Establishing the Planting Layout of Mixed-Species and Variable Spacing Trials

Introduction

The Mixed-Species and Variable Spacing are the two field trials that will be established in Goroka in 2016. The objectives of these trials, methods of establishment and the species that will be used are discussed in Briefing Notes 1 and 2, dated 3 January and 22 January 2016, respectively. This briefing note is a supplement to Briefing Notes 1 and 2 and focuses on the methods of delineating the experiment blocks and plots, and establishing the planting layout. Establishment of the experiment layout includes locating and marking the planting points.

Materials

The following are materials necessary for delineating the planting blocks, establishing the experiment plots, and locating and marking the planting points:

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Specification</th>
<th>Quantity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveyor’s tape</td>
<td>100 m long</td>
<td>2 pcs</td>
<td>Measuring blocks, plots, and planting distance</td>
</tr>
<tr>
<td>Rope</td>
<td>75 m long</td>
<td>2 pcs</td>
<td>Marking plot boundaries</td>
</tr>
<tr>
<td></td>
<td>31 m long (calibrated; see page 8)</td>
<td>3 pcs</td>
<td>Identifying planting points in Variable Spacing Trial; strong enough to reduce change of length to minimum when stretched from both ends</td>
</tr>
<tr>
<td>Compass</td>
<td>Prismatic or surveyor</td>
<td>1 pc</td>
<td>Measuring direction and angle, ensuring square-shaped blocks</td>
</tr>
<tr>
<td>Stakes</td>
<td>1 m long, about 10 cm diameter</td>
<td>18 pcs</td>
<td>Marking the corners of the plots and center of the blocks; can be longer than 1 m depending on the height of grasses</td>
</tr>
<tr>
<td></td>
<td>50 cm long</td>
<td>800 pcs</td>
<td>Marking the planting points; 400 stakes are needed for each of the two field trials</td>
</tr>
<tr>
<td>Spray paint</td>
<td>4 colours</td>
<td>2 cans for each color</td>
<td>Marking the stakes corresponding to each species in the mixed-species trial</td>
</tr>
<tr>
<td>or Ribbon</td>
<td>4 colours</td>
<td>2 rolls of each color</td>
<td>Marking the stakes corresponding to each species in the mixed-species trial</td>
</tr>
<tr>
<td>Marking pens</td>
<td>Permanent marker</td>
<td>3 pcs</td>
<td>Bold tip with black ink</td>
</tr>
</tbody>
</table>

Methods

Identifying the site for the field trials

Warea has identified the field trial site. Necessary legal arrangements for the use of the land are being undertaken. A panoramic view of the site (Figure 1) shows that it is appropriate for the proposed field trials. The site is open grassland and presumably degraded with relatively homogenous terrain – a typical site for forest restoration. It is adjacent to the road, which is essential, considering that the field trials will also be used as demonstration sites and field-learning facilities for the PNG Forest Authority.
Identifying and delineating experiment blocks

Two blocks of 70 m x 70 m will be established corresponding to the two field trials. As indicated in Briefing Notes 1 and 2, each trial requires two blocks of 60m x 60m. However, 70m x 70 m dimension will be delineated to provide space for constructing the perimeter fence. Ideally the land should be flat, but if this is not possible, the team will select a land area with slope and aspect that is not too irregular to cause a significant error in the results. Figure 2 illustrates the dimension of the blocks and relative position of the perimeter fence. The fence can be connected on two sides if the blocks are adjacent to each other.

Figure 1. The proposed site of the variable spacing and mixed-species trials

Figure 2. Illustration of the blocks showing the relative position of the perimeter fence

In delineating the blocks, the following process is suggested:

1. Establish a straight 60 m line using the 100 m tape. Designate this as Side 1.

2. Using the compass, measure a 90-degree angle left or right from Side 1, depending on where the experiment block will be oriented. Establish another 60 m line following the 90-degree angle from Side 1. Consider this as Side 2.
3. From Side 2, repeat the procedure to establish Side 3.

4. From Side 3, repeat the same procedure to establish Side 4. The four lines will comprise the four sides of the experiment block.

5. Adjust lines by moving up or down, left or right, when the end of Side 4 will not meet the start of Side 1. Remember not to reduce or increase the length of the lines (i.e. 60 m) when moving the line. Only shift the position, do not alter the length.

6. Once the lines are fixed, mark the corners with stakes, driven into the ground such that they can be easily seen but not easily removed. Mark the top 5 cm of the stakes with coloured ribbons or spray paint for easy identification. Do not remove the tapes until the following step is completed.

7. For the block designated for the Variable Spacing trial, measure 30 m from zero end of Side 1 using the tape and mark it with a stake. This is the center point of Side 1. On the opposite side of the block (Side 3), measure another 30 m and mark with a stake. This is the center point of the Side 3. Connect the two opposite stakes of Sides 1 and 3 using the tape and mark the 30 m distance. This is the tentative center point of the block (C1). Repeat the process on the remaining Side 2 and Side 4 of the block. Connect the 30 m marks of Side 2 and Side 4 and locate the 30 m mark (C2) on the tape after connecting the opposite stakes of Sides 2 and 4. This should coincide with C1. Once C1 and C2 coincide, mark the point of intersection with a stake. This is the center of the block, which will serve as the common corner of plots 1, 2, 3 and 4.

8. Measure an additional 5 m from each corner of the block and mark with stakes. These stakes mark the corner of the perimeter fence lines.

*Establishing the field trial layout*
A. Mixed-species trial

The experiment layout of the mixed-species trial is illustrated in Figure 3. The symbols correspond to the four species that will be planted.

![Figure 3. The planting design for the mixed-species trial (for now, ignore the shaded polygons)](image)

Planting points will be established using a surveyor’s tape. Each planting spot will be marked with a stake (50 cm long or appropriate length that can be seen above the grass level) for easy identification. In establishing the planting points, the method is suggested below:

1. Extend the two 100 m tapes on two adjacent sides of the previously established four sides of the experiment block. Be sure to set the zero end of the tape on the stake used to mark the corner of the block and the opposite stake hitting the 60 m mark on the tape.
2. Put stakes (50 cm long) every 3 m distance along the length of the tape on both lines up to the 57 m mark of the tape (i.e. 0, 3m, 6m, 9m, . . .57m). From the zero end (i.e. the corner stake) up to the 57 m mark should have 20 stakes corresponding to the 20 planting spots along the established lines. Ignore the last row corresponding to the 60 m mark on the tape. The illustration below shows the distribution of the planting points and the length of the two adjacent sides of the experiment block.
3. Remove the two 100-m tapes after the stakes are placed to mark the planting points of the first two sides of the experiment block and repeat the same procedure on the remaining two sides of the block - i.e. Sides 3 and 4.

4. Once the planting points on the four sides of the block are established, use the two 75-m long ropes to locate the boundary of the four plots inside the experiment block. From one corner of the block, locate stake number 10 on Side 1 and Side 3, be sure to count the reference corner as stake number 1 and count in the same direction - i.e. either to go to the left or right, just be consistent. Connect these planting points on opposite sides using the rope. Repeat the process for sides 2 and 4. Again, count in the same direction on both sides. Once the ropes are laid to connect the planting points on opposite sides, the boundaries of the four plots are established (see red line in the illustration below. The blue lines are imaginary, marking the edge rows of the planting points of the other three plots.
5. Once the four plots are established, use the two 50-m tapes to locate the planting points on the two sides of each plot (designated by red and blue lines). Lay the tapes following the previously extended ropes and put stakes every 3-m distance on remaining two sides of each of the four plots until reaching plant number 10.

6. Once the planting points of the four sides of each plot are established, using the 50-m tapes, simply connect planting points on opposite sides of each plot and mark the planting points on every 3 m distance.

7. When all planting points have stakes, mark the corners of each plot (plots 1, 2, 3 and 4) with coloured ribbons or spray paint for easy identification. Also, mark stakes with coloured ribbons or spray paint to correspond with the four species to be planted.

B. Variable spacing trial

The experiment layout of the variable spacing trial is illustrated in Figure 4. The symbols correspond to the four species that will be planted. The size of the experiment block is 60m x 60m. The block is divided into four plots of uniform size. Each plot will be planted with a single species. The seedlings will be planted with the following distances (in meters) from the center of the block: 1 (0.3), 2 (1.10), 3 (2.20), 4 (3.60), 5 (5.60), 6 (8.20), 7 (11.60), 8 (16.10), 9 (21.90) and 10 (29.40).
The following suggests the method to establish the planting layout.

1. After completing Step 7 on page 3, use the two 75-m ropes to connect the 30 m marks on Sides 1 and 3, and Sides 2 and 4. In doing so, the intersection of the two ropes will indicate the center of the experiment block (See illustration in Step 7, page 3)
2. Calibrate the three 31-m long ropes to show the variable spacing of seedlings when planted. In calibrating, lay the rope on the ground next to an extended surveyor’s tape. Mark the zero end of the rope using a bright-colored ribbon. Be sure to leave about 15 cm before placing the zero mark for holding or attaching the rope to stakes when establishing the planting lines. To prevent the ribbon from moving, the rope can be twisted in the opposite direction to how it is constructed to make an opening in between strands. Alternatively, a nail can be used to open the strands (Figure 5). Insert the ribbon into the opening, tie it tightly and twist back the rope to return it to its original structure. The planting distance the ribbon corresponds with can be written on the ribbon for easy identification. The ribbon should stay in place once it is tied and held by the rope strands. The zero end will be the reference in measuring the variable planting distances.

Figure 4. The planting design for the mixed-species trial

Khaya senegalensis ○
Agathis robusta +
Acacia mangium X
Eucalyptus grandis □
3. After marking the zero point on the rope, repeat the process in measuring the following distances (in meter) from the zero mark: 0.30, 1.10, 2.20, 3.60, 5.60, 8.20, 11.60, 16.10, 21.90, and 29.40 (Figure 6). Each number corresponds to the distance to the center of the block that each of the 10 seedlings for each line will be planted at. Hence, it is highly important to precisely locate the center of the block.

4. After calibrating the three 31-m ropes, tie the zero end of two calibrated ropes to the stake marking the center of the block. Tie the other end of the ropes to the stakes indicating the 30-m mark of adjacent sides of the experiment block (e.g. Side 1 and Side 2). Put stakes (50 cm long) on the ground to mark each spot of the ropes with ribbons. This should establish ten stakes (with distances corresponding to the planting distances marked in the rope) on both sides of the plot (Figure 7).
5. Remove the two calibrated ropes. Tie the zero end of one rope to the last stake (the 29.40 m mark) of one of the two lines established in Step 4. Do the same using the other rope on the last stake of the other line. Connect both ends (marked 29.40) of the two ropes to form a 90-degree angle. As in Step 4, put stakes on points indicated by the ribbons on the two ropes. The stakes established in Step 4 together with the stakes in Step 5 should mark the planting points on all sides of the first experiment plot (Figure 8).

**Figure 8.** Illustration of four sides of the first plot with planting points indicated by the ribbons attached on the ropes
6. To mark all planting points inside the plot, remove one of the ropes and tie the zero end to the stake (marked 0.30 m) next to the stake marking the center of the block. Tie the other end to the stake on the other side that is exactly opposite to the stake where the zero end of the rope is attached. This stake also marks the 0.30 m point on the opposite side. Put stakes on all spots indicated by the ribbons on the rope. Repeat the process until all planting points are marked (Figure 9).

**Figure 9.** Illustration showing connections of planting points on opposite sides of the plot
7. Once the first plot is completed, repeat the process to establish the planting points in the remaining three plots (see Figure 9).

8. After establishing the planting points in all four plots, remove the stakes along the center line (i.e. on the line connecting the stake marking the center of the block and the 30 m mark on Sides 1, 2, 3 and 4 of the experiment block). These stakes are not designating planting points but the reference in establishing the planting points in all of the plots.

9. Do not remove the stakes that mark the corners of the blocks, those that mark the 30 m point on each side of the experiment block, and the one indicating the center of the block. Mark these stakes with spray paint or a ribbon for easy identification.