Protocol for the Lincoln University Experiment to Study Effects of Trees on Soils

D J Mead
Department of Plant Science
Lincoln University
Canterbury
New Zealand

Introduction

Following the workshop, a design protocol was formulated to establish a long-term trial at Lincoln University. The anticipated establishment date is 1997. Preliminary research has begun on the litter quality of nine tree species as a method of screening species to be included in the trial. This screening technique was suggested at the workshop.

Comments on this protocol are welcome.

Experimental Aims

The overall aim is to evaluate how different tree species alter soil properties with time, in order to provide a benchmark on long-term biological sustainability of trees used in afforestation.

Specific Objectives

1. To determine the extent to which tree species alter soil properties in a sub-humid, temperate environment.
2. To identify and quantify the processes involved in these changes.
3. To determine if the changes vary with rainfall and soil properties.
4. In the longer term, to develop predictive tools to describe the biological sustainability of different tree species.

Overall Design

The overall concept is of a large experiment close to Lincoln University in which intensive process studies will be undertaken, along with a series of smaller step-out trials to provide gradients in rainfall and soils. All these trials will be at about the same latitude. It is hoped that other agencies will establish complementary trials elsewhere in New Zealand, so that the data may be pooled for the developing models (Objective 4).

The proposed design of the Lincoln experiment is described in detail here. The smaller step-out trials will be established within 3 years of the main trial. They will consist of only three contrasting species selected from those in the trial at Lincoln.

Site

The Lincoln trial will be on a deep, well-drained, fertile silt loam soil located on one of the university's research farms. This type of soil is required in order to facilitate studies of soil processes and rooting habits. The climate at Lincoln University is described as sub-humid and sub-temperate, with rainfall averaging about 660 mm per annum.

Experimental Design

The experiment will have five tree species plus a grazed ryegrass/clover pasture control, as main plot treatments, replicated four times. Blocking, if any, will be determined after a detailed survey of the site. The experimental treatments will be randomised.

Each of the main plots (with trees) will be subdivided into two subplots, one of which will have no understorey. This will allow the effect of the tree species to be separated from the understorey effect.

The tree species used in the trial will be selected based on:

- litter quality
- growth habit (deciduous/non-deciduous/N fixer/rooting pattern etc)
- likely importance in future afforestation.

Radiata pine will be used as one of the species.

Plot Layout

Initial tree spacing of 2.5 x 2.5 m (1600 stems/ha), but this could vary with the species selected.

MAIN PLOT

Gross size 70 x 70 m (0.49 ha).

Surround width (four rows of trees) of 10 m.

SUBPLOTS

Net size 0.1 ha or 8 rows of 20 trees per row (20 x 50 m).

Understorey buffer area between subplots will be 10 m (four rows of trees).

Total area required for experiment is about 13.5 ha allowing for shelter plantings and tracks. The shape of these subplots allows flexibility for further subdivision although there would be plot size implications to consider.

Silviculture

Optimum establishment practices will be used for the trees, to ensure high survival and initial growth rates. However, they will not be given fertiliser additions at any time.

The trees will eventually be thinned down to a final crop stocking of about 300 stems/ha. This will leave 30 trees in each measure-ment subplot. Both thinning and pruning will follow good management practices for the species.

The understorey will be controlled in one subplot treatment; in the other, it will be allowed to develop naturally, except for normal establishment weeding practices. The understorey will not be grazed.

Measurements

Prior to planting the selected site will have a detailed soil survey and aerial photographs will be taken at different seasons in order to detect any underlying site fluctuations.

After plot layout, but prior to tree planting, detailed soil samples will be collected and analysed for basic properties, and a large sub-sample will be archived for future use. At the same time, metal reference pegs will be driven

into the ground and their locations mapped. Additional soil samples will be taken close to each peg; these will be archived.

Detailed descriptions of the soil, the vegetation and the soil meso and micro fauna will be recorded at this time also.

A climate station will be established in the open, adjacent to the site, and will record basic climatic measurements including soil and air temperature, relative humidity, solar radiation, rainfall, and wind speed and direction.

Trees will be measured annually in the first 9 years, initially for height and then for height and breast height diameter and leaf area. Subsequently, these measurements may be made at 3-year intervals. Measurements will be taken if thinning or pruning is to occur outside this 3-year cycle.

Aerial photographs will be taken each winter and summer. Understorey changes will be recorded or undertaken on the same cycle as tree measurements.

At a minimum further soil sampling will be taken on a 3-year cycle. At the time of thinning, above and below ground biomass studies will be made of both trees and understorey.

In addition to these basic measurements, detailed process studies will be encouraged within trial. The timing of these will depend on resources available.