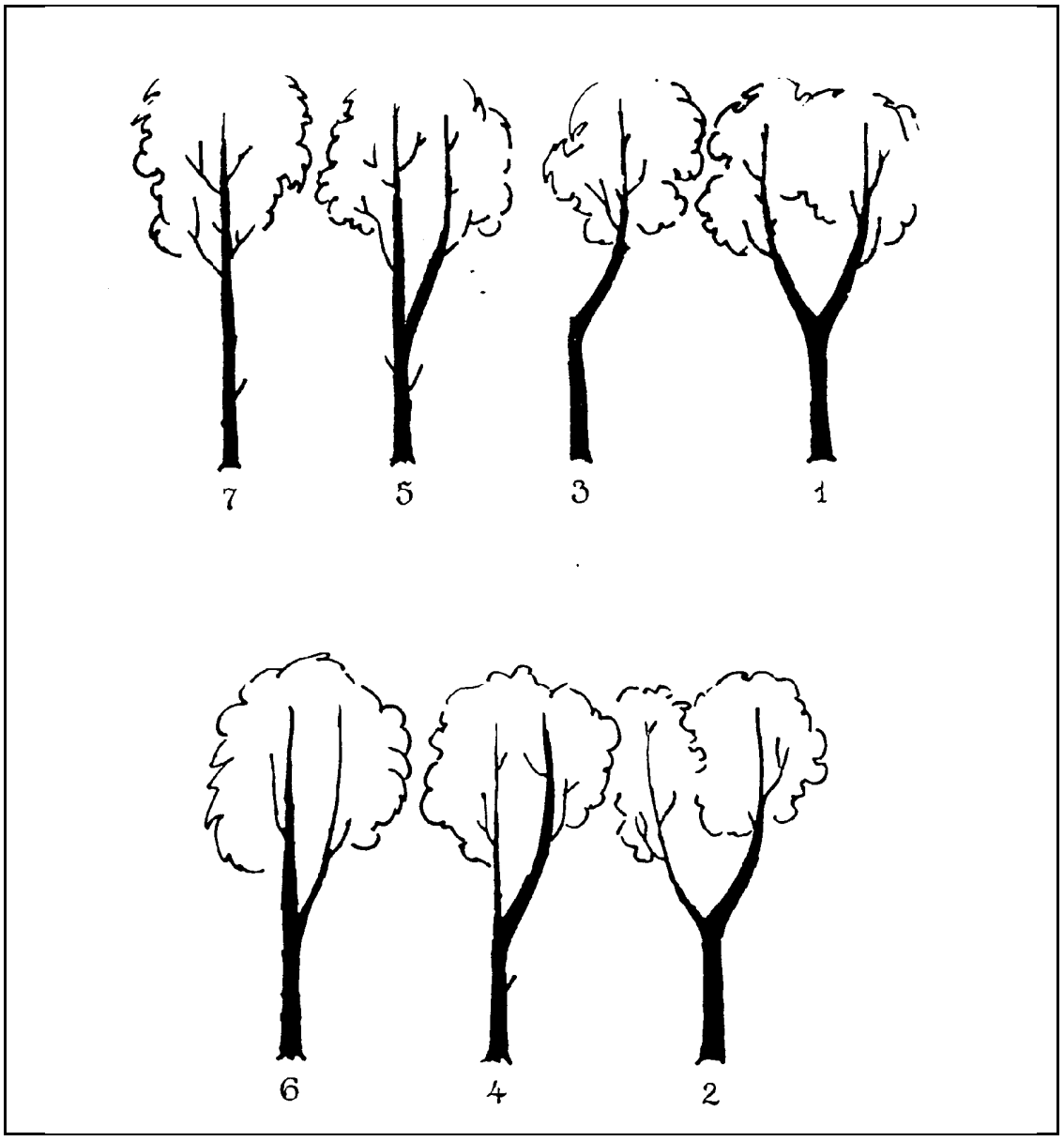


Figure 1 Types and classes of axis dominance in *Gmelina arborea*

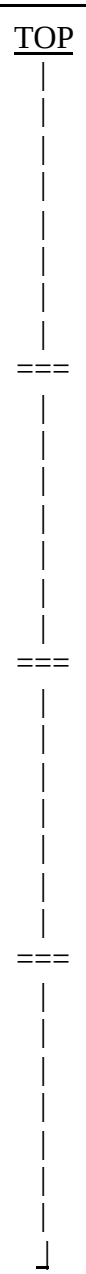
TREE DIVIDED INTO FOUR QUARTERS	CLASS DESCRIPTION	NUMBER OR SCORE
	Axis is broken near top of tree or no break: Around mid of 4th quarter: Around division between 3rd and 4th quarter: Around mid of 3rd quarter: Around division between 2nd and 3rd quarter: Around mid of 2nd quarter: Around division between 1st and 2nd quarter: Around mid of 1st quarter (lowest): Forking or branching at ground level:	9 8 7 6 5 4 3 2 1

Figure 2 Classes and scores for assessing axis persistence

MAIN CLASS DEFINITION	SUB CLASS DEFINITION	SCORE
STRAIGHT TREES Even when faults are present, it is evident that the tree has a strong tendency to grow straight. Faults do not dis-tort the general impression of straight growth.	Straight stem and/or limbs, free of any faults Poorer than "9" Poorer than "8"	9 8 7
FAIR TREES Acceptable from a general forestry point of view. However, the trees in this group tend to have a wavering to staggering form.	Fair looking trees, free of bends or kinks, wavering is slight Poorer than "6" Poorer than "5", almost staggering.	6 5 4
UNACCEPTABLE TREES The trees in this group have large bends, waves and kinks, affecting a large part of the stems or limbs.	Better than "2" Better than "l" Completely crooked, bent, twisted tree	3 2 1

Figure 3 Classes and scores for stem straightness

Basal swelling

A big tree of *Gmelina arborea* will typically have a pronouncedly large diameter at the base, and appears swollen. This swelling may extend above breast height, hence DBH will indicate a stem volume that is larger than the actual volume.

It was thus found necessary to obtain information of the nature, size and variation of this swelling. Diameters were measured at various heights from ground level to the height where the swelling appeared to have disappeared. However, in the present evaluation only the height where the basal swelling appeared to have disappeared was analysed.

The values adjusted for tree size were used in the analysis.

Non-assessed character - flowering

The question may invariably be asked why flowering is not included in the evaluation. The aspect of flowering is related to seed procurement and tree improvement. It is in this connection important that selected provenances are able to produce seeds at the planting site.

However, the period of flower initiation has nearly passed for all trees at the age of 11-13 years. It was observed if flowering was a problem in each locality, but flowering was not otherwise included in the assessment.

Presentation of data

There is one spreadsheet table with the main results of the analysis of variance for each trial for each of the two evaluations. They are called “ALL83” AND “ALL95”

Further, spreadsheet tables for first and second evalaution showing for each provenance in each trial the estimated genetic deviation from the trial mean in percent of the trial mean. The characters are: Survival, health, diameter (basal area weighted), tree area per plot, axis persistence, stemform and pilodyn measure.

As a help in selecting provenances there are for each of the characters a graphic presentation showing the average performance (genetic deviation) of each provenance. There is a graph for sources from natural populations and one from plantations.