PN-ABA-173

AGENCY FOR INTERNATIONAL DEVELOPMENT
PPC/CDIE/DI REPORT PROCESSING FORM

ENTER INFORMATION ONLY IF NOT INCLUDED ON COVER OR TITLE PAGE OF DOCUMENT

1. Project/Subproject Number: 936-5547

2. Contract/Grant Number: LAC-5547-C-00-5124-00

3. Publication Date: ~~1987~~ 11/25/88

4. Document Title/Translated Title: Manual for Multipurpose Tree Species Research Cooperators for the F/FRED 1987 Humid and Sub-Humid Network Trials

5. Author(s)
1. Kirtland M. Barker, Editor, Winrock International
2.
3.

6. Contributing Organization(s): Winrock International

7. Pagination: 56p.

8. Report Number: Manual No. 2

9. Sponsoring A.I.D. Office: S&T/FENR

10. Abstract (optional - 250 word limit)

11. Subject Keywords (optional)
1.
2.
3.
4.
5.
6.

12. Supplementary Notes: ~~Restricted to selected people with interest in forestry research.~~

13. Submitting Official: Norma Adams

14. Telephone Number: 525-9430

15. Today's Date: 8/29/88

DO NOT write below this line

16. DOCID

17. Document Disposition: DOCRD [ ] INV [ ] DUPLICATE [ ]

WORK SHEET

Multipurpose Tree Species Network Research Series

MANUAL FOR MULTIPURPOSE TREE
SPECIES RESEARCH COOPERATORS

for the

F/FRED 1987 HUMID AND
SUB-HUMID NETWORK TRIALS

MANUAL NO. 2

Kirtland M. Barker, Editor
Winrock International

Forestry/Fuelwood Research and Development (F/FRED) Project

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PREFACE

This manual describes the collective work of dozens of agricultural and forestry researchers with interests in multipurpose tree species research. The task of preparing and refining a manual for laying out a standard method for establishing, maintaining and monitoring the 1987 MPTS Network Experiment has been a formidable one.

The manual, and the multi-location experiment it describes, are a major step in encouraging coordinated network research on the priority MPTS species. However, this guide is at present only intended as a manual for a single multi-location trial now being conducted in Indonesia, Malaysia, Pakistan, the Philippines, the Republic of China and Thailand. It is not intended as a general guide to MPTS research. However, it is a step in the process of developing a widely-accepted minimum data set and guide for field trials for MPTS research.

A number of people contributed significantly to the development of this manual. Acknowledgement should be made of the contributions of Drs. Celso Lantican, Kovith Yantasath, C.B. Briscoe, the F/FRED Global Research and Development component staff and cooperators in the 1987 MPTS Network Trials.

The F/FRED Project looks forward to continued development of standard methods and a minimum data set which will help improve MPTS research for decades to come.

K.G. MacDicken
Team Leader/MPTS Network Specialist
Forestry/Fuelwood Research and Development Project

Introduction

The 1987 Humid and Sub-Humid Zone Network Management Trials is the first set of a series of experiments that will be designed and conducted by groups of scientists participating in the Multi-Purpose Tree Species (MPTS) Research Network under the Forestry/Fuelwood Research and Development (F/FRED) project.

A network experiment includes the following critical elements:

- o common design and standardized methodology;
- o common germplasm;
- o the same experiment on multiple sites;
- o thoroughly described soils and climate at each site;
- o data exchange and professional interaction between participants; and
- o intersite combined analysis of data

The purpose of the 1987 Humid and Sub-Humid Zone Network Trials is three-fold:

- o to enhance the knowledge of site requirements, growth rates, and fodder versus wood yield interactions of priority MPTS. Coordinated multiple-site testing of MPTS allows far greater opportunity for making conclusions based on experimental results through the use of statistical modeling.

  By conducting the same experiment using the same methodology in several locations, growth characteristics of priority species can be predicted for sites with different environmental conditions. This network of experiment sites has the potential of identifying limiting factors for growth and providing information that will contribute to improving species characteristics for given site conditions.

- o to provide a focus for network development. Research networks cannot exist without experimentation. Successful agricultural research networks have included multiple location tests of cereal varieties which have not only generated critical data, but have also helped to create a core of researchers who share common research interests and experience.

- to help improve and standardize research methodologies used in forestry research. The design of network experiments provides a forum for discussing research priorities.

This set of trials was designed by network participants in a meeting in Kuala Lumpur, Malaysia in December 1986 and established by ten cooperators at sixteen sites in six countries in Asia.

1.0 Purpose of the Manual

The purpose of the 1987 Humid and Sub-Humid Zone Network Trials Manual for Multipurpose Tree Species research cooperators is to serve as a guide for cooperators in the 1987 Humid and Sub-humid zone network trials being carried out under the Forestry/Fuelwood Research and Development (F/FRED) project, which is being implemented by Winrock International. The first part of the manual describes the standard procedures for producing seedlings. The second section includes experimental design, site preparation, planting, and maintenance. The third section explains site description, tree measurements and plot observation methods through the use of minimum data set forms used for experiment database management.

This manual is specifically focused on this set of research trials, but it will be useful for others who would like to conduct the same experiments and for those interpreting the results of these trials. The basic methods described for these experiments can be applied to other MPTS research in this and other environmental zones in Asia and other tropical regions.

2.0 Experiment and Treatment Design

A randomized complete block design with four replications has been chosen for the first set of experiments. This first set of experiments involves two genotypes of three species of trees and three management treatments, which are (Table 1):

- o pollarding at one meter;
- o pruning; and
- o no cutting at all.

The species and genotypes included in the trials are:

Species	Provenance - Seedlot
Acacia auriculiformis	Queensland No. 15477 Papua New Guinea No. 15648
Acacia mangium	Queensland No. 15677 Papua New Guinea No. 15642
Leucaena diversifclia	Hawaii hybrid KX3 (K743) Hawaii K156

FACTOR A SPECIES	FACTOR B GENOTYPE		FACTOR C CUTTING MANAGEMENT		
			C-CONTROL	PO-POLLARD	PT-PRUNING
ACACIA MANGIUM	IRON RANGE	(QLD)	1	2	3
	BOITE	(PNG)	4	5	6
ACACIA AURICULIFORMIS	MORE HEAD	(QLD)	7	8	9
	BENSBACH BALAMUK	(PNG)	10	11	12
LEUCAENA DIVERSIFOLIA	K 156		13	14	15
	KX3 (K743)		16	17	18

Table 1.

Species, genotypes and management treatments involved in the trials.

3.0 Block and Plot Layout

Since there are three management regimes on six different genotypes (3 species, 2 genotypes of each), there will be eighteen plots, with one genotype under one management treatment randomly assigned to plots within each of four blocks. A sample layout of one block is provided in Figure 1. The 72 plots should be numbered from 1 to 72. Ideally, plots within a block should not exhibit any significant microclimate or soil heterogeneity. Therefore, in sloping areas, it is advisable to make blocks long and narrow across the slope.

The plots in each block are to be planted in 7 rows of 7 trees for a total of 49 trees per plot. The spacing should be 2 meters between each row and 1 meter between trees in each row, with the rows being parallel to the long side of the plot. In each plot, number the tree in the corner closest to the northwest as 1 (Figure 2). Number 2 would be the tree to the east of this corner, 3 one more tree to the east and so on down the row. The next row (to the south) would begin numbering below the number 1 tree.

4.0 Understanding and Pooling Data

This manual describes a set of techniques for establishing trials, measuring and recording data that will be used by all participants in the network research program. It is necessary to adopt a standard methodology for this research because data collected in the experiments will be compared and combined with results from other experiments. Some participants in the research program may have used different techniques in previous work. For the F/FRED measurements and data entry there must be only one interpretation of methodology if all of the objectives of the program are to be achieved. Measurements will be done at six-month and one-year intervals from the time of planting through the life of the experiment. The six-month measurements include tree height, stem diameter at breast height and at ten centimeters above ground level, and foliage and wood biomass production. Soil measurements will be made every year and weather data will be collected daily. After one and a half years, management treatments will be implemented on the trees. Pollarding and pruning cutting treatments are planned for the trials. The third management treatment will be control. Changes in the techniques can be made by consensus of all research contributors and comments and criticisms are welcome.

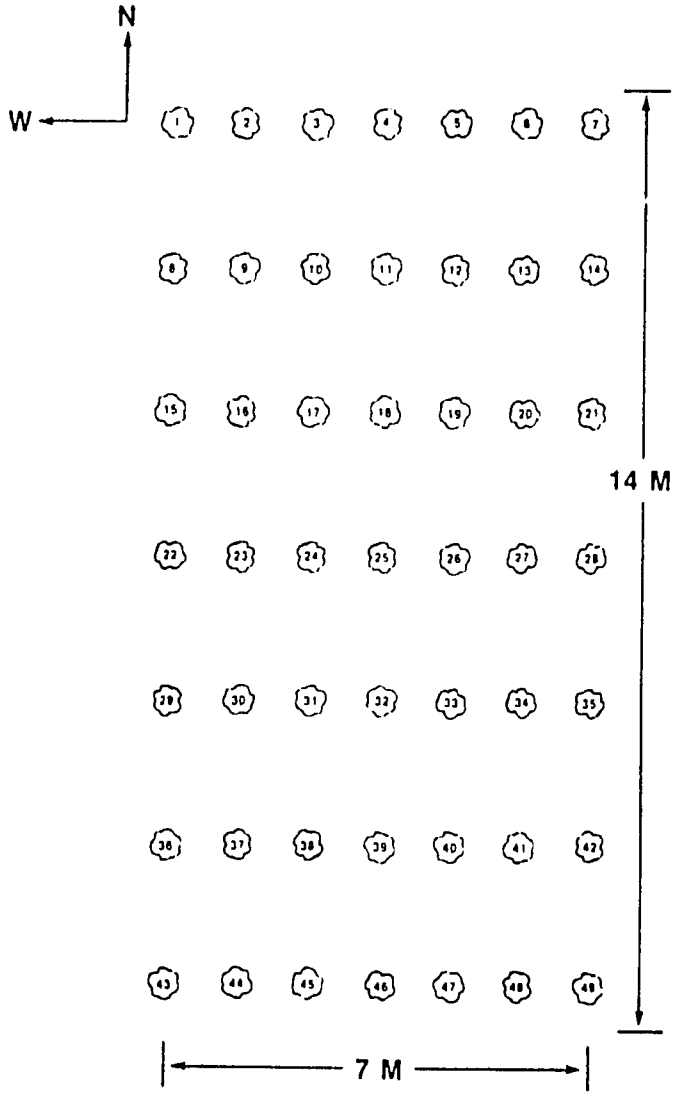
Figure 1.

Sample layout within a block.

TRT 12 Aric PNG Pruning Plot 1	TRT 6 Mang-PNG Pruning Plot 2	TRT 16 Leu K156 Control Plot 3	TRT 18 Leu K156 Pruning Plot 4	TRT 11 Aric-PNG Pollard Plot 5	TRT 3 Mang-QLD Pruning Plot 6
TRT 17 Leu K156 Pollard Plot 7	TRT 9 Aric-QLD Pruning Plot 8	TRT 1 Mang-QLD Control Plot 9	TRT 15 Leu KX3 Pruning Plot 10	TRT 4 Mang-PNG Control Plot 11	TRT 8 Aric-QLD Pollard Plot 12
TRT 10 Aric-PNG Control Plot 13	TRT 14 Leu KX3 Pollard Plot 14	TRT 2 Mang-QLD Pollard Plot 15	TRT 7 Aric-QLD Control Plot 16	TRT 13 Leu KX3 Control Plot 17	TRT 5 Mang-PNG Pollard Plot 18

Figure 2.

Plot Tree Numbering Scheme.



In conjunction with data analysis and interpretation of each trial, data collected during the course of the experiment will be combined to relate experimental results to environmental gradients and to estimate biomass prediction models for the six genotypes being investigated.

5.0 Information and Decision Support System (IADSS)

Each scientist collaborating in this set of trials needs to manage, analyze and interpret each trial's response data. These data will be entered and stored in the project's experiment database, the prime residence for collected data in the F/FRED's information and decision support system. Cooperators will then be able to display and analyze data, develop and validate prediction models, and assess MPTS technology transfer. The experiment database can be modified to accommodate other research trial data.

A user's manual for this experiment database and the information and decision support system has been developed for the management and analysis of the humid and sub-humid zone trials.

6.0 Seedling Production

As in other aspects of network research, it is important that seedlings be produced by a common technique. The following procedures have been agreed to by the research cooperators.

6.1 Seed Storage

Seeds of the 1987 trials will be provided by NFTA and CSIRO. Due to the timing of the 1987 network trials program it is not likely that long-term storage will be required. It will however be necessary to scarify the seed as described in Section 6.4.

6.2 Potting Medium Preparation

The potting medium should consist of the following, or some similar mixture depending on composition of the soil:

50% clay soil (by volume)
40% river sand (by volume)
10% compost (by volume)

Chemical fertilizer (12-24-12 preferred) should be added at a general rate of 20 to 50 g. (2-4 table spoons) per 10 liters of medium and mixed thoroughly before putting in plastic containers. The medium should have a pH of 6.0 to 7.5.

6.3 Containers

The containers should be black 6 cm x 15 cm plastic bags about 0.075 to 0.100 mm in thickness. Punch 8 drainage holes above 5 mm from the bottom on each bag using a standard office paper punch before the bags are filled with the potting medium. Containers should be placed on a plastic sheet to prevent the roots from penetrating into the soil.

6.4 Seed Treatment

A hot water treatment is generally required to break the dormancy of the seeds of each species.

For the leucaena species, heat water to 80° C and immerse the seeds in the water for 30 seconds. After immersion, allow the seeds to soak in cold tap water. After 24 hours, seeds that show signs of swelling can be sown. Seeds which have not swollen should be wrapped with moist gunny sacks or cloth, or can be soaked for another 24 hours in fresh tap water to allow swelling.

For the treatments of A. mangium and A. auriculiformis it is recommended to immerse the seeds for 30 seconds in hot water (80° C). After immersion, allow the seeds to soak in cold tap water for 10 minutes. Repeat this procedure three times. Seeds should then be air-dried to prevent them from sticking together. Sowing should proceed immediately afterwards, though the seeds can be stored in a cold storage place (0-4° C) for a period of time (some weeks) without any further treatment. If Rhizobium inoculants are available it is advisable to apply the inoculum to the seed prior to sowing (Section 6.6).

6.5 Sowing Technique

6.5.1 Direct Sowing into Plastic Bags - Leucaena Species

Sow only the seeds that show signs of swelling. Direct sowing of seed (1-2 seeds) in each container is recommended. The seeds are expected to germinate in three to fourteen days after they are sown.

This technique is recommended only for the Leucaena species or hybrids.

6.5.2 Pre-germination - Acacia species

It should be emphasized that irregular and low germination percentages often occur due to the low viability percentages of seedlots or inadequate seed treatments. A useful way of ensuring rapid and uniform germination could be done by sowing treated seeds in sterilized sand-filled flats. Uniform seedlings will be transferred to the containers as soon as the hypocotyl is erect and before the seed coat has been shed. This pre-germination technique is recommended for both Acacia auriculiformis and Acacia mangium seedlots.

6.5.3 Sowing Time

Experience has shown markedly different seedling growth rates between different species/provenances. A guideline for nursery time from sowing to outplanting of the leucaenas should be 2-3 months and 3-4 months for Acacia provenances so that sowing of Acacia species should be done 1-2 months earlier than the leucaenas to have all the seedlings ready at the same time.

6.6 Rhizobium Inoculation

Inoculation of seeds with appropriate strains of Rhizobium to increase the chances of effective nodulation of NFT in an exotic environment may be very important in places where these species have not been previously grown. All three of the species used in the network trials are already in use in each participating country. Inoculum may be obtained from research institutions such as the Microbiological Resources Centers (MIRCEN) or from university soil science departments or from government soils offices. Inoculant should be mixed with seeds before sowing. If commercial inoculant is not available, soil from under mature trees may be used.

6.7 Shading

The seedlings should be partially shaded (about 50-75%), although they can also successfully be grown in full sunlight. A number of shading materials may be used including Sarlon netting, bamboo slats, coconut fronds etc. Shade should be gradually reduced to harden seedlings to sunlight and completely exposed to the sun at least one to two weeks prior to transplanting.

6.8 Watering

It is difficult to define a standard watering schedule because of variations in day temperatures, humidity and wind. In general, the seedlings should be watered if the upper part of the pots are already dry. A good watering in the morning before it gets too hot is recommended.

6.9 Fungicide Application

The most serious fungal problems that may be met in the nursery are damping off and root rot. To prevent their occurrence, application of the fungicides Terrazole (25% active ingredient) and Benlate (75% ai) are recommended. Terrazole should be applied before sowing to be followed by weekly applications of Benlate and Terrazole alternately until the seedlings are 10 cm in height. These chemicals should be applied using a knapsack sprayer. It is advisable not to apply chemicals during the hot period of the day to prevent burning of the juvenile plants.

6.10 Insecticide Application

Appropriate, locally-available general insecticides should be sprayed as needed for specific pest problems.

6.11 Weeding

Weeds should be removed from the pots by uprooting as soon as they appear so that they will not interfere in the growth of the seedlings. This is best done when the soil is moist.

6.12 Root Pruning

With the aid of a scissors-type pruning shear, cut any part of the roots of the seedlings that come out of the drainage holes in the plastic containers. Placement of seedlings on a rack or on a hard surface will help reduce the need for root pruning. Regular movement of seedling containers will also help prevent the growth of roots out of the bags and into the soil.

6.13 Age and Size of Seedlings

As stated in section 6.5.2 the nursery time required from sowing to outplanting varies for the species/provenance. Nursery time for L. diversifolia should be 2-3 months, while for Acacia provenances it

should be 3-4 months. Seedlings should have a height of at least 30 centimeters at the time of transplanting.

6.14 Conditioning

One or two weeks before dispatch to the planting site, the seedlings should be conditioned. This should be done by:

a. removing shade completely, seedlings raised inside buildings should be moved outside at this time
b. reducing watering
c. root pruning
d. spacing of seedlings

6.15 Sorting the Seedlings Before Dispatch

Before dispatch to the trial site, all seedlings should be sorted out to make sure that only healthy seedlings of the desired size leave the nursery. The seedlings that will be dispatched should be more or less uniform in height.

7.0 Site Preparation, Planting and Maintenance

Planting should be done at the early part of the rainy season. Initial site preparation may be more convenient before this season.

7.1 Clearing the Site

Within six weeks before planting, clear the whole area completely by cutting all trees and other existing vegetation. Cut all woody stems and branches into convenient lengths and pile them outside the area where the experimental blocks will be laid. Adequate tillage should be done to ensure good establishment of the trees.

7.2 Block and Plot Layout

After the site has been cleared, lay out the blocks and plots in accordance with section 3 of this manual. Blocks and plots must be properly demarcated with appropriately labelled stakes. To ensure regular spacing and facilitate hole digging, mark the planting spots on the ground with wooden stakes.

7.3 Hole Preparation

Holes for planting the trials should be prepared prior to transporting seedlings to the site. The planting hole should be 25 cm deep and 25 cm in diameter. Cultivate 10 cm of soil, 15 cm around the hole, to make the soil surface friable and to remove weeds (see Figure 3).

Before planting, 20 to 30 grams of complete fertilizer (12-24-12 preferred) should be deposited at the bottom of the planting holes and carefully covered so that seedling roots are not in direct contact with the fertilizer.

8.0 Transport of Seedlings

Once the site is ready for planting, the seedlings to be used may be transported to the site. The following guidelines should be observed:

a. Soak the soil and the seedlings immediately before they are transported from the nursery to the planting site.

b. Pack the potted seedlings in wooden or plastic trays in such a manner that they won't be shaken during transport.

c. To avoid mix up, do not mix species or provenances within one tray.

d. Protect the seedlings from wind during transit.

e. Seedlings should be appropriately labelled at all times.

f. If the seedlings can not be planted immediately, place them in a shaded area and protect them from strong wind. Water the seedlings daily.

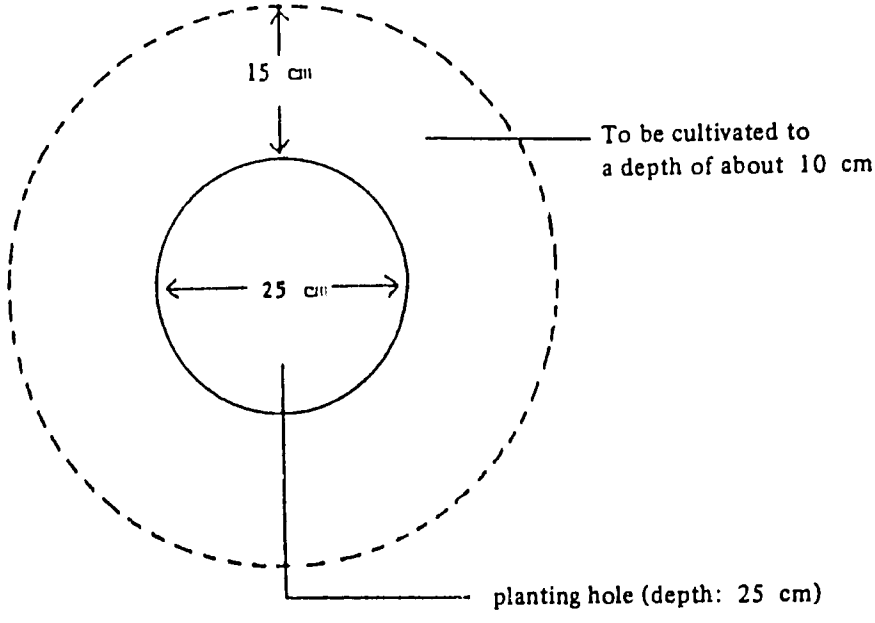
8.1 Planting

The procedure for planting the seedlings is outlined below:

a. Distribute the labelled seedlings to their respective planting positions not more than four hours prior to planting.

Figure 3.

Diagram of planting hole preparation.



b. With the aid of a sharp knife, make 2 or 3 equally-spaced vertical cuts and carefully remove the plastic container, making sure not to dislodge the soil around the roots.

c. Set the seedlings in the hole such that the root collar is in level with the ground surface.

d. Firm the soil around the seedling by tamping it with the flat part of the foot.

e. Apply mulch using previously cut grasses around the seedlings.

8.2 Replanting

Replace the seedlings that do not survive in the first two months after planting. After this period, no replanting is to be done. All replanted materials will be included in the assessment of the trials.

9.0 Maintenance

Routine maintenance and observation of the trials will help reduce weed competition and identify pests and other disturbances.

9.1 Weeding

Frequency and timing of weeding will vary from one site to another; however, it is essential to keep the plants free of competing weeds as much as possible. The following guidelines should be observed:

a. Completely cut all weeds every 2-3 months or as often as necessary during the first year.

b. Pull out the weeds within a 50 cm radius of the seedlings every 2-3 months during the first year.

c. For succeeding years, weed as necessary.

9.2 Fire Protection

Construct fire lines that are at least 20 m wide around the experimental area at the start of the dry season. Vegetation within the fire lines should be cut regularly during the dry season.

Cut grasses and other flammable debris should be removed from the experimental area.

9.3 Protection from Pests and Diseases

Regularly monitor the occurrence of pests and diseases and if they occur, appropriate control measures should be carried out as soon as possible. It will be very important to monitor the leucaena species for psyllid damage. Additional guidelines on now this might be done will be provided by the NFTA as part of their psyllid resistance research network program.

9.4 Protection from Damage due to Animals and Man

Appropriate measures should be taken to prevent damage due to animals and/or man. Where funds permit, the area should be fenced and have a regular caretaker assigned to the area. An effort should be made to inform the residents near the site of the purpose and importance of the research.

10.0 Trial Site Description, Establishment Procedures and Field Methodology. The Minimum Data Set.

The minimum data set for The 1987 Humid and Sub-Humid Zone Network Management Trials was decided upon at a meeting in Kuala Lumpur in December 1986 by the network research cooperators. The data set has been selected to provide information on wood and foliage biomass production under three management regimes in a variety of locations. The trials are designed to characterize the effect of environment on growth and yield at each site and to estimate this interaction at sites with different conditions. This process is known as environmental prediction modeling.

The minimum data set is organized as subsets of information with forms corresponding to:

- Information Forms (A,B,C, L-1)
- Descriptor Forms (D,E,F)
- Experiment description forms (G to K,T,U)
- Field Measurements (L-2 to Q)
- Observations (R,S)

The forms are designed to facilitate data collection, entry and analysis.

10.1 Information Forms

Form A Institution Information

ID

Appendix A contains a list of institution IDs

Institution Name

Name of the institution with which the principal investigator (cooperator, research program participant) is affiliated. Include as much information as is relevant for identification eg. department, division, agency, center.

Mailing Address

Complete street address and building information eg. room number, floor, etc. This information will help for delivering packages, commercial cables and other items that cannot be sent to post office boxes.

Country

Full country name with no abbreviations.

Telex

Full telex information, including country code.

Telephone

Country code, city code number and extension. Separate these numbers by a hyphen and if there is one, delineate extension from the rest of the numbers by an x.

Cable

Commercial cable identification code.

Form B Cooperator Information

Principal Investigator

The name of the one person who is responsible for the experiment as stipulated in the F/FRED research agreement.

Institution Name

Mailing Address,
Country,
Telex,
Telephone, and
Cable of principal investigator (if different from Form A).

Other Researchers

Other researchers who are involved with the experiment.

Form C Trial Site Information (Figure 4)

Site Name

Name of the experiment location as it is commonly referred to.

Site ID

The identification code (ID) for each site (see Appendix A).

Elevation

Site elevation above sea level in meters.

Latitude and Direction

Degrees and minutes and position (direction) relative to the equator.

Longitude and Direction

Degrees and minutes and position (direction) relative to the prime meridian (Greenwich meridian).

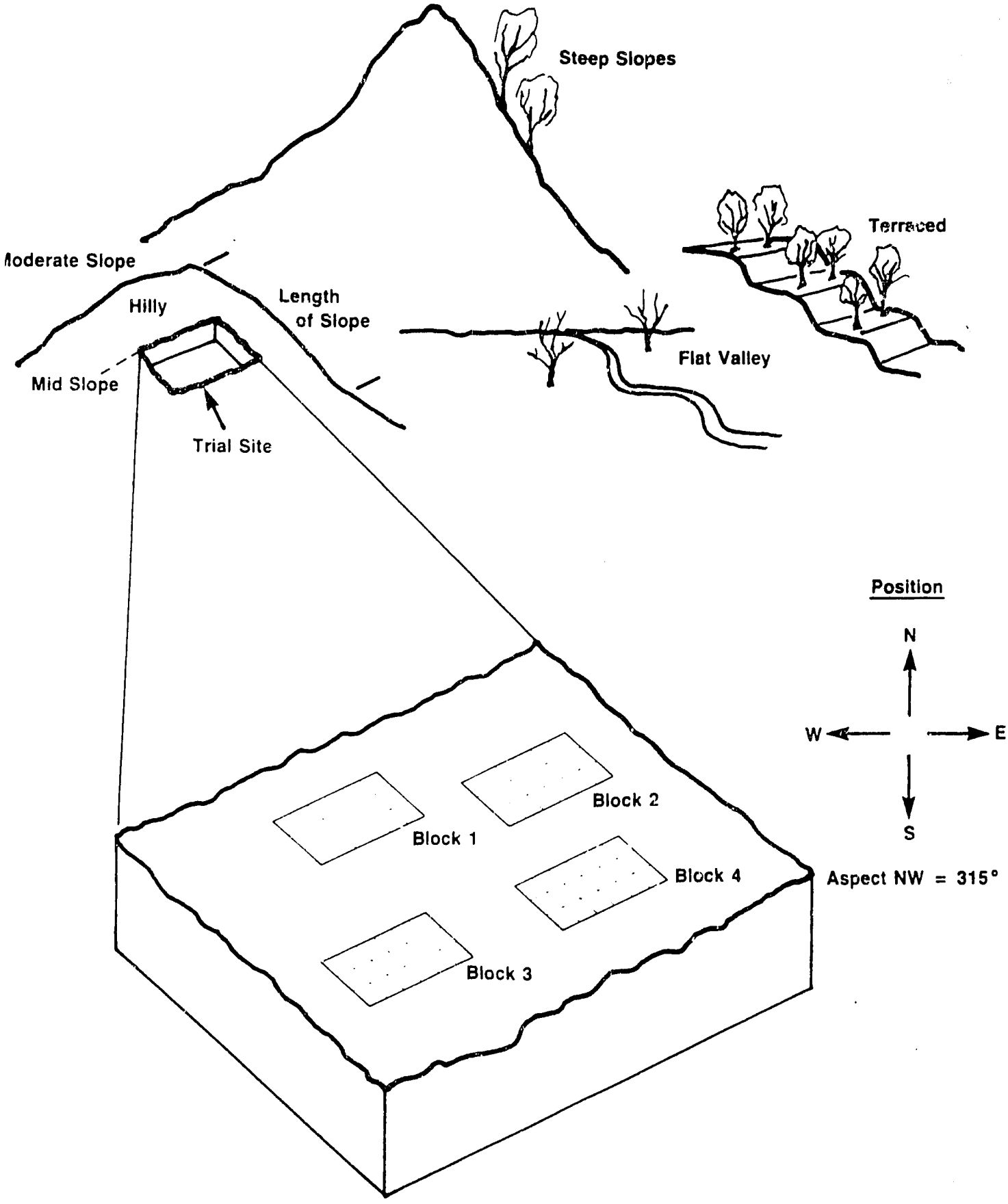
Aspect

Direction that the topography faces in degrees. East = 90, Southeast = 135, South = 180, Southwest = 225, West = 270, Northwest = 315 and North = 360. Use a compass to make this reading if available.

Trial Site Topography

Slope Gradient (degrees)

Figure 4.


Steep Slopes
Terraced
Moderate Slope
Hilly
Length
of Slope
Flat Valley
Mid Slope
Trial Site
Position
N
W
E
S
Block 2
Block 1
Block 4
Block 3
Aspect NW = 315°

Slope of land on which the trial is planted in degrees. If the land is level, enter zero. This can be measured with a clinometer, abney hand level or other means.

Slope Position (Upper, Middle, Lower)

Enter the location of the trial in the general topography.

- If the trial is located on the top 1/3 of a sloping area, choose upper;
- if it is in the middle of the hill choose mid-slope; and
- if the trial is situated on the bottom 1/3 of the hill, enter lower.

If you entered zero slope above, leave this entry blank.

General Topography

Slope (degrees)

Enter the inclination of the topography surrounding the site. Choose the average slope of the entire area.

Length of Slope (<100 m, 100-500 m, >500 m)

Length of the entire slope on which the experimental site is situated.

Form D Site Descriptor-Socioeconomic

Village Name:

The name of the village that is closest to the experiment site as it is commonly referred to.

Village ID:

First seven letters of the village name.

Land Ownership (public or private)

If the experiment site is owned by the government or government affiliated institution, or if it is a community parcel of land, choose public. If the experiment site is located on privately owned property, choose private.

Proximity of nearest household (km) and Proximity of nearest village (km):

From a map or by estimate, the distances of the nearest household and village to the experiment site.

Primary surrounding land use (crop/forest/pasture):

Form of land use that is most representative of the land around the experiment site.

Grazing pattern adjacent to plot (tended/untended).

If there is grazing in the area around the experiment site, choose the option that most accurately describes the way that animals are allowed to graze.

Plot observation by researchers/guards (daily/weekly/biweekly):

Choose the option that best describes the monitoring of the experiment site.

Plot Area Protection:	Fencing	(yes/no)
	Guards	(yes/no)
	Agreement	(yes/no)

Form E Long-Term Climate Site Descriptors

Climate Station Name

A national meteorological station near the site should be selected for obtaining accumulated weather data that have been collected over at least seven years. There may be such a station operating at the trial site. In this latter case, the climate station is the same as the weather station. If the weather station used for making daily weather measurements has not been operating for a period of seven years, then the nearest national meteorological station that best reflects the climate at the trial site should be used for obtaining climate data.

Climate Station ID

First seven letters of the climate station name.

Latitude

Degrees and minutes and position (direction) relative to the equator.

Longitude

Degrees and minutes and position (direction) relative to the prime meridian or Greenwich meridian.

Elevation

Elevation above sea level at the climate station in meters.

Distance from Experiment Site

The straight line distance from the experiment site to the climate station. This information may be collected from a map.

Years of Record

Number of years that weather data has been collected at the climate station.

Min T and Max T

Monthly values for maximum and minimum temperature in degrees centigrade should be calculated from daily values. Most climate stations will have these numbers already. If they do not, use the following:

For each month sum of daily max T (and the sum of min T values) divided by the number of days in that month, added to other averages for that month in each year, divided by the total number of years used for each month.

Precip

The precipitation totals for the site can usually be obtained from meteorological (climate) stations. If not: The rainfall amount for each month can be obtained by adding daily readings for each month and computing the average for all of the years. For each month: sum of daily precip values, added to other averages for that month in each year, divided by the total number of years used.

Form F Site Descriptor-Soil

This information is provided as a result of a collaborative effort between the U.S. Soil Conservation

Service soil characterization program, the Soil Management Support Service and the F/FRED network cooperators. The information includes Soil Pedon ID, Soil Family Classification, Soil Moisture and temperature regimes, Soil Texture, Soil Parent Material, Soil Drainage, Soil Color, and special problems affecting tree growth.

Form G Experiment Site Preparation

Existing vegetation

Description of vegetation that was present just before site preparation. Density of vegetation:

- o Describe the density of the vegetation as thick if the site was completely occupied by vegetation;
- o if the site was completely vegetated, but not heavily, enter medium; and
- o if the vegetation was thinly distributed, enter sparse.

Species composition

If the site was used for crops or a tree plantation, give information about the number of rotations and period of rotation if known.

Method of clearing

Describe the site preparation procedures that were used to clear the site. Was a bulldozer used? Were stumps removed, was the site tilled by tractor, animal team or by hand?

Residue

Choose the option that best represents what was done with the residue on the site. Enter an estimate of the percentage of bare, or exposed soil (not covered by debris or residue) at planting.

Method of soil cultivation

Enter the method of soil cultivation that was done after clearing the site.

Form H Experiment Description

Experiment Name: 1987 Humid/Sub-humid Zone Network Trials.

Objective: To evaluate the F/FRED priority species under three management regimes in multi-location trials.

Experiment Design

A randomized complete block design with four replications is used. Six genotypes will be planted to assess three management regimes in a network of experiments with identical design on 16 sites in 5 countries. Plot area is 98 square meters.

Plot area: 98 square meters.

Weather Station ID

The identification code (ID) for weather station (see Appendix A).

Distance from Weather Station

Distance (meters) between the trial site and the weather station where daily weather data collection is done.

Form I-1 Treatment Factors and Levels

Factor A: Species

Levels: Acacia mangium, Acacia auriculiformis, and Leucaena diversifolia.

Factor B: Genotype

Levels: Two provenances of Acacia mangium and Acacia auriculiformis and two types of leucaena, one from psyllid resistant L. diversifolia parent trees and one an F2 hybrid of L. leucocephala and L. diversifolia.

Factor C: Cutting Management

Levels: Control (no cutting), pollarding and pruning.

Form I-2 Treatment Design

The treatments are factorial combinations of three management regimes being performed on three

species and two genotypes of each species, or a 3x3x2 factorial. This makes a total of 18 treatments in each replication, one treatment per plot.

Form I-3 Experiment Design

Plot No. (1-72)

It is important that each plot of 49 trees has a unique number for each site. There will be a total of 72 plots for each site if there are 18 treatments and four replications of each treatment. Treatments are randomly assigned to plots within each block of the randomized complete block design.

Replication Number	Plot Numbers
1	1-18
2	19-36
3	37-54
4	55-72

Trt. No. (1-18)

Rep. No. (1-4)

In a randomized complete block design, with each treatment occurring one time in each block, each block is also a replication.

Form J Experiment Planting

Planting date

Date that the trees were planted.

Tree spacing

The spacing between rows for this experiment is 2 meters. The spacing between trees in each row is 1 meter.

Control of competing vegetation at planting

Description and % control of work done at planting (in addition to the site preparation work).

Preplant amendments

Fertilizer, lime, organic matter or other amendments added to the site at planting, including the amounts and method of application (broadcast or incorporated).

Soil moisture

The actual soil moisture conditions at planting and over the first three months after planting. Soil moisture at planting time is an important factor affecting the severity of transplanting shock and root establishment. Although the 1987 trials were to be planted at the beginning of the rainy season, there may be a break in rain patterns, some soils drain quickly and others become water-logged. Form J is meant for actual observations in two periods, at planting and after planting.

Condition At Planting: describes the moisture condition of the soil at planting time as influenced by weather conditions during the one week period prior to planting.

Condition After Planting: should be used for describing the first two to three months following planting.

1 = dry. Soil is frequently without available water in any of the upper horizons during the observation periods and this condition is causing some vegetation to wilt.

2 = damp. Water is present in the upper soil horizons throughout the observation period with no observed plant stress due to lack of water, but without consistent rainfall to replenish all soil horizons.

3 = moist. If the soil is holding water but could absorb more rain without becoming saturated and drainage is still good in all places at the site, choose 3.

4 = wet. Soil is not saturated with water, but is close to that point where a little rain would not easily be absorbed by the site and some run off or local standing water exists and there are signs of waterlogging stress on susceptible species.

5 = very wet. Soil is saturated with water or there are several places that have standing water or run-off on the site, or there is noticeable plant stress from soil waterlogging.

Form K Tree Species

Species ID: Preassigned.

Tree species: genus, species and genotype.

Seed Origin, Seed Supplier and Lot Number:

The following information describes the seed source or provenance of the seed lot.

Country
State/Territory
Locality
Elevation
Latitude/Direction
Longitude/Direction
Seed Supplier
Lot Number

For the 1987 trials there are six seedlots that have been distributed to each of the experiment cooperators: KX3 (previously called K743), K156 for NFTA seed or 15642 (MANG-PNG), 15677 (MANG-QLD), 15477 (AURI-QLD), and 15648 (AURI-PNG).

Form L-1: Weather Station Information

Weather station ID: See Appendix A.

This number should be assigned by the principal investigator at each site. Choose the first four letters, numbers, or combination of the weather station name at the site.

Weather station Name

Name of the weather station at the trial site.

Responsible Institution

Institution that is operating the weather station.

Observation Time

It is important that the weather data be collected at the same time each day. 9 am is a good time to measure relative humidity because at this time the daily temperature is usually between the minimum and maximum values. If possible, use this time to collect all daily weather data. If it is not possible to measure daily weather values at 9 am, choose another time and try to make the measurements at this time every day.

Start Date of Collecting Data

Date that daily weather data collection began even if it is different from the planting date.

Elevation

Elevation of the weather station in meters above sea level. The elevation should be the same as that recorded on Form C: site information and Form E if the weather station is the same as the climate station.

Latitude/Direction

Latitude and position (direction) relative to the equator.

Longitude/Director

Latitude and position (direction relative to the prime meridian.

10.2 Field Measurement Forms

L-2: Daily Weather Measurements (Figure 5)

Date

Max T & Min T

The daily temperature readings should be made with a max-min calibrated thermometer of good quality. If it is not possible to use such a thermometer every day at the same time, a thermograph devise is acceptable. The thermograph should be maintained, frequently calibrated with a max-min thermometer and read as often as possible if not every day.

Precip

Precipitation should be measured at the same time every day, preferably at 9 am, with the other information. A simple rain gauge is adequate for this measurement. Provision for evaporation reduction should be made if this appears to be a potential problem. Many rain gauges have a funnel arrangement to collect water and direct it into a small opening, reducing evaporation and accumulation of debris.

Humidity

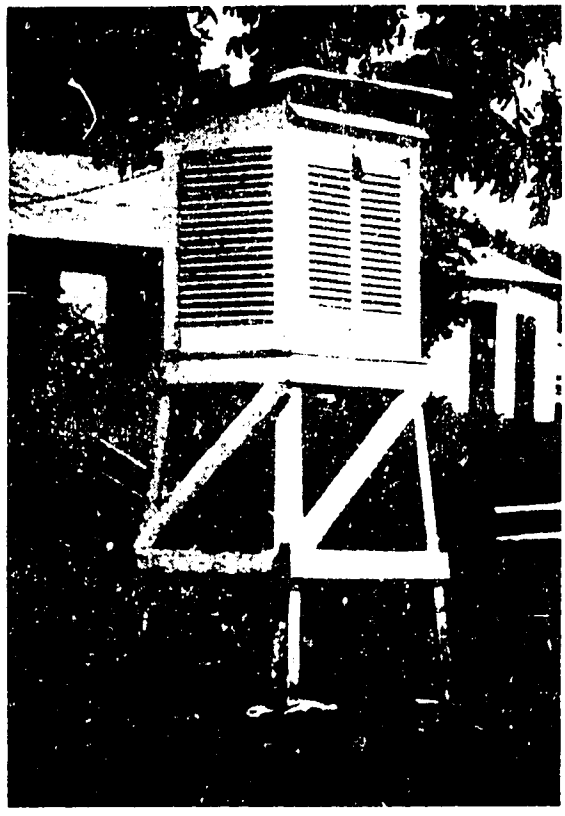


Figure 5.

Weather stations should be located at the trial site in an open area.

Relative humidity can be measured with a sling psychrometer (provided by F/FRED). It is important to make the relative humidity measurement at the same time each day because temperature has a direct relationship with this variable. 9 am has been chosen for this measurement.

Form M-1. Preplant Soil Measurements

Date

Date of soil sampling.

Layer

The upper and lower soil layers.

pH, %N, ppm P, meq/100g K and % OM

For most sites these data have been provided from analyses by the U.S. National Soil Survey Laboratory.

Form M-2. Soil Measurements

Plots will be sampled every 12 months to assess changes in the soil resulting from the different treatments. Soil samples from matching treatment plots in each block will be mixed for analysis. For two soil layers - 0-15 cm and 15-30 cm, sample two locations in each plot for each treatment in all replications and bulk these samples for analysis. This is commonly done by mixing samples in a bucket. There will be a total of 18 samples analyzed, one sample for each treatment.

Date

Date of soil sampling.

Layer

The depths of each soil layer. The top layer begins at the point where there is only soil, no litter. The upper depth of the top layer is zero. Thus layer 1 is 0-15 cm, layer 2 is 15-30 cm.

pH, % total N, ppm extractable P, meq/100 g extractable K and % OM - These analyses will be done according to methods to be distributed to all cooperators.

Core soil samples collected from each plot by layer with an auger and composited by like treatments from

each replication at 12 month intervals. They should be analyzed in a soils laboratory with a procedure common to all sites. The data will be entered by soil layer.

Form N Tree Measurements (by tree)

Each plot will be measured every six months. There are 49 trees per plot, all of which should be tallied for survival. For the purposes of this experiment, only the inner 3 x 3 group of trees will be measured each time. This will minimize the effect of borders. There is a form for recording these measurements in the field. Recording data on these forms will make data entry into the database management system easier. If any measurements are missing, eg. tree less than 1.3 m means no dbh, enter -9.0.

Date

Date that trees are measured.

Plot

Unique plot number for the plot being measured. There should be 72 plots for each trial if four replications were planted.

Survival

Number of trees that are living in the plot, and the total number of trees in the plot at the beginning of the six months measurement period. Initially the total number of trees in the plot should be 49. As trees are removed for biomass measurements or if trees do not survive, this number will change. Dead seedlings should be replaced in the first eight weeks after initial planting (Section 8.2).

No. of trees measured

Every six months, the inner 3 x 3 trees in each plot and the trees harvested for biomass measurements in each plot should be measured as described below.

If one or more of the inner 3 x 3 trees has died, enter the number of trees that are alive and measured in this group. Do not select a dead tree from the outer row(s) for biomass measurements. If all are living enter 9 + the number of trees harvested for biomass. In most cases this will be 9+2 or 11. This number will be used for calculating plot averages and for providing the requisite number of rows for entering measurement data below.

Tree number for the tree that is being measured. Trees within each plot should be numbered the same way (Section 3.0). An example is given in figure 2.

Height

This measurement will be made to record total tree height. If there are multiple stems, the tree should be measured from ground level to the top of its highest apical bud. If the site is sloping significantly, measure the principal stem from the uphill side of the tree. If the stems are bent over, straighten them if possible, so that the actual length of the stem is measured (Figure 6).

This measurement should be made with some type of marked, rigid pole and should be recorded on the field form in meters to the nearest 0.1 meter.

Basal Diameter

Measure the principal stem diameter (and other stems originating below 10 cm) at 10 cm above ground level. These measurements should be made with a metric diameter tape or vernier caliper. For multiple stemmed trees, record the average diameters using the formula:

$$\sqrt{d_1^2 + d_2^2 + \ldots + d_n^2}$$

where d_1, d_2, ... d_n are the diameters of the stems.

DBH

Measure all tree stems that originate below 50 cm above the ground at 1.3 meters above ground level. A paint mark on the tree at this height can be useful for being sure that the same height is used for measuring trees each time. If there is an abnormality in the tree at 1.3 meters, measure the tree diameter at a point near this height which is representative of the stems diameter. (For addittional information, see Figure 7)

Form N Tree Measurements (by plot)

All information on this form will be calculated from the individual tree data (Form N by tree) by the F/FRED information and decision support systems. No additional measurements are needed for this form.

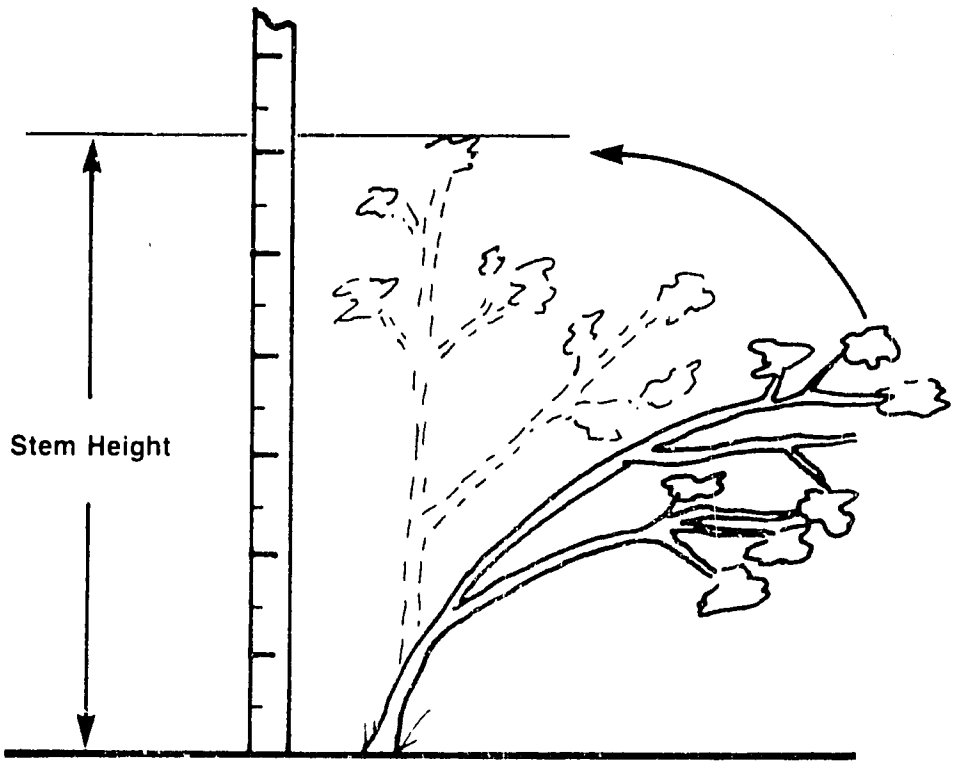
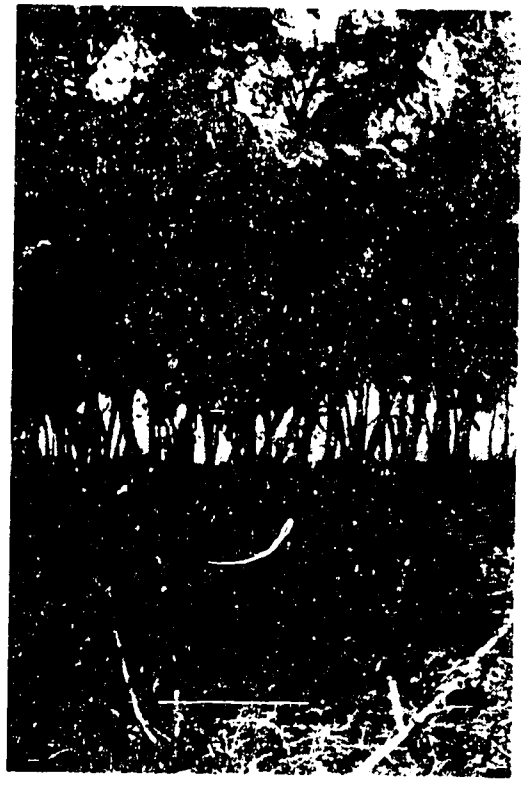


Figure 6.
Measurement of Tree Height.



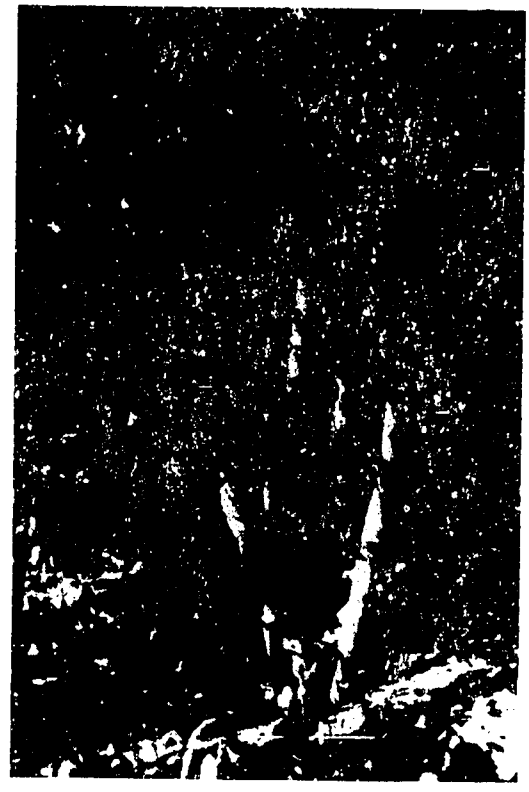


Figure 7.

The diameter at 1.3 meters (dbh) of each stem of multiple-stemmed trees will be used to calculate the geometric average diameter for the tree if their diameters are 70% of the diameter of the principal stem or larger and they originate below 50 cm. Similarly, the multiple-stem diameters at 10 cm (basal diameter) will be used in the geometric average for a tree if the stem diameter at that height is 70% of the principal stem diameter or larger.

Form O Foliage Biomass Measurements (by tree)

Date

Date that foliage biomass measurements were made.

Plot

There will be two trees removed from the outer row of each plot every six months for biomass measurements (Figure 8). This should be done as randomly as possible, but such that two adjacent trees are not removed. This will minimize the impact of removing trees for biomass measurements.

Tree

Enter the number of the tree that is being harvested, using the numbering scheme for Form N above (Section 3.0). Each tree in each plot will have a unique number.

TWW

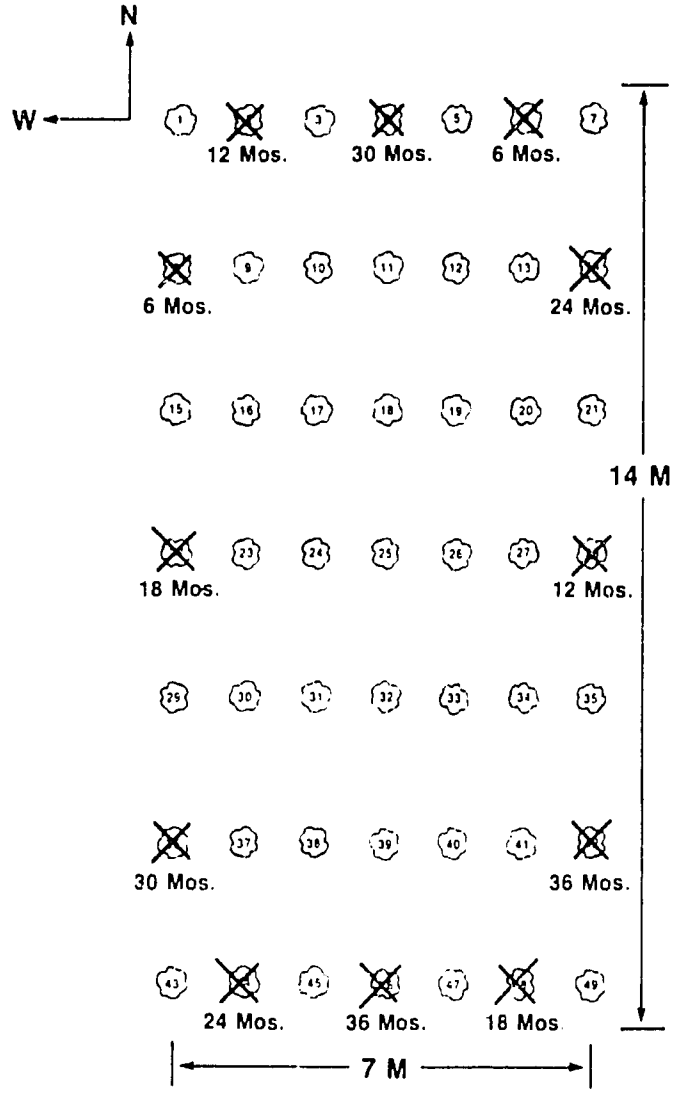
Tree foliage wet weight. See the section in Form P: Wood Biomass Measurements (tree) for information about separating parts of the tree.

For this experiment, foliage will be collected from two harvested trees from each plot. The foliage will be weighed for total tree wet weight and then samples will be taken for nutrient analysis and tree dry weight calculations. For nutrient analysis, samples may be combined or bulked like the soil samples (form M-2) by treatments. Before management treatments begin, samples can be combined by genotype. Before management treatments, there will be 6 samples for nutrient analysis: after the management begins, there will be 18 samples.

In order to accurately measure fodder production, foliage must be separated from woody material to the extent that the samples are composed of leaves with no twigs (See Figure 9 for tree measurement guidelines). In order to do this, strip the leaves off the twigs from the trees that have been harvested for biomass. The petioles should be left on the leaves. Do this for the entire tree until all of the leaf material is removed. Exclude flowers and seeds from the foliage material. Weigh the entire collection of foliage. Record this value under TWW on the field form.

Figure 8.

Plot tree numbering scheme showing example of 6 month biomass harvest possibilities.



From the whole-tree collections of foliage for the two trees in each plot, randomly take a sample (about 40-50% for trees 1-2 yrs and 75-100 g for 2-5 yrs) of foliage from each tree. It is important to include a representative number of young leaves, and older leaves from both shade leaves and sun leaves in the sample. Record the wet weight and carefully label the sample. After the samples have been collected from each plot, put them into labelled paper bags and send them to a laboratory for drying and analysis. Weigh the samples for sample wet weight again and dry them on trays at 60-80xC until sample weights remain constant. A drying oven of some sort will need to be available for drying the foliage and wood samples. Weigh the dried foliage samples with the same balance that was used for the sample wet weight measurement in the laboratory.

This process will be used to convert tree wet weight to tree dry weight. The wet weight and dry weight values for samples of each genotype will be used to obtain an average ratio that will be used to calculate dry weight from the tree wet weights of samples from each genotype.

Form O Foliage Biomass Measurements (by plot)

Plot and Date

Enter plot number and date.

Dry Wt

This will be calculated by the system based on wet weight of trees sampled and calculations using the difference between wet and dry weights of the small samples.

N, P, K %

Dry weight samples will be used to analyze the N, P and K content.

Form P Wood Biomass Measurements (Tree)

Date

Enter the date that wood biomass measurements are made.

Plot

Enter the plot number for the trees being sampled.

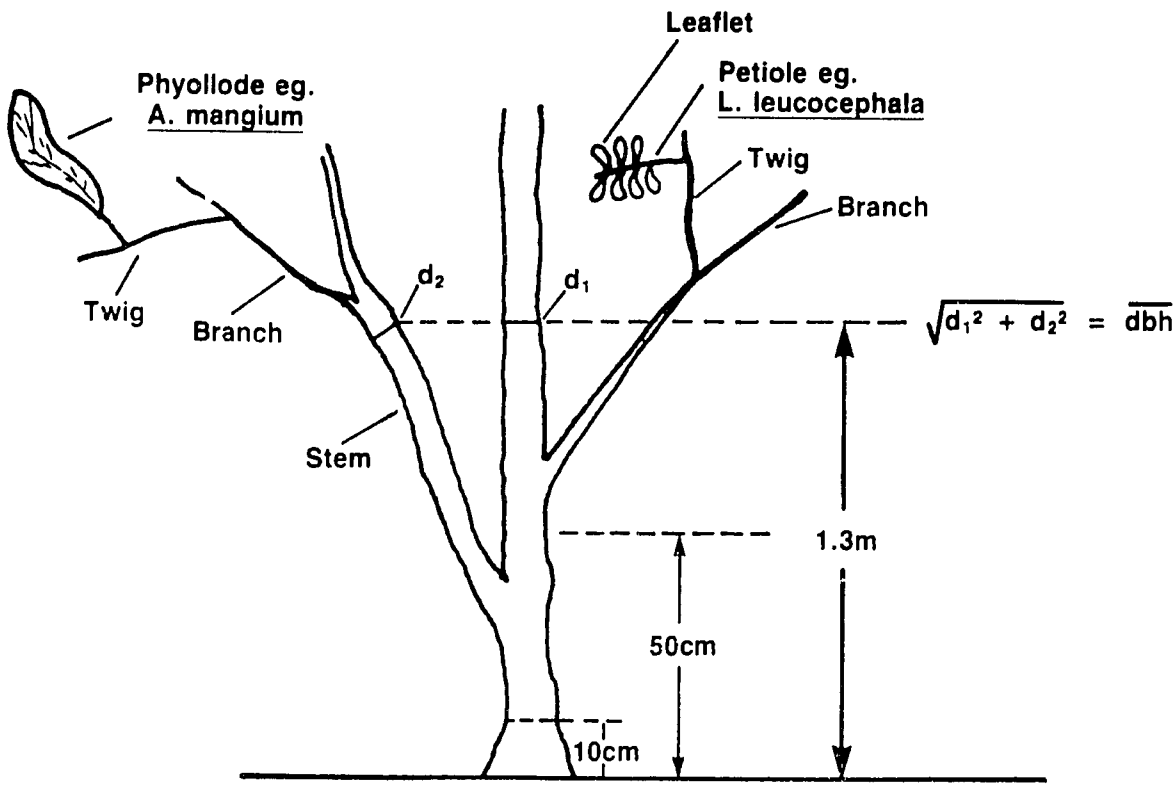


Figure 9.
Tree measurement guidelines.

No. of trees measured

Enter the number of trees measured in this plot. The usual number of trees harvested for biomass measurements will be two per plot for each six month measurement. These trees should be selected from the outer rows of each plot, not from the inner 3x3 trees for each plot, which will be measured for annual growth and yield for the duration of the experiment and for total rotation biomass by final harvest.

Note that the trees harvested for biomass measurements must also be measured as described in Form N.

Tree

Enter the number of the tree being measured.

TWW (kg)

Biomass harvests will be made by cutting trees at 10 cm above the ground and dividing the tree into stems, branches (including twigs) and foliage. A stem is defined as a major woody axis originating below 50 cm above the ground. If there are woody stems originating below 50 cm that are significantly smaller than the other stems, treat these as branches. If there is a question about whether to call something originating below 50 cm a stem or a branch, compare the diameter at 1.3 meters above ground level (DBH) to the principal stem or stems of the tree. If the diameter of the axis in question is less than 70% of the diameter of the principal stem include it with branches and twigs, not stems.

If a stem forks above 50 cm, a choice has to be made as to whether all parts of the divided stem are stems or whether some are to be designated as branches. If a stem forks above 50 cm into equal components or codominant stems, include both of these axes as stems for biomass measurements. If one of the axes is not about 70% of the principal stem at the point where they /divide or otherwise does not codominate the crown, measure the weight of this axis with the branches. In either case, include stem material to a diameter of 2 cm in the stem category and the rest or top in the branches and twig material.

After dividing the tree into stems, branches and foliage (See Figure 10), weigh the stem and branch components. Record the weight of the entire component under TWW in kilograms measured to the nearest 0.1 kg.

Figure 10.

A Leucaena spp. tree harvested and separated into foliage, stems and branches and twigs for biomass measurements.

SWW

From the total tree wet weight samples collected, take a disk from a stem and a disk from a branch. When the trees are larger, more disks will be collected from the stem and branch components. The disks should be taken from representative places on the stems and branches and not areas that are damaged. The disks should be about 10 cm long. Weigh these disks to the nearest 1 g.

SDW

Dry the samples at 100 °C until the weights remain constant. Record this weight measured to 1 g. If this is done for two trees from each treatment, there will be six trees from each genotype per replication. If all replications are planted at each site, there will be a total of twenty-four samples per genotype to determine the relationship between sample wet weight and sample dry weight. The sample dry weight measurements will also be used for specific gravity calculations.

Form P Wood Biomass Measurements (Plot)

Plot

Enter the plot number that the trees being measured came from.

Date

Enter the date that measurements are being done (the day that trees are harvested for biomass measurements).

Wood Dry Wt - Stems and Branches

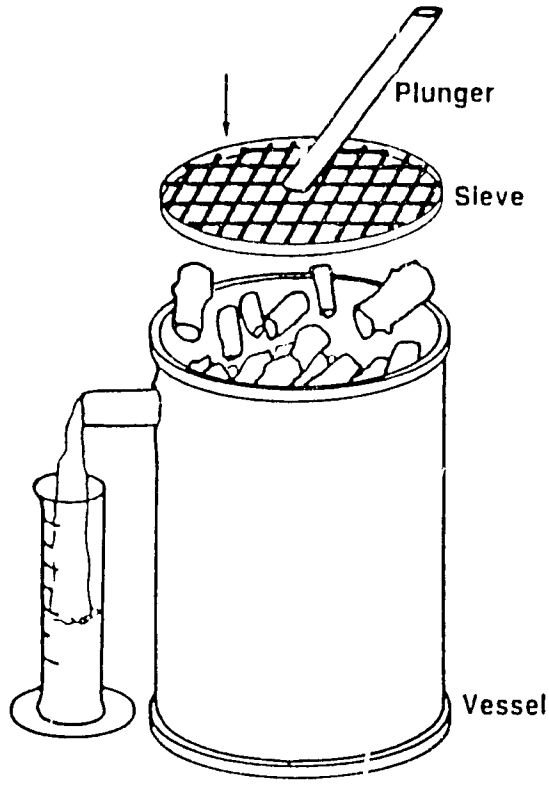
This will be calculated by the stem from information entered in Form P (tree).

Specific Gravity

The water immersion method is the most common way to determine wood specific gravity (Figure 11). Specific gravity will be determined for each genotype using samples collected for wet weight and dry weight ratios. A vessel, preferably with a spout for draining water and a plunger apparatus will be used to determine sample volume. The vessel with the plunger in it (to depth that samples will reach) is filled until water begins to flow out of the spout. Remove the plunger, place all of the weighed green stem and branch samples

Figure 11.

Water immersion method of wood volume determination for specific gravity measurement.



for each genotype in the vessel. These samples should be wet so they do not absorb any water. Immerse the samples in the water with the plunger. Collect and measure all of the water that flows from the spout. The volume of water that is collected from this procedure is equivalent to the volume of the samples. Specific gravity is calculated by dividing the sample dry weights by the weight of the volume of water that was displaced.

Form Q Tree Litter Measurements

Plot and Date

Enter the plot number that is being measured and the date that the plot is measured.

The litter that has accumulated below the trees represents an important source of nutrients, can enhance soil structure, retain soil moisture and provide a favorable environment for microorganisms. The objective of this measurement is to estimate litter production and to ascertain the nutrient content of the litter.

Layer (mm)

One year after planting, measure the thickness of the leaf litter layer on the ground to the nearest millimeter at a representative 1m by 1m square in the inner 3x3 group of trees in each plot. If there is more than one layer, measure each layer thickness. In this case, Ao is an organic horizon in which essentially the original form of most vegetative matter is visible to the naked eye. Aoo is then an organic horizon in which the original form of most plant and animal matter cannot be recognized with the naked eye.

Dry WT

Collect, dry (in drying oven at 60-80°C until weight remains constant) and weigh the material collected from each plot. Record this measurement in the dry weight fields. These samples will be used for nutrient analysis.

Nutrients(%)

Take a representative selection of leaf and other materials from the dried litter collections and combine them by like treatments from each replication to obtain a sample for analyzing N, P and K percentages.

10.3 Trial Observation Forms

Form R Tree Phenology Observation

Although the trials will be measured at six-month intervals, observations of the plots should be made as often as possible to assess the condition of the site by treatment. Tree phenology and damage information should be noted at each of these observations. Other items not on the forms, but good to note may be tree form and leaf fall information.

Treatment

Enter the treatment that is being observed.

Observe the plots in each block that correspond to the 18 different treatments and enter flower bud appearance and flower opening dates. Before the management treatments begin the observations will be by genotype as there will be three like plots for each genotype in each replication. Thus if there are 4 replications, observations will be made on 12 plots for each genotype before management and 4 plots for each treatment after management begins. List the general situation in the plots being observed and make note of any major differences in the plots in reporting the observations.

Flowering

Date of flower bud appearance (50% of trees):

Enter the date that some flower buds are first observed on about 50% of the trees by genotype or treatment.

Flower bud abundance

These observations are designed to make general records of species phenology, specifically to assess the interactions of genotype, management regimes and environment and flowering cycle.

For different species, buds an then flowers have different relative abundance possibilities. Some species can be completely dominated by flowers under normal conditions, while others have only a small number of blossoms even when flowering is heavy for that species. Some species initiate flowers over a period of time, others initiate all flowering in a short period of time.

In order to make these observations uniform among network participants, these general species characteristics must be taken into account. As a guideline for flowering observations, assess abundance relative to maximum for the species being observed. Use the control plots as a gauge after management treatments begin, keeping in mind the influence of environment.

- For the control plots, if the species has buds at all locations that are possible for this species it would be considered heavy.

- If there are buds on the trees, but there could be buds at more locations, designate this medium.

- If the control trees have very few buds, but there are many locations where there could be buds, designate this as light.

Flower appearance

As in bud appearance and abundance, these observations should be relative to the normal phenology patterns of the species being observed and for trees under management treatments, in relation to the control plots. Flower opening is relative to buds present.

- If open blossoms have appeared from most buds on most of the branches enter heavy.

- If there are open blossoms from the buds on many of the branches but not more than about 75% of them have opened, enter medium.

- If the trees in the plots that correspond to the treatment being observed have occasional blossoms, but many unopened buds choose light.

Fruiting

First fruit appearance

Record the date that about 20% of the trees in the plots being observed for the treatment have begun to fruit and the length of the majority of fruit is greater than 1 cm.

Mature Fruit appearance

Record the date that fruit has matured on about 50% of the trees that have fruit in the plots being observed for each treatment.

Form S Tree Damage Observations

As with phenology information this field form is designed for observing individual plots and making a general statement about the condition of thee genotypes at first and the individual treatments later. On visits to the site for general observations, check the plots by treatment to determine whether there are any problems with the trees and note overall appearance of the trees.

Date

Enter the date that the observation is being made.

Treatment

Enter the number of the treatment that is being observed.

When making notes on the general tree health, observe all plots in each treatment (4 plots for each of the 18 treatments in most cases for this experiment) and note whether there are differences between the plots for reporting.

General Health

1. If trees are growing well in the treatment, with no evidence of limitation from pests, competing vegetation or environmental factors, general health would be coded as 1.

2. If the treatment shows less than optimum growth, if leaves are discolored or shoot growth is limited in any way but the overall health of the trees is good, code the general health as 2 and record the apparent cause of any problems. Describe the problem in the note section and indicate the % of damage of leaves and stems in comparison to optimal growth.

3. If growth is limited significantly by some factor, but the trees in the treatment being observed are growing and there are some healthy leaves, code the general health as 3 and note probable cause of the problem. Indicate extent of damage by % of leaf area affected or % of stem damaged in the notes field, and describe the problem.

4. If the treatment is not showing growth or if leaves are in very poor condition code the treatment health as 4 and note the cause and % damage of leave and stems.

Form T Irrigation

Amount

Any water added to the system other than precipitation which is recorded in daily weather measurements should be recorded here. Irrigation measurements should be done every time irrigation is done. In order to use this information in data analysis, the irrigation should be uniform in all plots of all replications, or it should be measured separately in each replication.

Method

Record the type of irrigation that is used. And describe the process i.e. time of day, duration, uniformity.

Form U Log of Experiment Operations

Date

Enter the date that a management operation is done on the trials.

Management Operation

Management Operation includes anything done to the trials that may influence growth of the trees. If weeding is done, record the type of weeding that is done and describe the size of the weeds, whether they were incorporated into the soil, whether they were removed and how the weeding was done, eg. cutting or tilling.

When one of the management treatments is done, use the remarks field to list any comments on the process.

Appendix A

Participants in 1987 Humid/Sub-humid Zone Network Trials

This appendix contains information about the cooperators in the F/FRED 1987 Humid/Sub-humid Zone Trials.

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Appendix B

Identification Code Information for F/FRED Information and Decision Support System

Identification Codes (IDs)-F/FRED Experiment Database: Network ID is preassigned.

Experiment ID (Main menu)

A preassigned two-letter institution ID, plus a two-digit trial number assigned by the principal investigator. Two or more principal investigators at the same institution should coordinate to assure unique trial numbers.

If institution ID is not included in master list of institution IDs in the Users Manual, assign a two-letter institution ID.

Site ID (Form C)

A site name (first five letters as it is commonly referred to) plus a unique two-digit site number assigned by the PI. A site ID ha a single pedon ID and each pedon ID can be assigned to only one site.

Village ID (Form D)

First seven letters of the village used in the Village and Farm Forestry Database. Otherwise, use the nearest village.

Climate Station ID (Form E)

First seven letters of the nearest representative, and usually national, meteorological station with at least seven years of precipitation and maximum and minimum temperature data.

Soil Pedon ID (Form F) is preassigned.

Tree Species ID (Form K) is preassigned.

Daily Weather Station ID (Form L-1)

First three letters of weather station name, usually the first three letters of the site name, plus a unique two-digit daily weather station number assigned by the principal investigator.

If the long-term climate station (Form E) is at the trial location and is utilized for the daily weather data during the experiment, the daily weather station ID should be the climate station ID. The daily weather station should be identical for two experiments using the same weather station. If the weather station is relocated within the same general area for a second experiment and one or more of the daily weather variables are believed to be sufficiently different to affect tree growth, a new two-digit daily weather station number should be assigned.

Appendix C

Glossary of Terms

Treatment - A generic term used in comparative trials to describe the effect of a procedure (agent or intervention). Treatments can be physical as with cutting managements or definitional with species or planting dates. Each type of treatment is commonly called a treatment factor.

Treatment Design - A structural arrangement of treatments. A single-factor treatment design will normally have two or more categorical states e.g., species or management packages, or three to five quantitative levels e.g., rates of fertilizer or planting density. The number of treatments is the number of categorical states or the number of quantitative levels.

A two-factor treatment design is a factorial arrangement of treatments where the number of possible treatments is the product of the number of levels (or states) for each of the two factors. Each treatment is a factorial combination of one level of one factor with one level of one factor with one level of the second factor. For example, treatment one may be the combination of species A and a pruning management.

Experimental Design - A set of rules for allocating (assigning) treatments to the plots. When all replications of each treatment are assigned to the plots completely at random (no restriction) the design is called <u>completely randomized design.</u>

When the plots are arranged in subgroups or <u>blocks</u> so that the variability among plots within a block is minimized and the randomization is restricted so that each treatment occurs in each block, the experimental design is called a <u>randomized complete block design</u> (RCBD). When each treatment is replicated once in each block, the number of blocks is equal to the number of replications (the most common RCBD).

An <u>augmented block design</u> is a RCBD with additional nonreplicated treatments in each block.

Randomization or Randomized Experiments. A specification of assigning treatments to the plots so that each treatment is equally likely to be assigned to a plot.

Plot, field - a specified land area which is associated with a treatment.

Trial or Experiment - a set of plots with one or more treatments. A demonstration plot is commonly associatted with one relatively large plot on a farmer's field with one treatment.

A comparative trial is a set of plots with two or more treatments, whereas a replicated trial is a set of plots with each treatment replicated at least twice.

Replication - repetition of plots with the same treatment.

Network of trials - A series of experiments with identical or similar treatment designs.

Branch - In this experiment, a branch is defined as a woody appendage originating from a stem that is not part of the main axis of the stem. If a stem divides into two parts with equal diameter, criteria such as straightness along the main axis of the stem and height should be used to distinguish between branch and stem.

Control - The control in an experiment is a treatment that has no intervention. In this experiment, it refers to those plots of trees in each block that have no management regime. There will be six control plots (3 species 2 genotypes of each) for this experiment.

Coppice - A cutting treatment where entire tree is severed at its base (10cm for research purposes) and allowed to sprout. Sprouts are generally selectively thinned and managed as individual stems.

Dry weight - weight of a sample after it has been dried at 60-80°C until there is no change in its weight.

Factor - treatment factors are species (3), genotypes of each of the species (2) and management regime (3) in this experiment.

Foliage - Foliage is leaf material from the base of the petiole to include the petiole (leaf stalk) and all leaflets but not woody material (twigs).

Genotype - 1. An individual's hereditary constitution. 2. Individuals characterized by a certain genetic constitution.

Management - There are three management regimes for this experiment. Control, or no intervention, pollarding at one meter and pruning.

Pedon - The smallest three dimensional sample that is large enough so that the nature of its horizons can be studied and the range of its properties identified and thus be called a soil.

Phenotype - The result of a genotype interacting with the environment. The organism as it has developed in a specific location.

Plot - The smallest experimental land unit associated with a treatment in a replicated comparative experiment. In the case of these trials, it is 49 trees undergoing one treatment factor.

Pollarding - A cutting treatment, like copicing done at various heights above the base where the entire stem is evered and allowed to resprout. Coppicing is designed primarily to obtain 1-4 sprouts, depending on end use and species, that will eventually become quality stems, whereas pollarding is generally a treatment for managing branch and canopy characteristics. For this experiment, pollarding will be done at one meter.

Provenance - The place in which a stand of trees is growing. The stand may be indigenous or non-indigenous.

Prune - Selective removal of portions of the crown for obtaining preharvest products and improving stem quality to produce higher value products at harvest.

Seed Lot - This refers to a specific collection of seeds at a particular time and place. Each lot of seed collected is usually numbered for reference.

Seed Origin - For indigenous trees, seed collected from them have origin where the trees are growing. For non-indigenous trees, seed origin would be the place from which the trees are indigenous.

Site - For this experiment, site is the experimental plot area with one soil type (classified at the soil family level of soil taxonomy).

Sprout - In this experiment, sprout refers to a stem or branch that originates from a stem that has been coppiced or pollarded. A sprout is also a stem that originates from a root.

Stem - That part of the tree which constitutes a major woody axis of a tree originating at or near (less than 50cm) ground level. A tree may be multi-stemmed. If an axis diameter of the tree originating below 50cm is 70% or more of the principal stem diameter, it is considered a stem.

Trial - The experiment at a unique site. One of the experiments making up the research network trials.

Twig - Small woody material, not listinguished from branches for this experiment.

Wet Weight - Fresh weight or green weight.